INTERNATIONAL ENERGY AGENCY

# Energy Policies of IEA Countries



## 2005 Review

OECD

## INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six of the OECD's thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

The IEA member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission takes part in the work of the IEA.

## ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

# FOREWORD

Reviewing the energy policies of member countries is a central activity of the International Energy Agency. For this purpose, the policies of individual member countries are periodically reviewed in depth by their peers. In intervening years, brief standard reviews update the main energy policy developments. These regular reviews have contributed substantially over the years to policy-making at the national level. In addition to the above country-specific reviews, a comprehensive overview of the energy-related developments across the countries that focuses on certain key themes is also essential for sound policy-making. The purpose of *Energy Policies of the IEA Countries*, the annual compendium, is to provide comprehensive information on these two fronts, namely, country-specific analysis and cross-country analysis on key themes.

The Overview Part focuses on recent developments in the energy market and energy policies. It examines trends in energy markets, including an analysis of energy demand, energy supply, energy prices and energy-related $CO_2$ emissions. It also highlights key policy trends across member countries on energy security, energy market reform, climate change mitigation, energy efficiency, renewable energies and energy R&D. Notable developments in major non-member countries, including major findings of the *World Energy Outlook 2005 – Middle East and North Africa Insights* are also presented.

The years 2004-2005 can be characterised by important energy policy challenges, including high energy prices, volatile energy markets, an activation of the IEA's co-ordinated stock draw after hurricane Katrina and coming into force of the Kyoto Protocol. The 2005 edition contains a chapter on "2005 IEA Ministerial Meeting and G8 Gleneagles Summit", where energy security, climate change and clean energy future were intensively addressed. The new chapter, "Cross-Country Overview – Good Practices", as a follow-up of the "In-depth Reviews in the Past Four Years" in the 2004 edition, for the first time, presents good practices in addressing common energy policy challenges from the in-depth reviews carried out over the past four years, covering all 26 countries. In this chapter, the IEA not only describes challenges but – as requested by its Ministers – also offers solutions, for both member and non-member countries.

This book contains summaries of the reviews of Australia, the Czech Republic, Luxembourg, Norway, Spain and Turkey conducted from October 2004 to June 2005. Shorter standard reviews are also covering six other member countries: Finland, Hungary, Ireland, Italy, Japan and Switzerland. Key statistical information is also included.

**Claude Mandil**
**Executive Director**

# ACKNOWLEDGEMENTS

Much of the information in this report is drawn from in-depth reviews conducted by representatives of IEA member countries and members of the IEA Secretariat. The information contained in this publication is the best available as of September 2005 and is subject to change. The desk officer listed in each team was responsible for managing the review and was principal author of the report, which has also been published in a separate volume and appears in summary form here. The desk officers also wrote the shorter standard reviews included here.

Jun Arima, Head of the Country Studies Division, supervised preparations for this book and wrote the sections of Cross-Country Overview – Good Practices (Chapter 3) and Market Trends (Chapter 4). Noé van Hulst, the Director of the Office of Long-Term Co-operation and Policy Analysis, provided support and encouragement throughout the project. Many members of the IEA staff contributed to this book. Major contributions came from Lawrence Eagles, Jeff Brown, David Fyfe, Harry Tchilinguirian (oil), Dan Simmons, Sylvie Cornot Gandolphe (natural gas), Brian Ricketts (coal), Ian Cronshaw, Doug Cooke, Ulrik Stridbaek (electricity), Kristine Kuolt, Jason Elliott (emergency response), Dunia Chalabi (producer-consumer dialogue), Julia Reinaud (climate change), Alan Meier, Paul Waide (energy efficiency), Peter Tulej (renewables), Mitsuhide Hoshino, Fridjof Unander (R&D), Jeffrey Logan (China), Dagmar Graczyk (India), Brett Jacobs (South-East Asia), Augusto Ruiz-Abensur (Latin America), Isabel Murray (Russia), Meredydd Evans (Ukraine), Emmanuel Bergasse (Central and South-Eastern Europe), Chirstof Van Agt (Caspian and Central Asia) and Fatih Birol (Middle East and North Africa). Karen Treanton and Ana Belen Padilla prepared Key Statistics and Indicators, Monica Petit prepared the figures and Marilyn Ferris provided administrative assistance for the project.


## 2004–2005 IN-DEPTH REVIEWS

### Australia

*Team Leader:* Bo Diczfalusy (Sweden). *Team Members:* Vidar Christensen (Norway), Philippe Geiger (France), Masahide Kokubun (Japan), Noé van Hulst (IEA), Rick Bradley (IEA), Sylvie Cornot (IEA), Mitsuhide Hoshino (IEA), Jonathan Coony (IEA).

### Belgium

Although the in-depth review for Belgium was conducted in the 2004-2005 review cycle, the timing of its publication meant that the summary and conclusions were unable to appear in this volume.

*Team Leader:* Erik Johnsen (Norway). *Team Members:* Cecilia Kellberg (Sweden), Antti Paananen (Finland), Helen Donoghue (EC), Robert-Rush Price (OECD), Daniel Simmons (IEA), Jun Arima (IEA), Jolanka Fisher (IEA).

### Czech Republic

*Team Leader:* Loraine Dawson (United Kingdom). *Team Members:* Marc Deprez (Belgium), Mats Nilsson (Sweden), Sonya Kumar (Australia), Jean-Claude Schwartz (EC), Pál Kovács (OECD NEA), Jun Arima (IEA), Jonathan Coony (IEA).

### Luxembourg

Although the in-depth review for Luxembourg was conducted in the 2003-2004 review cycle, the timing of its publication meant that the summary and conclusions were unable to appear in *Energy Policies of IEA Countries – 2004 Review*.

*Team Leader:* Marc Deprez (Belgium). *Team Members:* Helen Donoghue (EC), Thomas Levander (Sweden), Jun Arima (IEA), Pierre Audinet (IEA).

### Norway

*Team Leader:* Aad van Bohemen (Netherlands). *Team Members:* Hans-Christoph Pape (Germany), Carolyn Barton (Australia), Kim Smith (Canada), Noé van Hulst (IEA), Doug Cooke (IEA), Andreas Biermann (IEA).

### Spain

*Team Leader:* Martin Renggli (Switzerland). *Team Members:* David Molho (France), Uwe Schröder-Selbach (Germany), Manfred Decker (EC), Timo Haapalehto (NEA), Ulrik Stridbaek (IEA), Jun Arima (IEA), Andreas Biermann (IEA).

### Turkey

*Team Leader:* Hartmut Schneider (Germany). *Team Members:* Philippe Guillard (France), Päivi Janka (Finland), Kohei Miwa (Japan), Bob Pegler (Australia), Jun Arima (IEA), Nicolas Lefèvre-Marton (IEA), Lea Gynther (IEA).

## STANDARD REVIEWS

*Finland:* Jonathan Coony; *Hungary:* Andreas Biermann; *Ireland:* Jonathan Coony; *Italy:* Jolanka Fisher; *Japan:* Andreas Biermann; *Switzerland:* Jolanka Fisher.

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# OVERVIEW OF ENERGY POLICY AND MARKET DEVELOPMENTS

# EXECUTIVE SUMMARY

## 2005 IEA MINISTERIAL MEETING

When Energy Ministers convened in Paris to discuss key energy issues on 2-3 May 2005, it was in a climate of uncertainty in the energy sector, with tight energy markets, growing reliance on a few suppliers in gas markets and reliability issues in the electricity sector. Among the issues debated by the Ministers were curbing energy import dependence, lowering economic vulnerability to high and volatile energy prices, including through increased energy efficiency measures, and reducing the environmental impact of the world's growing reliance on fossil fuels.

Throughout the meeting, Ministers repeatedly identified a number of policy priorities and several fundamental themes emerged. There was strong endorsement of the Agency's mission on emergency response function, objective market analysis and work in energy security, the latter defined to include gas and possibly other fuels and electricity. But broader energy issues must also be addressed. Solutions must focus not only on the supply side, but also on demand, with increased assessments of the medium term. Technology will play a critical role. All of these elements were well reflected in the Ministerial Communiqué. In particular, Ministers provided guidance for greater focus in the Agency's future activities, as follows: improved transparency and analysis of energy markets; deeper engagement with non-member countries; the pursuit of energy efficiency, particularly in the transport and building sectors; research, development and uptake of cleaner combustion technologies and carbon dioxide capture and storage; encouraging an improved investment environment to meet the challenges of future energy demand; and further work on economic growth and $CO_2$ reduction.

## G8 GLENEAGLES SUMMIT

Climate change, promoting clean energy and achieving sustainable development, all of which were the major focus in the 2005 IEA Ministerial, were also major issues in the G8 Gleneagles Summit on 7-8 July 2005. In its Communiqué, the G8 emphasised the need for working together in partnership with major emerging economies to find ways to achieve substantial reductions in greenhouse gas emissions and promote low-emitting energy systems. The investment needs of USD 16 trillion over the next 25 years were regarded as opportunities for cost-effective investment in cleaner technologies and energy efficiency. The G8 declared that it will take further action under the Gleneagles Plan of Action to *i)* promote innovation, energy efficiency and conservation, improve policy, regulatory and financing frameworks, and accelerate the deployment of cleaner technologies, particularly lower-emitting technologies; *ii)* work with developing countries to enhance private investment and transfer of technologies, taking into account their own energy needs and priorities; and *iii)* raise awareness of climate change and other multiple challenges, and the means of dealing with them; and make available the information which businesses and consumers need to make better use of energy and reduce emissions. They also agreed to take forward a Dialogue on Climate Change, Clean Energy and Sustainable Development to encourage global concerted efforts, and invited other interested countries, in particular Brazil, China, India, Mexico and South Africa, to participate.

The G8 invited the IEA to contribute to this global effort through an extensive programme of analysis, assessment, and dissemination to promote the energy efficiency of buildings, appliances, vehicles and industry as well as clean coal and other fossil power technology, carbon capture and storage, renewable energy, hydrogen, and international energy R&D. The proposals from the G8 are all in line with the instructions from the IEA Ministers, reinforce their messages and will give added impetus to the delivery of the mission of the IEA. The IEA has accordingly put forward a detailed programme of work for the implementation of its role in the G8 Plan of Action for consideration by its 26 member countries.

Another major energy issue at the Summit was high and volatile oil prices. The G8 agreed that secure, reliable and affordable energy sources are fundamental to economic development and recognised the critical role of energy efficiency, technology and innovation. They also encouraged oil-producing countries to take all the necessary steps to foster a favourable investment climate sufficient to support strong global economic growth. In this context, the important role of producer-consumer dialogue in the International Energy Forum (IEF) was underlined. Emphasis was put on the reduction of market volatility through more comprehensive, transparent and timely data, the Joint Oil Data Initiative (JODI) managed by the Secretariat of the IEF was welcomed, and all countries were urged to contribute to its success.

## CROSS-COUNTRY OVERVIEW – GOOD PRACTICES

As a follow-up to its "In-depth Reviews in the Past Four Years – Cross-Country Overview" in the Compendium 2004 where, for the first time, the Secretariat tried to identify common challenges in the fields of general energy policy, energy and environment, energy efficiency, renewables, energy market reform, security of supply, nuclear and energy R&D, in the Compendium 2005 the Secretariat presents "Cross-Country Overview – Good Practices" covering over a hundred good practices in various countries that address each of the common challenges mentioned above. The bulk of good practices have been picked up from in-depth reviews over the last four years and from other information sources. This meets one of the most crucial objectives of the Country Studies, namely, sharing good practices among member countries, which was also highlighted in the 2005 IEA Ministerial Meeting.

Of course, each member country develops its energy policy depending on its specific national circumstances and therefore "good practice" in one country may not necessarily be applicable to all countries. However, it would be a useful point of departure for member countries to learn from other countries' positive experiences as a source of inspiration for their own policy development. It should be borne in mind that any list of good practices is not exclusive.

While the reviewed countries are making considerable efforts and progress in implementing energy policies in line with IEA Shared Goals, the challenges which member country energy policy-makers have to address are becoming increasingly complex. When the IEA was established in 1974, the primary mission of energy policy-makers was to mitigate the damage from any future oil supply shock. However, in response to the changes in energy markets and in the world surrounding them, the mission of energy policy-makers has expanded from oil supply security to broader energy security, including other forms of energy such as natural gas and electricity. Furthermore, this needs to be compatible with other energy policy objectives, namely, the pursuit of greater economic efficiency in the energy sector and the mitigation of the environmental consequences of energy production and use. Neither of these was recognised as a primary energy policy objective in 1974. Achieving all of these objectives simultaneously is a daunting task. While market reforms should, in principle, reinforce energy security, this depends on the design of reforms and incentives for investors. Actions to reduce greenhouse gas (GHG) emissions could have profound implications on energy markets and energy security.

In pursuing energy policies, it is becoming increasingly important to ensure public awareness and visibility of the national energy situation and future challenges. This is particularly crucial in addressing climate change issues where the general public is responsible for the rapid increase of GHG emissions in the residential/commercial and transport sectors and in overcoming not-in-my-back-yard (NIMBY) phenomenon to energy-related investments, which is indispensable for future energy security. The cross-sectoral nature of energy policy challenges requires stronger co-operation among relevant ministries and between central/local governments.

Ensuring cost-effectiveness in addressing GHG emissions reduction targets is a challenge that all countries face. However, assessing the cost-effectiveness of policies and measures does not yet form an integral part of the decision-making process in most countries. Such assessments should lead to the re-evaluation of the current priority of policy mix, if necessary. Emphasis should be placed on market-based instruments. Some policies promoting renewable energies are instrumental, but tend to be costly to the economy. Energy efficiency improvements in residential/commercial sectors and the transport sector are often lagging behind.

Although energy markets are undergoing liberalisation in all countries, this does not automatically lead to effective competition. For example, the strong market power of incumbents is a big obstacle in many countries. Expanding market size through regional integration is one viable solution. A strong and independent energy regulator, effective unbundling and non-discriminatory access to facilities are also essential.

Unlike the period when governments managed the energy sector, the governments' role in liberalised electricity and gas markets is to define the right framework for market players so that markets can deliver reliable supplies and ensure that market players follow the rules. To fulfil massive investment needs in the coming decades, governments should monitor investment needs, and if markets fail to generate the necessary investment on their own, they should provide additional market incentives. At the same time, care should be taken that any direct intervention by government does not decrease the economic efficiency of the system as a whole.

The preceding discussion shows that energy policy-makers in member countries are facing complex challenges. Good practices presented are examples of how member countries are trying to address these challenges. The value of the peer review process could further increase in the face of such difficulties and complexities. Policy-makers could use this process to overcome domestic bottlenecks to implement more effective policies, and could benefit not only from information exchange with other member countries but also from the learning opportunities to be gained from both successful and unsuccessful practices experienced in other countries.

## MARKET TRENDS

Energy markets in 2004-2005 can be characterised by significantly higher energy prices. Average crude oil prices for 2004 were about USD 12/bbl higher than in 2003. For the first three quarters of 2005, crude oil prices were on average 35-40 % higher than in 2004. In August 2005, crude oil prices peaked at USD 69.91/bbl for West Texas Intermediate, USD 67.33/bbl for Brent and USD 55.45/bbl for Dubai. The key drivers behind the rise in crude oil prices were the strong demand for light products and the emerging capacity constraints in the supply chain both in the upstream and the downstream. Strong growth in the US and China were the leading contributors to world oil demand. The years 2004-2005 turned out to be a "demand shock" with world oil product demand growing significantly above the historical long-term trend. Spare capacity in the oil complex tightened rapidly, putting upward pressure on prices. More stringent product specifications amplified such trends. The oil market became "product-driven" where the increase in product prices, due to strong demand, led to increases in crude oil prices. The tighter situation in terms of oil supply and demand fundamentals also made the market more sensitive to geopolitical risks and weather-related uncertainties – notably hurricane Ivan at the end of 2004 and hurricane Katrina in August 2005.

Spot prices at the US benchmark Henry Hub increased by 80% from an average of USD 3.33/million British thermal units (MBtu) in 2002 to USD 6.09/MBtu in 2004. In the first three quarters of 2005, the average price was USD 7.80/MBtu. A peak of USD 8.12/MBtu in October 2004 was eclipsed in September 2005 with spot prices of USD 14.84/MBtu in the aftermath of hurricanes Katrina and Rita. In the EU, average gas import prices by pipeline increased by 36% from USD 3.20/MBtu in 2003 to USD 4.34/MBtu in 2004 and upward to USD 4.83/MBtu in the first quarter of 2005. Although European gas import prices are linked to the price of oil products (with a six- to nine-month time lag), US Henry Hub prices are starting to influence LNG-importing countries who rely on spot contracts such as Spain, due to increased trans-Atlantic arbitrage. Japanese buyers index the price of LNG supply to the Japanese crude cocktail (JCC) with a cap resulting from the introduction of "S" curve mechanism in the indexation formulae. LNG import prices have therefore risen steadily with oil prices in the past few years, from USD 4.32/MBtu in 2002 to USD 4.82/MBtu in 2003, and then USD 5.23/MBtu in 2004. The average price for the first three quarters of 2005 has been USD 5.66/MBtu.

The total OECD steam coal import cost for the fourth quarter of 2004 was 54.5% higher than the previous year due to finely balanced Pacific and Atlantic markets with continued strong pricing. The increase was greatest in Japan which saw a rise of 60.6%, followed by EU-15 with 48.9%, and the USA with 29.7%. In the Pacific steam coal market, spot prices rose due to a variety of factors, most notably soaring Chinese coal imports owing to strong domestic demand, logistical bottlenecks for the domestic transportation of coal, and mine closures for safety reasons. The European market was also tight with stronger than expected demand, and production from South Africa, Colombia and Venezuela was insufficient to match steady demand growth in the Atlantic market.

## ENERGY SECURITY

Recent developments in the energy market and the geopolitical arena, such as rapid growth in demand, diminishing spare oil production capacity and surging oil prices (as well as rising gas and coal prices), have pushed energy security back to the top of the policy agenda in many countries. The terrorist threat, combined with political instability and conflict in key producing regions such as the Middle East, have highlighted the danger of becoming overly reliant on oil imports. At the same time, the rapid growth in trade in natural gas, power failures in North America and several European countries, and incidents at nuclear reactors have reminded us that other forms of energy are not immune to security concerns. This serves to underline the central role that governments have to play in ensuring reliable supplies and investment. Long-term energy trends suggest that these concerns will become more urgent and will call for stronger policy responses on the part of IEA member countries and the rest of the world.

Measures to address short-term supply emergencies or price shocks will have to be improved. Relations with energy suppliers will also need to be strengthened. Governments will have to look anew at ways of diversifying their fuels, as well as the geographic sources of those fuels and mode of transport (pipelines, ships, etc.). But, now and in the future, stronger demand-side policies are essential to reduce energy use through conservation and improved efficiency. Governments will also need to devise new, cost-effective approaches to securing reliable gas and electricity supplies within a competitive market framework. In particular, they will need to lower regulatory and market barriers and ensure that the investment climate is sufficiently attractive within a stable and transparent market framework. Worldwide, NIMBY resistance to energy-related investments is increasing.

## IEA'S COLLECTIVE ACTION TO THE HURRICANE KATRINA OIL SUPPLY DISRUPTION

On 2 September 2005, the IEA Executive Director announced that all 26 IEA member countries would take collective action in response to the interrupted oil supplies in the Gulf of Mexico caused by hurricane Katrina. The IEA member and candidate countries plus the European Commission unanimously supported this action to make available to the market 60 million barrels of oil, or an average of 2 million barrels per day (2 mb/d) for an initial period of 30 days. The IEA also consulted with major producers and the President of the Organization of the Petroleum Exporting Countries (OPEC) who had also committed to make incremental oil available to the market. This was only the second time in its history that the IEA co-ordinated a stock release. All of these illustrated the flexibility and well-preparedness of the IEA in handling an international energy crisis. By end October 2005, approximately 54 million barrels would have been made accessible to the markets through IEA member countries' emergency stocks and through increased indigenous oil production.

## TRANSMISSION SYSTEM RELIABILITY

Substantial electricity supply disruptions involving a failure of generation plant and transmission services affected a number of IEA countries in North America, Europe and Australia during the latter half of 2003 and 2004. A common feature of these supply failures was the collapse of transmission networks over large areas. Supply disruptions of this magnitude clearly demonstrate the fundamental importance of networks to the efficient and secure operation of electricity markets and highlight the vulnerability of electricity markets to network failures. In response to these issues, the IEA undertook a project to examine network performance and reliability, including two workshops in 2004. Common lessons from the blackout case studies can be summarised as the 3Ts: Tools, for system operators to monitor and assess a wide area and to evaluate actions; Training, to improve system operators' capacity to manage increasingly complex network environments in real time; and Trees, effective vegetation management to minimise the risk of tree flashover. Where different system operators work in a common integrated region, jointly prepared and agreed protocols for co-ordinated action in the event of disruption, consistency of rules for system security across jurisdiction, and rapid and unambiguous communication between and among system operators are essential in reducing the potential for cascading failures in the future.

A sound, consistent (or at the very least harmonised) stable regulatory framework across a given network is essential if efficient network operation and investment are to be maintained, consistent with contemporary reliability standards. Ideally, a single system operator seems to offer considerable advantages. In the presence of multiple jurisdictions, achieving these objectives will be difficult, but some regions have managed to construct such entities, with improved outcomes. Co-operative bodies of system operators in a given region may prove helpful in advancing this evolution and improving co-ordination and communication. Structural separation and independence of system or transmission operators from other players are also a common feature of more successful systems. A clear legal basis for all parties' roles and responsibilities also appears essential if high levels of system security in contemporary markets are to be achieved. The recent blackouts have provided a timely warning that modern economies are heavily dependent on reliable electricity supplies. It is incumbent on governments to examine fully the causes of, and proposed remedies for, these supply interruptions, and ensure, in co-operation with industry (and particularly transmission system operators) and regulators, that all appropriate and cost-effective measures have been implemented to improve reliability of supply.

## PRODUCER-CONSUMER DIALOGUE

The IEA has long valued its involvement in the Producer-Consumer Dialogue and sees this as an essential part of its outreach activity. Interaction takes place at different levels. At the 9th International Energy Forum (IEF), which was held in Amsterdam in May 2004, Ministers stressed their support for the newly established International Energy Forum Secretariat (IEFS). The IEF emphasised its commitment to the JODI exercise with the IEF Secretariat as well as to other activities linked to the development and promotion of the Initiative. Producer-consumer interaction is also undertaken through various forums, including the IEA-sponsored biennial Energy Experts Meetings. The IEA has so far hosted eight such energy experts meetings, bringing together representatives from government, international organisations, academia and industry. Workshops involving both the IEA and OPEC Secretariats have moreover become a regular feature and are in the process of establishing themselves as necessary "reality checks" for respective member countries. So far, three workshops have taken place with a fourth scheduled for 2006, dedicated to demand issues.

## ENERGY MARKET REFORM

Electricity market reform has advanced at a slow but steady pace in many IEA member countries throughout 2004-2005. IEA member countries are in various stages of reform. With their relatively long track record of robust performance, the first pioneer markets have now demonstrated their viability and positive contribution to efficiency. No markets are perfect and they are continuously developing to improve and to meet new needs and challenges. During the past year, since the last Compendium, electricity market reform has taken important steps forward in some markets and countries. In general, market reform has continued to develop in a slow evolutionary process drawing from experiences and under increasing pressure from various stakeholders such as consumer groups. The IEA will publish a report drawing on the lessons learnt during the first ten years of liberalisation in some of the pioneer markets. In general, liberalisation of electricity markets has delivered significant long-term benefits for consumers. Price reflecting the inherent volatility of electricity is a key feature in liberalised electricity markets. Liberalisation is a lengthy and demanding process rather than an event. It requires strong and committed government involvement, although the role of government becomes fundamentally different in a liberalised market. There are limited but important aspects of generating, transporting and consuming electricity that markets will fail to address appropriately. These failures must be identified and carefully addressed through specific policies.

In the gas industry, several market trends have developed and strengthened across OECD regions in 2004-2005, including the continued building of gas-fired power stations, the emergence of a nascent Atlantic market in LNG, and consistently high prices of gas in all regions. Increasing dependence on natural gas imports in Europe, North America and other regions will heighten concerns over gas supply security. Europe, for example, where market reform is further proceeding, is highly import-dependent on two main sources, Russia and Algeria. The expected expansion of international LNG trade could alleviate some of the risks of long-distance supply chains. The United States experienced continuously high prices for natural gas in 2004 along with increased price volatility, although there were almost no changes in the status of natural gas industry restructuring from 2003 to 2004, except that two states stopped considering the option of unbundling. The tight gas market inspired greater interest in LNG imports. More than 50 applications have been filed with the Federal Energy Regulatory Commission (FERC) to build new gas import terminals. This has created tension between the federal government and the states on the siting of regasification terminals. In Europe, the European Commission sent final warning letters in May 2005 to ten countries that had not implemented the second EU Gas Directive. This resulted in some positive developments, such as a new energy act in Germany in July 2005. Meanwhile, in 2004 the UK became a net importer of gas after 20 years as a net exporter, causing an unprecedented level of import investments. In Asia-Pacific, IEA countries are beginning to see the effects of the globalisation of the LNG industry on their domestic gas markets, with spot cargoes now making up a small but significant share of gas supply into the region.

## CLIMATE CHANGE

2004 marked the ratification of the Kyoto Protocol by Russia, and thus its entry into force on 16 February 2005. The Protocol sets binding targets for developed countries to reduce greenhouse gas emissions by an average 5.2% below 1990 levels. With its entry into force, Kyoto's emission targets become binding legal commitments for those industrialised countries that have ratified it. The Kyoto Protocol was designed as a first step. The challenge now is to forge an international framework that engages all major emitting countries in an effective long-term effort. At the tenth annual Conference of the Parties in December 2004 in Buenos Aires, parties to the UN Framework Convention on Climate Change (UNFCCC) prepared for the imminent entry into force of the Kyoto Protocol, and agreed to convene a "Seminar of Government Experts" in May 2005 to provide an opening for discussing possible future efforts but that explicitly "does not open any negotiations leading to new commitments." In parallel, during 2004, the main climate change policy developments included the debut of the European Emissions Trading Scheme, the announcement of Climate Plans (*e.g.* France, the Czech Republic, Portugal, etc.), and the launching of carbon funds (*e.g.* Japan and Denmark).

In July 2005, at the Gleneagles Summit the G8 countries pledged to introduce innovative measures to achieve substantial reductions in greenhouse gas emissions and promote low-emitting energy systems. This pledge was supported by five major non-G8 countries: Brazil, China, India, Mexico and South Africa. Also in July 2005, the United States, China, India, Japan, Korea and Australia announced the Asia-Pacific Partnership on Clean Development to promote the development and deployment of existing cleaner, more efficient technologies and practices. The partnership will be consistent with and contribute to the efforts under the UNFCCC and will complement, but not replace, the Kyoto Protocol.

## ENERGY EFFICIENCY

High oil prices, concerns regarding global climate change and energy security have greatly raised the profile of energy efficiency in most IEA member country governments. These concerns have already been translated into new efficiency policies in some countries while others are laying the groundwork for new or strengthened policies. Governments have a wide range of tools available to encourage energy conservation and efficiency, including adjusting energy prices, establishing financial instruments to encourage the use of efficient products and practices, mandating minimum efficiency levels, creating voluntary programmes, and rationing energy. In 2004-2005, IEA member countries employed all of these tools (except rationing) to promote energy efficiency. At the May 2005 IEA Ministerial, there was strong consensus among IEA member countries on the need to strengthen energy efficiency policies, and renewed attention to demand-side policies featured strongly in the communiqué. In June 2005 the European Commission published a green paper on energy efficiency that establishes an objective of saving 20% of EU energy demand through increased deployment of cost-effective energy efficiency measures. The recent G8 Summit repeatedly stressed the need for policies to increase efficiency and its "Plan of Action" underscored this concern by specifically mentioning several areas where increased efficiency needs to take place, including buildings, transportation and appliances. The President of the United States has also spoken this year about the importance of energy efficiency in energy policy.

## RENEWABLE ENERGY

Fluctuations in oil prices and uncertainty of supply, the ratification of the Kyoto Protocol, and last but not least, the rapid technical and economic evolution of many renewable energy technologies, all point to a cautiously optimistic future for renewable energy. Renewable energy shows great potential for contributing to the solution of some of today's energy security and environmental challenges, but more attention must be paid to what is really happening with renewable energy policies and markets, with particular consideration given to cost-effectiveness. The key element in securing the role of renewables in the energy mix is the accelerated technological advancement and cost reduction of all renewable energy technologies, combined with novel applications and deployment in the context of distributed generation, global production, and trading of fuels, as well as the bulk transmission of renewables-generated electricity.

The IEA Secretariat continued collaborative efforts with the Renewable Energy Implementing Agreements to define the targeted RD&D for renewables. The IEA prepared a questionnaire and set up a process of information exchange. Preliminary conclusions can be drawn as to the major technological developments and related policy issues. There has been significant progress in the area of renewable energy technologies. The cost of energy delivered from renewable sources has dropped dramatically through technological development and market feedback. The current cost of generating electricity is comparable with conventional forms of energy in the case of hydro, many forms of bioenergy and geothermal, and in niche markets for many other technologies. The physical and technical potential of all these technologies ranges from very large to unlimited, although there are of course geographic influences on the choice of option and technology. More funds should be put towards sound RD&D ideas. Assistance is needed in expediting major projects for mature renewable energy technologies and in adopting new technologies in the appropriate sectors of the economy (energy generation and transmission, buildings). To obtain the full environmental and sustainable benefits of renewable energy, stable and predictable funding for technology and industry development is essential for the proper planning and development of expertise. Successful policies for the commercialisation of emerging renewable energy technologies include capital assistance, premium prices for green energy generated, tax incentives, and mandated quotas, among others. There is overall agreement that more effort towards achieving cost-effectiveness is the most important issue.

At the International Conference for Renewable Energies in Bonn in June 2004, six IEA member countries announced their intention to work towards establishing a Renewable Energy Technology Deployment Implementing Agreement in order to *i)* elaborate and present options for "best practice" policy measures and mechanisms for cost reduction; *ii)* elaborate and present options for innovative business strategies and projects that encourage renewable energy technology deployment to public and private sector stakeholders; and *iii)* disseminate information and enhance knowledge about renewable technology deployment. To date, eight countries, Canada, Denmark, France, Germany, Ireland, Italy, the Netherlands and Norway, have committed themselves to become Contracting Parties of the Implementing Agreement for Renewable Energy Technology Deployment.

## ENERGY R&D

$CO_2$ capture and storage (CCS) from fossil fuel combustion is a promising emissions reduction option with potentially important environmental, economic and energy supply security benefits. National R&D programmes on CCS are being pursued by Australia, Canada, Germany, Japan, Norway, the United Kingdom, the United States and other countries. International R&D programmes include the activities of the European Union, IEA activities – *e.g.* the IEA Working Party on Fossil Fuels (WPFF), the IEA Greenhouse Gas R&D Programme (the IEA Implementing Agreement) – and the Carbon Sequestration Leadership Forum (CSLF).

Hydrogen and fuel cells are emerging as high-potential options to ensure a $CO_2$-free, secure energy future. Driven by recent technical advances and the increasing needs for diversified and sustainable technologies, OECD governments such as Australia, Canada, Germany, Japan and the United States have recently intensified their R&D efforts on hydrogen and fuel cells. These governmental R&D efforts are complemented by international activities, including three major international co-operation initiatives, namely the IEA Hydrogen Co-ordination Group (IEA-HCG), the International Partnership on Hydrogen Economy (IPHE) and the European Hydrogen and Fuel Cell Technology Platform (TP).

As stated in the *World Energy Outlook* (WEO-2004), achieving a truly sustainable future energy system will call for technology breakthroughs that radically alter how we produce and use energy. However, the fact that the linkage between basic sciences and energy technologies could help bring about these breakthroughs is less known. For this purpose, the Ad Hoc Group on Science and Energy Technologies (AHGSET) was established under the Committee of Energy Research and Technology (CERT) in March 2004. One of the most important activities of AHGSET is to organise workshops to bring key stakeholders together in areas of mutual interest. Two workshops on specific topics (*i.e.* the German-sponsored workshop on computational approach and the French-sponsored workshop on methodology) have taken place so far. The US-sponsored comprehensive conference is scheduled to take place in the USA in November 2005.

## ENERGY POLICIES IN NON-MEMBER COUNTRIES

There have been various developments in major non-OECD economies in terms of energy security, energy market reform and environmental protection. This book contains a short introduction to such developments in China, India, South-East Asia, Latin America, Russia, Ukraine, the Caspian region and Central and South-Eastern Europe (Chapter 11). The key findings of the *World Energy Outlook 2005 – Middle East and North Africa Insights (WEO-2005)* are also included.

In ***China,*** rapid economic growth continued to intensify strains on the Chinese energy sector in 2004 and early 2005. The energy sector continues to suffer from weak government co-ordination and planning. While a new energy task force was created in 2005 with the goal of better integrating energy policy, which is a step in the right direction, creating a new Chinese energy ministry may be necessary to make energy reliable, sustainable and affordable in the future. Oil demand grew explosively by 35% in 2004, accounting for 32% of the incremental growth in global oil demand that year. However, oil demand in the first half of 2005 has grown only half as quickly as it did in 2004. China has committed to the construction of its strategic petroleum reserves. Total coverage, after completion of the four depots which are reportedly under construction, is estimated at 35 days of imports or 100 million tonnes. The electricity sector continues to operate at a shortage. Needed reforms in the power sector continue to take a back seat to measures to address shortages. The decision in late 2004 to allow coal price changes to be reflected in electricity tariffs was a positive development to address distortions in the electricity sector. The Energy Bureau has moved quickly to encourage the building of new plants with about 50 GW capacity in 2004 and even more in 2005. There is a growing concern that China could experience overcapacity by 2007 or 2008, depending on several factors, including the pace of economic growth. The natural gas sector continues to attract considerable attention. Actions that support the government's new attention to gas include the completion of the 3 900-km-long East-West pipeline, the construction of two LNG import terminals, detailed discussions and feasibility studies to import natural gas from Russia's Kovytka field in 2008, and the acceleration of other smaller domestic and offshore pipelines to bring gas to urban areas. Coal production increased by nearly 16% in 2004 after exhibiting similar growth in 2003. China is also giving greater attention to renewable energy. A new law on renewable energy was issued in early 2005 to promote investments in small hydro, wind power and photovoltaics. There is growing talk in China of introducing more significant energy taxes to provide greater incentives for clean energy and demand-side energy management.

In ***India,*** energy security is increasingly seen as a national priority and in July 2005, the Prime Minister announced the set-up of an "Energy Co-ordination Committee" (ECC) in July 2005 to formulate a co-ordinated policy response that cuts across ministries in order to improve the overall energy scenario while addressing energy security concerns. The creation of the ECC and its wide-ranging responsibilities could be the first step towards the creation of an energy ministry, although there is no official announcement in this regard. The government is also moving ahead with its plans for the creation of strategic oil stocks. The Indian Strategic Petroleum Reserves Limited (ISPRL) was created in June 2004. Since the enactment of the Electricity Act 2003, the government has undertaken follow-up actions. These include the notification of the guidelines for competitive bidding and the National Electricity Policy outlining the objectives in the power sector, including provision of electricity to all households by 2012. A draft Tariff Policy has also been circulated for discussion, pending cabinet level approval during 2005. The national policies on stand-alone systems for rural areas and non-conventional energy systems and for local distribution systems in rural areas have been drafted and discussed. Spurred by unexpected massive power shortages in the western state, efforts to settle an international dispute over the abandoned Dabhol power station intensified during the first half of 2005, paving the way for a quick restart of power operations and for completion of the construction of the LNG terminal. Developments in the petroleum and natural gas sectors kept the fast pace which they gathered since 2004. Although the petroleum and gas sectors are of crucial importance to India's energy security, no substantial progress has been made in sector restructuring. The government has not yet announced whether it will implement the recommendations of the committee set up in early 2005 to analyse options for sector restructuring. The draft "Petroleum and Natural Gas Regulatory Bill" is still pending and the draft "Policy for Development of Natural Gas Pipeline Networks" is being discussed without any target date for approval. India's potential and its commitment to developing its non-conventional energy sources are considerable. The government aims to electrify 18 000 remote villages through non-conventional technologies by 2007. It is also pursuing a large programme for alternative fuels/biofuel for transport with a target of mandatory ethanol blend of 20% by 2010. A compressed natural gas (CNG) programme for vehicles has been implemented very successfully in New Delhi and Mumbai since 1998. The programme is now being expanded to several other cities.

In ***Russia,*** the Yukos situation has focused attention on troubling signs within the Russian government and its energy sector during the year 2004, reflected in a trend of expanding state-control over a substantial part of the country's oil reserves and production. This comes at a time when Russia is facing major decisions and requires major investment in its upstream oil and gas sector and in its electricity sector. With the Yukos case and the State's tightening grip on production and exports, after the *laissez-faire* privatisation of the early 1990s, there is reason for concern that investments will not keep pace with the exploration and production challenges ahead. The fiscal and regulatory systems are still unclear and cannot attract the needed investment levels. It is obvious that growing European imports of Russian oil and gas are counter-balanced by Russian reliance on oil and gas revenues. The only way forward for an energy-secure future for both Russia and OECD Europe is through meaningful market reform and real competition across Eurasian markets. The incident in Belarus in 2004 where Gazprom shut off gas to force negotiations to increase its control in the transit joint venture and similar actions in other countries demonstrates the risk of doing business with an unregulated monopolist. These concerns are more relevant with EU enlargement in May 2004, given the dominant position of Gazprom in some of the new EU countries – both in terms of a gas supplier and its increasing hold of the downstream gas sectors. On a brighter note, the Russian government embarked on a highly ambitious programme of electricity reform moving into its active phase in the second quarter of 2003. The government's commitment to the electricity reform process in late 2004 reflects the recognition that attracting timely investment will remain a substantial challenge. The government's recognition that tariff rebalancing and the removal of cross-subsidies is a necessary precondition for successful market reforms is reassuring. In its publication in 2005, the IEA commended the government's plan to gradually raise regulated end-user tariffs to levels consistent with the prices through the competitive wholesale and retail market. Russia ratified the Kyoto Protocol at the end of 2004 and the Protocol subsequently entered into force in February 2005.

The ***Middle East*** and ***North Africa (MENA)'***s vast oil and gas resources are critical to meeting the world's growing future energy needs; but questions are being raised as to whether the energy production from this key region will increase sufficiently to satisfy global demand. The greater part of the world's remaining reserves lie in the MENA region. They are relatively under-exploited and are sufficient to meet rising global demand for the next quarter century and beyond. The export revenues they would generate would help sustain the region's economic development. But there is considerable uncertainty about the pace at which investment in the region's upstream industry will occur, how quickly production capacity will expand and, given rising domestic energy needs, how much of the expected increase in supply will be available for export. The implications for both MENA producer and consuming countries are profound. The *World Energy Outlook 2005 – Middle East and North Africa Insights (WEO-2005)* sheds light on this issue.

Global energy needs are likely to continue to grow steadily for at least the next two-and-a-half decades. If governments stick with current policies – the underlying premise of the Reference Scenario – the world's energy needs would be more than 50% higher in 2030 than today. Over 60% of that increase would be in the form of oil and natural gas. MENA's share of global oil and gas output would grow substantially, as long as MENA countries invest enough in energy production and transportation infrastructure. But the global trends in the Reference Scenario would raise several serious concerns. Climate-destabilising carbon dioxide emissions would continue to rise, calling into question the long-term sustainability of the global energy system. And the sharply increased dependence of consuming regions on imports from a small number of MENA countries would exacerbate worries about the security of energy supply.

More vigorous government policies in consuming countries could, and no doubt *will,* steer the world onto a different energy path. The leaders of the G8 and several large developing countries, meeting at Gleneagles in July 2005, acknowledged as much when they called for stronger action to combat rising consumption of fossil fuels and related greenhouse gas emissions. Most OECD governments have declared their intention to do more and other countries around the world can be expected to follow suit. Such policies are all the more likely to be implemented if energy prices remain high.

Consuming country policies could curb demand growth and reduce the world's reliance on MENA oil and gas. A World Alternative Policy Scenario demonstrates that if governments around the world were to implement the new policies they are considering today, aimed at addressing environmental and energy security concerns, fossil fuel demand and carbon dioxide emissions would be significantly lower. But even in this scenario, global energy demand in 2030 would still be 37% higher than today and the volume of MENA hydrocarbon exports would still grow significantly. Far more radical policy action and technology breakthroughs would be needed to reverse these trends.

A critical uncertainty is whether the substantial investments needed in the upstream hydrocarbons sector in MENA countries will, in fact, be forthcoming. In a Deferred Investment Scenario, much lower MENA oil production drives up the international price of oil and, with it, the price of gas. Higher energy prices, together with slower economic growth, would choke off energy demand in all regions and would, therefore, reduce demand for oil and gas compared with the Reference Scenario. MENA exports, nonetheless, continue to grow. Current market instability and the recent surge in oil prices demonstrate the vital importance of adequate investment in upstream and downstream capacity and the threat posed by surging global demand. The prospects for MENA's role in global energy supply developments have far-reaching implications for the global economy. The governments of producing and consuming countries alike have a mutual interest in addressing the concerns highlighted in *WEO-2005.*

# 2005 IEA MINISTERIAL AND G8 GLENEAGLES SUMMIT

## 2005 IEA MINISTERIAL MEETING

### BACKGROUND

On 2–3 May 2005, Energy Ministers from the 26 member countries of the International Energy Agency, the European Community, IEA candidate countries Poland and the Slovak Republic, convened in Paris to discuss key energy issues. Mexico and China attended a part of the sessions. Ministers also joined OECD Finance and Economy Ministers at a working lunch to address the challenge of ensuring adequate investment in the energy sector. While the last IEA Ministerial meeting was held in April 2003 only weeks after the beginning of military action in Iraq, this year a greater sense of urgency seemed to draw more Ministers to the table. The result was a franker exchange of views, broader expression of members' priorities and a clear call for a more proactive and prescriptive IEA.

Ministers face many challenges. During the past two years, geopolitics have aggravated tightness in energy markets, putting further pressure on prices. Concerns about supply – underscored by capacity constraints and infrastructure issues – have increased due to low surplus production capacity in the oil sector, growing reliance on a few suppliers in gas markets, and reliability issues in the electricity sector, which came to a head during the summer of 2003 when blackouts hit many IEA member countries. In short, the energy sector has been beset by uncertainty.

The world's current trajectory, portrayed in the *IEA World Energy Outlook* Reference Scenario, is not sustainable. Some of the issues debated by the Ministers included:

- How to respond to the geographic shift of energy production and the tools for achieving energy savings.
- How to engage non-OECD economies in combating climate change, securing energy supply and gaining greater access to modern energy services.
- How to manage market liberalisation while ensuring reliability.
- How to support and accelerate technology research, development and uptake.

- How to overcome public resistance to new investments in energy infrastructure.
- And last but not least, how to ensure adequate investment across the energy sector.

## A CALL TO ACTION

During the meeting, Ministers repeatedly raised a number of policy priorities and several fundamental themes emerged. There was strong endorsement of the Agency's mission on emergency response function, objective market analysis and work in energy security, the latter defined to include gas and possibly other fuels and electricity. But broader energy issues must also be addressed. Solutions must focus not only on the supply side, but also on demand, with increased assessments of the medium term. Technology will play a critical role. All of these elements were well reflected in the Ministerial Communiqué.

The Ministerial Communiqué provides guidance for greater focus for the Agency's future activities (see paragraph 15 of the following Communiqué):

*"Ministers stressed the important role of the IEA in meeting energy security and sustainability challenges, emphasising the importance of demonstrating clear and measurable outcomes in this regard. To further enhance the effectiveness of the IEA, Ministers agreed to prioritise the IEA work programme, with a focus on:*

- *improved transparency and analysis of energy markets;*
- *improved engagement with key non-member countries;*
- *the pursuit of energy efficiency, particularly in the transport and building sectors;*
- *research and development of cleaner combustion technologies and carbon dioxide capture and storage;*
- *encouraging an improved investment environment to meet the challenges of future energy demand, much of which will occur in the developing world; and*
- *further work on economic growth and $CO_2$ reduction."*

Ministers not only discussed the substantive focus of IEA work, but also the way in which it is conducted and presented. Many felt that the Agency could be more proactive in its approach. This sentiment is evident in the final paragraph (paragraph 16) of the Communiqué:

*"In order to bridge the gap between what is happening and what needs to be done, IEA will help to develop strategies aiming at a clean, clever and competitive energy future. This needs leadership and co-operation."*

# COMMUNIQUE
# INTERNATIONAL ENERGY AGENCY

### Meeting of the Governing Board at Ministerial Level
### 2-3 May 2005

## Key Messages

We can and will achieve a sustainable and secure energy future through stronger actions now to:

- curb our growing energy import dependence as world reserves narrow to fewer sources;
- lessen our economic vulnerability to high and volatile energy prices, including through increased energy efficiency measures; and
- reduce the environmental impact of the world's growing reliance on fossil fuels.

## Energy Security

1. Energy security remains our core mission, particularly in oil, gas and electricity. Our vision of energy security is greater global availability of reliable, affordable, clean energy. Persistent high energy prices are a significant concern for us, as they are a drag on economic activity and growth, and penalise the poor. We remain resolute in our commitment to act together to ensure adequate supply in times of market disruption.

2. Speculation is a concern in oil markets, but it is not the underlying cause of volatility and high prices. Energy markets require both timely investment and sufficient stocks to absorb unpredicted yet inevitable surprises. Price subsidies distort markets and barriers to investment impose capacity restraints. Today's prices demand actions to stimulate and diversify energy supply and curb demand.

3. Our deepening dialogue with oil producing and major consuming countries has proven critical to promoting market stability and we welcome efforts by producers to increase supplies to meet growing demand. We are particularly pleased to be joined today by Minister Elizondo of Mexico, a major oil producer and member of OECD. In cooperation with producers and building on the example of the Joint Oil Data Initiative, we will seek higher standards for transparency in oil markets through better data.

4. A challenge confronting producers and consumers alike is the need to strengthen the flow of capital to the energy sector. IEA estimates that USD 16 trillion in investment will be needed in the energy sector by 2030. However, we are witnessing underinvestment in power generation and transmission as well as up and down stream along the oil and gas value chains. We reaffirm our conviction that market forces must guide the shaping of these competitive markets as governments remove impediments to investment.
5. We commit to creating a more stable and transparent framework to ensure adequate and timely investment. We call upon governments worldwide to adopt this commitment as their own. We recognise that private sector investors face different risks in reforming markets and that they will require new mechanisms to manage risk and induce the needed flow of capital.

## Global Energy Markets

6. We welcome the participation of Vice Minister Zhang Xiaoqiang from the People's Republic of China. China's rapid economic growth means greater economic welfare for its 1.3 billion citizens. However, fuelling that growth in China and the rest of the world will be a major challenge. We will reinforce our effort to share our experiences and best practices worldwide to help us all embark upon a more sustainable energy path. Our relations with China exemplify the importance of such dialogue with other major energy producers and consumers worldwide. We applaud China's determination to build strategic oil stocks.
7. We welcome the participation of Minister Piechota from Poland and Vice Minister Pomothy from the Slovak Republic and recognise the considerable progress made by Poland and the Slovak Republic in meeting the conditions of IEA membership. Their membership will also reinforce our collective ability to deploy up to ten million barrels of oil per day during several months in times of severe supply disruption. This remains our most important first line of defence. Adequate strategic and commercial oil stocks are especially important as asymmetry grows between where the world's oil is produced and where it is consumed.

## Cleaner Energy Systems Worldwide

8. In a business-as-usual scenario, IEA projects that 85% of the world's incremental energy needs over the next 25 years will be met by fossil fuels. Global energy demand and carbon emissions both grow 60%. Under this scenario, developing country carbon emissions would

double by 2030, surpassing the OECD, and nearly 1.4 billion people would still have no access to electricity in 2030.

9. But we are not bound to any business-as-usual energy future.

10. IEA's Alternative Scenario shows that by implementing policies we have under review today, we could reduce IEA consumption by 10% and $CO_2$ emissions by 16% by 2030 below the Reference Scenario. End-use efficiency would contribute 60% of this. The rest would be realized by better power generation using clean coal technologies, more gas and renewables and nuclear power in those countries having chosen nuclear power as an option. Yet we can do better.

11. OECD countries' energy efficiency improved even faster between the oil shock of 1973 and 1998. Our collective energy consumption would have been 49% higher absent the efficiency savings over that period. Efficiency gains have slowed since the mid-1980s but stronger policies now can reverse that trend. We commit to reinforcing our efficiency effort and we instruct the IEA to monitor our efforts to do so, including in our peer Country Reviews and in sharing our best practices globally.

12. A sustainable lower carbon future is clearly possible, but only through more rigorous policies, market-based instruments and by engaging the rest of the world. We will do this directly and through existing mechanisms including G8, UNFCCC and elsewhere. This is a shared responsibility.

13. We must extract more from today's technologies and accelerate tomorrow's if the promise of technology is to become reality. We can and will increase the efficient, cleaner use of fossil fuels, even as we identify and deploy cost-effective low or no-carbon fuels. Accelerating energy technologies requires substantial private and public resources. We undertake to do our part to mobilize strong financial and policy support for these essential energy technologies.

14. With the lessons of the past and our vision of the future as guides, we will draw on the power of markets, the promise of technology and our policy resolve, to achieve for ourselves and the world, secure and sustainable energy for future generations.

15. Ministers stressed the important role of the IEA in meeting energy security and sustainability challenges, emphasising the importance of demonstrating clear and measurable outcomes in this regard. To further enhance the effectiveness of the IEA, Ministers agreed to prioritise the IEA work programme, with a focus on:

- improved transparency and analysis of energy markets;
- improved engagement with key non-member countries;

- the pursuit of energy efficiency, particularly in the transport and building sectors;
- research and development of cleaner combustion technologies and carbon dioxide capture and storage;
- encouraging an improved investment environment to meet the challenges of future energy demand, much of which will occur in the developing world; and
- further work on economic growth and $CO_2$ reduction.

16. In order to bridge the gap between what is happening and what needs to be done, IEA will help to develop strategies aiming at a clean, clever and competitive energy future. This needs leadership and co-operation.

In these three lines, the Ministers provide a mandate for a more "forward leaning" role for the IEA. They clearly call for action – a message that could bring sharper focus to the way the IEA carries out its future work.

## G8 GLENEAGLES SUMMIT

### CLIMATE CHANGE, CLEAN ENERGY AND SUSTAINABLE DEVELOPMENT

Climate change, promoting clean energy and achieving sustainable development, all of which were the major focus in the 2005 IEA Ministerial, were also major issues in the G8 Gleneagles Summit on 7-8 July 2005.

In its Communiqué, the G8 identified the following challenges in tackling the above issues:

- Climate change is a serious and long-term challenge that has the potential to affect every part of the globe. Increased need and use of energy from fossil fuels, and other human activities contribute in large part to increases in GHGs associated with global warming. While uncertainties remain in the understanding of climate science, it is necessary to act now to slow, and as the science justifies, stop and then reverse the growth of GHGs.
- Global energy demands are expected to grow by 60% over the next 25 years. This has the potential to cause a significant increase in greenhouse gas emissions associated with climate change.

- Reducing pollution protects public health and ecosystems. This is particularly true in the developing world. There is a need to improve air and water quality in order to alleviate suffering from respiratory disease, reduce public health costs and prolong lives.

- Around 2 billion people lack modern energy services. It is necessary to work with G8 partners to increase access to energy to support achievement of the goals agreed at the Millennium Summit in 2000. Reaffirming their commitment to the UNFCCC and its ultimate objectives to stabilise greenhouse gas concentration in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system, the G8 emphasised the need for working together in partnership with major emerging economies to find ways to achieve substantial reductions in greenhouse gas emissions and promote low-emitting energy systems. The fact that an estimated USD 16 trillion will need to be invested in the world's energy systems over the next 25 years was regarded as an opportunity for cost-effective investment in cleaner technologies and energy efficiency.

With a view to addressing these challenges, the G8 declared that they will take further action under the Gleneagles Plan of Action (see below) to:

- Promote innovation, energy efficiency, conservation, improve policy, regulatory and financing frameworks; and accelerate deployment of cleaner technologies, particularly lower-emitting technologies.

- Work with developing countries to enhance private investment and transfer of technologies, taking into account their own energy needs and priorities.

- Raise awareness of climate change and other multiple challenges, and the means of dealing with them; and make available the information which business and consumers need to make better use of energy and reduce emissions.

They also agreed to take forward a Dialogue on Climate Change, Clean Energy and Sustainable Development to encourage global concerted efforts and invited other interested countries, in particular the non-G8 countries which were present in Gleneagles, namely Brazil, China, India, Mexico and South Africa, to contribute. The purpose of the Dialogue is to:

- Address the strategic challenge of transforming energy systems to create a more secure and sustainable future.

- Monitor implementation of the commitments made in the Gleneagles Plan of Action and explore how to build on this progress.

- Share best practice between participating governments.

The UK will hold meetings to take the Dialogue forward in the second half of 2005, and identify specific implementation plans to carry out each of the commitments under the Plan of Action. Japan will receive a report on the Dialogue at the G8 Summit in 2008.

The G8 has invited the IEA to join this global effort by carrying out an extensive programme of analysis, assessment, and dissemination to promote the energy efficiency of buildings, appliances, vehicles and industry as well as clean coal and other fossil power technology, carbon capture and storage, renewable energy, hydrogen, and international energy R&D. Climate change is high on the agenda of the IEA.

As previously mentioned, at the 2005 Ministerial Meeting,, IEA Ministers asked the Agency to focus its work on a number of key areas. They included the pursuit of energy efficiency, particularly in the transport and building

## GLENEAGLES PLAN OF ACTION CLIMATE CHANGE, CLEAN ENERGY AND SUSTAINABLE DEVELOPMENT

**(Extract)**

1. We will take forward actions in the following key areas:
   - Transforming the way we use energy.
   - Powering a cleaner future.
   - Promoting research and development.
   - Financing the transition to cleaner energy.
   - Managing the impact of climate change.
   - Tackling illegal logging.

### Transforming the Way we Use Energy

2. Improvements to energy efficiency have benefits for economic growth and the environments, as well as co-benefits such as reducing greenhouse gas emissions, preventing pollution, alleviating poverty, improving security of energy supply, competitiveness and improving health and employment.

3. At Evian, we agreed that energy efficiency is a key area for G8 action. And following agreement at the Sea Island Summit in 2004, the 3Rs (Reduce, Reuse, Recycle) initiative was launched in Tokyo this April – an important step towards encouraging more efficient use of resources and materials, which increases economic competitiveness whilst decreasing environmental impacts.

4. We also recognise the importance of raising consumer awareness of the environmental impact of their behaviour and choices, including through international efforts such as the United Nations Decade of Education for Sustainable Development.

## Buildings

5. To promote energy-efficient buildings, we will:
   a) invite the International Energy Agency (IEA) to review existing building standards and codes in developed and developing countries, develop energy indicators to assess efficiency, and identify policy best practices;
   b) encourage the work of existing partnerships such as the Renewable Energy and Energy Efficiency Partnerships in outreach to developing countries;
   c) develop domestic guidelines or standards for procurement and management of public buildings in our respective countries.

## Appliances

6. To encourage co-ordination of international policies on labelling, standard setting and testing procedures for energy efficiency appliances, we will:
   a) promote the application of the IEA's 1 Watt Initiative;
   b) ask the IEA to undertake a study to review existing global appliance standards and codes, building on its existing capacity on energy efficiency in appliances;
   c) extend the use of clear and consistent labelling to raise consumer awareness of energy consumption of appliances;
   d) work nationally and in co-operation with other countries to seek improvements in the efficiency and environmental performance of products in priority sectors;
   e) explore the potential to co-ordinate standards with other countries, building on the examples provided by existing international bodies.

## Surface Transport

7. We will encourage the development of cleaner, more efficient and lower-emitting vehicles, and promote their deployment by:
   a) adopting ambitious policies to encourage sales of such vehicles in our countries, including making use of public procurement as appropriate to accelerate market development;
   b) asking the IEA to review existing standards and codes for vehicle efficiency and identify best practice;
   c) encouraging co-operation on technology research, development and, where relevant, deployment in areas including cleaner gasoline and diesel technologies, biofuels, synthetic fuels, hybrid technology, battery performance and hydrogen-powered fuel cell vehicles;
   d) continuing our discussions on these issues at the United Kingdom's international conference in November on cleaner, more efficient vehicles;
   e) raising consumer awareness of the environmental impact of their vehicle choices, including through clear and consistent labelling for relevant energy consumption, efficiency and exhaust emissions data, and encouraging the provision of clearer information on the results of driving behaviour and choices of mode of transport.

## Aviation

8. We will:
   a) undertake a programme of collaborative work to explore and accelerate the potential for operational advances (including air traffic control and ground operations) that will continue to enhance safety, improve fuel efficiency and reduce emissions in air transport;
   b) work with IPCC to provide, as part of its forthcoming Fourth Assessment Report, an up-to-date assessment of the latest evidence on aviation's impacts on the climate;
   c) support climate science research, aimed at improving our understanding of specific issues such as contrails and cirrus cloud effects, to inform technological and operational responses;.
   d) encourage co-ordination among our existing national research programmes on long-term technology developments with the potential to significantly reduce emissions.

## Industry

9. We will:
   a) work with the multilateral development banks (MDBs) to expand the use of voluntary energy savings assessments as a part of major investments in new or existing projects in energy-intensive sectors;
   b) invite the IEA to develop its work to assess efficiency performance and seek to identify areas where further analysis of energy efficiency measures by industry sector could add value across developed and interested developing countries;
   c) develop partnerships, including sectoral and cross-border partnerships, with industry to reduce the greenhouse gas emissions intensity of the major industrial sectors of our economies;
   d) continue to support the work of the UNFCCC clearing house on technology transfer TT: Clear in disseminating information on available technologies, and co-operate further on sharing information on best practices and national policies to encourage the deployment of energy efficiency technologies.

## Powering a Cleaner Future

10. Reliable and affordable energy supplies are essential for strong economic growth, both in the G8 countries and in the rest of the world. Access to energy is also critical for poverty alleviation: in the developing world, 2 billion people lack access to modern energy services.

11. To respond to the scale of the challenges we face, we need to diversify our energy supply mix, including increased use of renewables. Fossil fuels will continue to be an important part of the global energy mix, and we will need to find ways to manage the associated air pollution and greenhouse gas emissions. We need to capitalise on all the opportunities available to improve the efficiency along the entire process chain, from extraction to energy generation and transmission, and to maximise the large and untapped potential of lower-emitting alternative sources of energy.

12. We take note of the efforts of those G8 countries who will continue to use nuclear energy to develop more advanced technologies that would be safer, more reliable and more resistant to diversion and proliferation.

## Cleaner Fossil Fuels

13. We will support efforts to make electricity generation from coal and other fossil fuels cleaner and more efficient by:
    a) supporting IEA work in major coal-using economies to review, assess and disseminate widely information on the energy efficiency of coal-fired power plants; and to recommend options to make best practice more accessible;
    b) inviting the IEA to carry out a global study of recently constructed plants, building on the work of its Clean Coal Centre, to assess which are the most cost-effective and have the highest efficiencies and lowest emissions, and to disseminate this information widely;
    c) continuing to work with industry and with national and international research programmes and partnerships on projects to demonstrate the potential of advanced fossil fuel technologies including clean coal.

14. We will work to accelerate the development and commercialisation of Carbon Capture and Storage technology by:
    a) endorsing the objective and activities of the Carbon Sequestration Leadership Forum (CSLF), and encouraging the Forum to work with broader civil society and to address the barriers to the public acceptability of CCS technology;
    b) inviting the IEA to work with the CSLF to hold a workshop on short-term opportunities for CCS in the fossil fuel sector, including from Enhanced Oil Recovery and $CO_2$ removal from natural gas production;
    c) inviting the IEA to work with the CSLF to study definitions, costs and scope for capture ready plant and consider economic incentives;
    d) collaborating with key developing countries to research options for geological $CO_2$ storage;
    e) working with industry and with national and international research programmes and partnerships to explore the potential of CCS technologies, including with developing countries.

15. We will encourage the capture of methane, a powerful greenhouse gas by:
    a) supporting the Methane to Markets Partnership and the World Bank Global Gas Flaring Reduction Partnership (GGFR), and encouraging expanded participation;
    b) working bilaterally to support an extension of the World Bank's GGFR Partnership beyond 2006.

## Renewable Energy

16. We will promote the continued development and commercialisation of renewable energy by:
    a) promoting the International Action Programme of the Renewable 2004 Conference in Bonn, starting with a Conference at the end of 2005, hosted by the Chinese government, and supporting the goals of the Renewable Energy Policy Network (REN21);
    b) welcoming the work of interested parties, including in partnerships, to take forward the Johannesburg Plan of Implementation, including the Renewable Energy and Energy Efficiency Partnership (REEEP) and the Mediterranean Renewable Energy Partnership (MEDREP);
    c) working with developing countries to provide capacity-building assistance, develop policy frameworks, undertake research and development, and assess potential for renewable energy, including bioenergy;
    d) launching a Global Bioenergy Partnership to support wider, cost-effective, biomass and biofuel development, particularly in developing countries where biomass use is prevalent following the Rome International Workshop on Bioenergy;
    e) welcoming the establishment and further development of the range of IEA implementing agreements on renewable energy.

## Electricity Grids

17. We will work with the IEA to:
    a) draw together research into the challenges of integrating renewable energy sources into networks and optimising the efficiency of grids and produce a report;
    b) identify and link "Centres of Excellence" to promote research and development in the developed and developing world;
    c) promote workshops during 2006/07 aimed at evaluating and promoting means to overcome technical, regulatory and commercial barriers.

## Promoting Networks for Research and Development

18. We recognise the need for increased commitment to international co-operation in and co-ordination of research and development of energy technologies. We will continue to take forward research, development and diffusion of energy technologies in all the fields identified in the Evian Science and Technology Action Plan.

19. We express our support for research and development of technologies and practices that use hydrogen as an energy carrier. We encourage continued support for the work of the IEA and International Partnership for the Hydrogen Economy (IPHE) to co-ordinate research efforts in this area.

20. We take note of the Energy Research and Innovation Workshop held in Oxford in May 2005, and will:
    a) work with the IEA to:
        - build on the work already underway through its implementing agreements to facilitate co-operation and share energy research findings;
        - reinforce links with the international business community and developing countries;
        - create an inventory of existing collaborative efforts to facilitate exchange on their effectiveness;
    b) raise the profile of existing research networks and encourage broader participation where appropriate; and
    c) seek ways to improve the current arrangements for collaboration between developed and developing countries, and enhance developing country participation in existing networks.

### Financing the Transition to Cleaner Energy

21. Positive investment climates and effective market models are critical to the uptake of new technologies and increase access to energy for economic growth. We recognise that there are a range of tools to support a market-led approach to cleaner technology and energy resources and that each country will select those appropriate to its national circumstances.

22. We will:
    a) support a market-led approach to encouraging energy efficiency and accelerating investment and the deployment of cleaner technologies which will help transition to a low-emission future;
    b) adopt, where appropriate, market-based policy frameworks which:
        - support re-investment in capital stock turnover;
        - remove barriers to direct investment;
        - leverage private capital for clean development;
        - use standards, or use pricing and regulatory signals to provide confidence in the near- and long-term value of investments, so as to reduce emissions of greenhouse gases and/or pollutants.

c) We will promote dialogue on the role, suitability, potential synergies and timing of various policy approaches within the context of each country's national circumstances, including:
   - developing long-term sectoral, national or international policy frameworks including goals;
   - market-based instruments including fiscal or other incentives for the development and deployment of technologies, tradable certificates and trading of credits for reductions of emissions of greenhouse gases or pollutants; and
   - project-based and voluntary offset mechanisms.

23. Those of us who have ratified the Kyoto Protocol will:
   a) work to strengthen and develop the implementation of the market mechanisms (including Joint Implementation, international emissions trading and the Clean Development Mechanism); and
   b) use our best endeavors to ensure that the CDM Executive Board and related institutions to support emissions trading are adequately funded by the end of 2005.

24. We acknowledge the valuable role of the Global Environmental Facility in facilitating co-operation with developing countries on cleaner, more efficient energy systems, including renewable energy, and look forward to a successful replenishment this year, along with the successful conclusion of all outstanding reform commitments from the third replenishment.

25. We will invite the World Bank and other multilateral development banks (MDBs) to increase dialogue with borrowers on energy issues and put forward specific proposals at their annual meetings to:
   a) make the best use of existing resources and financing instruments and develop a framework for energy investment to accelerate the adoption of technologies which enable cleaner, more efficient energy production and use;
   b) explore opportunities within their existing and new lending portfolios to increase the volume of investments made on renewable energy and energy efficiency technologies consistent with the MDBs' core mission of poverty reduction;
   c) work with interested borrower countries with significant energy requirements to identify less greenhouse-gas-intensive growth options which meet their priorities, and ensure that such options are integrated into Country Assistance Strategies;

d) develop local commercial capacity to develop and finance cost-effective projects that promote energy efficiency and low-carbon energy sources.

26. We will continue to work through our bilateral development programmes, in line with our national priorities, to promote more sustainable energy policies worldwide.

27. We will work with Export Credit Agencies with a view to enhancing the economic and financial viability of cleaner and efficient energy projects.

28. We will build on the work in other fora, including the UNFCCC Expert Group on Technology Transfer, to support necessary capacity building, enabling environments and information dissemination.

29. We will also work through multi-stakeholder partnerships to develop the policy, regulatory and financing frameworks needed in the major developing countries to provide a commercially attractive balance of risk and reward to private investors.

sectors, and research and development of cleaner combustion technologies and carbon dioxide capture and storage. Ministers also asked the IEA to "help to develop strategies aiming at a clean, clever and competitive energy future in order to bridge the gap between what is happening and what needs to be done". The proposals from the G8 are all in line with the instructions from IEA Ministers, reinforce their messages and will give added impetus to the delivery of the mission of the IEA. The IEA has accordingly put forward a detailed programme of work for the implementation of its role in the G8 Plan of Action for consideration by its 26 member countries.

## GLOBAL ECONOMY AND OIL

Another major energy issue addressed at the Gleneagles Summit was high and volatile oil prices. The G8 discussed the risks that sustained high energy prices could pose for global economic growth. Noting that oil demand is projected to continue its strong growth and that significant investment will be needed in the short, medium and long term in exploration, production and energy infrastructure to meet future needs, a number of measures were identified to help to ease the tightness of the oil market.

The G8 agreed that secure, reliable and affordable energy sources are fundamental to economic stability and development and recognised the important role that energy conservation and efficiency, technology and innovation can play, as emphasised in the Plan of Action.

They also encouraged oil-producing countries to take all the necessary steps to foster a favourable investment climate sufficient to support strong global economic growth. In particular, oil-producing countries were encouraged to ensure open markets with transparent business practices and stable regulatory frameworks for investment in the oil sector, including increased opportunity for foreign investment. In this context, the important role played by the dialogue between oil-producing countries and oil-consuming countries in the International Energy Forum (IEF) was emphasised. It was also agreed to consider measures to encourage the expansion of refinery capacity.

The need for concrete action to reduce market volatility through more comprehensive, transparent and timely data was emphasised. A factor exacerbating uncertainty is the lack of transparency in the markets, which could be ameliorated by a universally agreed reporting system for oil supply and demand to be applied by oil-producing and consuming countries and oil companies. Reliable and timely data on supply, demand and stocks facilitate timely adjustment to shifts in supply and demand while contributing to more solidly based investment decisions. In this context, the Joint Oil Data Initiative (JODI) launched by several international organisations, including the IEA, and now managed by the Secretariat of the IEF was welcomed, and all countries were urged to contribute to the success of this initiative so that market transparency can benefit considerably from the establishment of robust world oil market data. The IEA is committed to making an active contribution to this initiative.

# CROSS-COUNTRY OVERVIEW - GOOD PRACTICES

## INTRODUCTION

The in-depth reviews are the IEA's version of a long-standing element of OECD practice – peer review, namely, the systematic examination and assessment of the performance of a State by other States, with the ultimate goal of helping the reviewed State and other member States improve their policy-making, adopt best practices, and comply with established standards and principles. IEA member countries are subject to in-depth reviews approximately once every four years. Review teams composed of member country experts and Secretariat staff visit the countries under review to meet energy policy-makers, regulators, energy industries and energy consumers. These visits are followed by a final report containing a comprehensive description of the energy situation and energy policies of the reviewed country with critiques and recommendations for more effective energy policies.

The in-depth review has multiple objectives:

- To monitor periodically whether the energy policies of member countries are in line with the IEA Shared Goals and provide critiques and recommendations to guide the reviewed countries in developing and implementing effective energy policies.
- To share updated information about the energy policies of member countries.
- To provide basic input for other IEA activities.
- To give policy-makers valuable opportunities for learning and observing good practices. This is a two-way process. On the one hand, policy-makers from member countries can learn lessons from reviewed countries through participation in review teams and/or discussions at the SLT (Standing Group for Long-Term Co-operation). On the other hand, reviewed countries can learn lessons and different approaches from member countries through receiving peer review teams and discussions at the SLT.
- To share and spread good practices on energy policy planning and implementation within and beyond member countries.
- To broaden and deepen the network of energy policy experts among team members and officials of reviewed countries.

Particular emphasis was put on monitoring progress and sharing good practices at the 2005 IEA Ministerial Meeting when Ministers instructed the IEA to "monitor our efforts to reinforce energy efficiency, including in our peer Country Reviews and in sharing our best practices globally."

Although the critiques and recommendations are developed in a "tailor made" manner according to the reviewed countries' specific national circumstances, an analysis of critiques and recommendations for the twenty-six member countries over the past four years reveals many common challenges. In the *Energy Policies of the IEA Countries 2004 Review* (the Compendium 2004), the Secretariat tried to identify such common challenges in the field of general energy policy, energy and the environment, energy efficiency, renewables, energy market reform, security of supply, nuclear and energy R&D.

In the Compendium for 2005, the Secretariat highlights some of the "good practices" in addressing common challenges in each of the above fields. Most "good practices" have been taken from in-depth reviews over the last four years, where such practices were commended. Other examples have also been selected from recent IEA thematic works, including *Power Generation Investment in Electricity Markets* (2003) and *Security of Gas Supply in Open Markets* (2004), which contain specific national examples. In addition, recent developments reflecting the recommendations of a previous in-depth review or aimed at issues identified in other in-depth reviews have also been picked up from standard reviews, presentations at the IEA workshops and other information sources. As with the Compendium 2004, the Secretariat tries to present examples from as many different countries as possible. While European Commission policies have not been subject to an in-depth review, and "good practices" ideally should be taken from national level in-depth reviews, given the Commission's influence on the national energy policies of EU member countries, the Secretariat has also included some of EC policies that can be regarded as "good practices".

Of course, each member country develops its energy policies in the context of its specific national circumstances; therefore, what is considered "good practice" in one country may not necessarily be applicable to all countries. In this context, the examples presented here should be understood as "good practices" rather than "best practices". It remains true that member countries learn from other countries' positive experiences and can draw on these experiences as a source of inspiration for their own policy development. It should be borne in mind that a list of good practices is not exclusive and that other positive examples exist elsewhere.

## GENERAL ENERGY POLICY

In formulating their energy policies, all member countries are trying to achieve a balance among the 3Es, namely, energy security, environmental protection and economic growth, in line with the IEA Shared Goals. Below are some examples of good practices in addressing major challenges for the effective and efficient implementation of energy policies.

## DEVELOPING, MONITORING AND TIMELY UPDATING OF ENERGY SUPPLY-DEMAND PROJECTIONS

Almost all member countries base their energy policy planning on specific energy supply-demand projections. Such projections are particularly crucial in addressing GHG emissions mitigation targets. Many countries are using such projections to calculate the potential gap between the business-as-usual scenario and the GHG emissions mitigation target. However, the reality in the energy market may differ from such projections because of a more rapid than expected growth of energy demand or of $CO_2$ emissions, or the acceleration or delay of energy projects. In this context, developing, monitoring and timely updating of energy supply-demand forecasts are essential for effective energy policy planning.

In ***Japan***, for example, the *Long-term Energy Supply and Demand Outlook* has long served as a basic tool for energy policy planning. Since its first publication in 1967, the Advisory Committee for Natural Resources and Energy updates the *Outlook* every 3-4 years, taking into account changes in the energy situation. The *Outlook* shows the forecast impact of energy policies and measures in place, the difference between their impact and the various objectives as well as how to bridge the differences. The most recent *Outlook* published in March 2005, has several new features compared to the previous edition in 2001. It updated the base case scenario, taking into account the most recent energy situation, including the slower development of nuclear power, and extended the timeframe of the *Outlook* from 2010 to 2030. It also developed several sensitivity analyses taking into account varied rates of penetration of renewable energy and nuclear power and varied assumptions on macroeconomic growth. The central role of energy projection was recognised in the 2003 in-depth review of Japan; its timely updating, with multiple scenarios and a longer time horizon, reflects the recommendations in the review.

## TIMELY, CONSISTENT AND HIGH QUALITY ENERGY DATA

Good quality energy data is a prerequisite for effective energy policy formulation. Quality of statistics is a multi-faceted concept that stretches well beyond the narrow criterion of accuracy. The IEA puts utmost priority on five elements: timeliness, consistency/coherence, accuracy, credibility/transparency/integrity and interpretability/clarity. Recently, however, it has become increasingly difficult to maintain the very high quality of IEA data in many cases because national administrations have faced problems in maintaining the quality of their own statistics. Breaks in time-series and missing data have become frequent in some countries. These lapses compromise the completeness of IEA statistics and seriously affect any type of analysis, including modelling and forecasting and, ultimately, policy-making of member countries using IEA data.

Despite this general trend, the ***Netherlands*** has maintained its status as a good practice country among IEA member countries over the years. In terms of timeliness, for instance, the Secretariat received all five annual questionnaires by mid-October for a deadline of end October, and always received responses to its follow-up queries within a few days. As a result, the Netherlands was among the first countries to be finalised. As regards the other four dimensions, Dutch submissions give a complete, coherent and accurate picture of the Netherlands energy supply and demand market. Moreover, over time, the Netherlands has continuously improved its level of consistency with IEA's definitions and across questionnaires reporting. Finally, it is important to note the good working collaboration of a national focal point, the Central Bureau of Statistics in the case of the Netherlands, as a driving factor for success.

## EFFECTIVE CO-OPERATION AMONG RELEVANT MINISTRIES

Given its multi-faceted nature, the energy sector is affected not only by energy policies, but also by a wider range of policies such as environment, building, transport, taxation, science and technology. Closer co-operation between the ministry in charge of energy policy and other relevant ministries is therefore crucial.

In ***Finland,*** for example, while the Ministry of Trade and Industry has ultimate responsibility for energy policy and initiates all new policy developments, other ministries contribute through consultation and delegation of responsibilities. The National Climate Strategy in June 2001 was shaped by the work of six different ministries (Industry and Trade, Transport, Agriculture, Environment, Foreign Affairs and Finance). The inter-ministerial group regularly consulted with stakeholders through the presentation of drafts and strategies to both industry and the public. The 2003 in-depth review for Finland commended this group as a good example of consultation, shared information and a good understanding of the concerns that other ministries have on particular issues. This is essential to achieving a balanced and consistent energy policy encompassing diverse national policy objectives.

## EFFECTIVE CO-OPERATION BETWEEN CENTRAL/LOCAL GOVERNMENTS

In some member countries, sub-federal governments exercise powerful control over energy policy formulation and implementation. The challenge is to what extent local authorities and their constituent communities are fully informed of their national energy situation and challenges so that their decisions will reflect national as well as local interests. Given that the responsibilities of local governments are clearly defined in the constitution, the only viable approach is a process of closer dialogue and consultation. Energy market reform is one of the areas for such co-operation in countries where local governments have primary responsibilities.

In ***Australia,*** the Council of Australian Government (COAG), comprising the Prime Minister, State Premiers and Territory Chief Ministers, and the Ministerial Council on Energy (MCE), comprising ministers with responsibility for energy from the federal government and all states and territories, each plays a major role in co-operation between central and local governments. While state governments have primary responsibilities in the field of market reform, the federal government has worked with the state governments to develop the new programme (2003-2006) aimed at creating a national energy market and at improving consistency and clarity. A new single regulator, the Australian Energy Regulator (AER), will replace the current eight gas regulators and thirteen electricity regulators, and a new body, the Australian Energy Market Council (AEMC), will be responsible for market design and rule-making. This move to a more nationally focused market is helpful in minimising regulatory overlap and reducing the burden on companies wishing to work in multiple states. The 2005 in-depth review commended this development.

## BETTER UNDERSTANDING BY THE GENERAL PUBLIC OF THE NATIONAL SITUATION AND FUTURE CHALLENGES

A good understanding by the general public of the national energy situation and future challenges is a prerequisite for effective implementation of energy policies. At the same time, energy policies are frequently very complex and/or technical and often difficult to communicate to the general public. Effective public information is particularly crucial in the countries where important energy issues are decided through referendum or public initiatives.

***Switzerland*** held a referendum in May 2003 on two public initiatives, "Moratorium Plus" and "Power without Atoms", to phase out nuclear power, which currently produces 38% of total electricity generation. Given the significant impact a nuclear phase-out would have on Switzerland in terms of energy security, climate change mitigation and economic efficiency, the government disseminated comprehensive information on this issue. The information paper included *i)* the content of the two public initiatives, *ii)* the energy scenario towards 2030 based on the reference case and two phase-out initiatives, *iii)* the impacts on $CO_2$ emissions, *iv)* the economic costs of nuclear phase-out, *v)* the comparison of different scenario analyses, *vi)* the feasibility of efficient use of electricity and increased use of renewable energy compensating for the loss of nuclear. As a result, the general public rejected both initiatives while the nuclear energy law was passed, implying further operation of existing plants as long as security allows. This is in line with a recommendation in the 2003 in-depth review to keep the nuclear option and can be regarded as a successful example of ensuring better understanding by the general public of the national energy situation.

# ENERGY AND THE ENVIRONMENT

Dealing with climate change is a challenge for all IEA member countries. Those countries which have ratified the Kyoto Protocol are obliged to comply with the demanding targets under the Protocol and, for EU countries, the targets under the EU Burden-Sharing Agreement. It is imperative to develop a climate change strategy with cost-effective policies and measures, to monitor its progress, and to take prompt action if it goes off the track. Below are some good examples of how these tasks are being addressed.

## ENSURING COST-EFFECTIVENESS OF CLIMATE CHANGE POLICIES AND MEASURES

For those countries with legally binding obligations under the Kyoto Protocol, it is critical to develop policies that are certain to meet national targets. On the other hand, as policies become more stringent, they also cost more, and efforts to identify the cost-effectiveness of policy interventions are becoming increasingly important. Assessing the cost-effectiveness of policies and measures does not necessarily form an integral part of the decision-making process in many member countries.

Quantifying the contribution of each policy and measure is a prerequisite for any cost-effective approach in climate change mitigation policy. ***Switzerland,*** for example, conducted a comprehensive cost-effectiveness analysis of each measure included in its Energy 2000 Action Programme, which was developed in 1990 to stabilise by 2000 fossil fuel consumption and $CO_2$ emissions at 1990 levels. It estimated CHF cents/kWh saved or generated by each measure in major sectors such as public authorities, large consumers, small and medium-sized enterprises, motor fuels, residential buildings and renewables. The 2003 in-depth review highly commended such conscientious monitoring of the measures. This approach is being continued and strengthened in Swiss Energy (2001-2010), which succeeded Energy 2000, through publishing an annual report evaluating the cost-effectiveness of individual measures.

Cost-effectiveness also receives a lot of attention in the ***Netherlands,*** and is analysed as part of the process of developing the country's climate change mitigation package. Its environmental balance sheets for 2003 estimate the welfare cost of $CO_2$ mitigation measures in industry and agriculture, transport, renewable promotion, the building sector, non-$CO_2$ GHG emissions reduction and Kyoto mechanisms. Such analysis has contributed to the development of a policy package, namely, *i)* the use of JI (joint implementation) and CDM (clean development mechanism) to achieve up to 50% of the necessary reductions, *ii)* reduction of non-$CO_2$ emissions, *iii)* streamlined subsidies for renewables and CHP, and *iv)* keeping open the Borssele nuclear power plant. The government is currently calculating the cost-effectiveness, including social factors, of individual measures for climate change mitigation. The 2004 in-depth review commended such attentiveness to cost-effectiveness.

## MAKING USE OF EXTERNALITIES THROUGH MARKET-BASED INSTRUMENTS

As observed in the IEA database of climate change policies and measures, fiscal measures, regulatory instruments and voluntary agreements are the major components of member countries' climate change mitigation strategies. The majority of fiscal measures have been set up to support the development of emerging low-carbon technologies rather than to impose a direct cost on fossil fuel sources. On the other hand, the introduction of market-based mechanisms has been slow despite their economic efficiency and cost-effectiveness. This has been mainly due to member countries' limited experience in using such options to reduce GHG emissions and to the complexity of developing a framework which fully exploits the flexible nature of these instruments.

In this context, the introduction of the ***European Union*** Emissions Trading Scheme (EU-ETS) in 2005 has been the most significant policy development at the regional level in recent years. As a single market-based instrument for environmental policy, the EU-ETS is unprecedented in its coverage of activities and emissions and its expected contribution to internalising the cost of GHG emissions in the economy. It is a significant development given that the Kyoto Protocol emissions trading mechanism does not specify whether and how countries should devolve parts of their assigned amounts to so-called domestic "entities". The EU-ETS acknowledges that industry is best placed to decide on appropriate measures to reduce its emissions at lowest cost and, as such, is the ideal economic agent to participate in a cap-and-trade regime, assuming that emissions must be reduced in the first place. While its effectiveness and efficiency are difficult to assess at its initial phase and further improvement may be necessary based on practical experience, EU-ETS, with its 12 000 installations and diversity of activities, should contribute significantly to creating an international, hopefully liquid, GHG emissions trading market.

## MONITORING AND TAKING ACTION, IF NECESSARY

Effective monitoring of progress is also a prerequisite for successful climate change strategy. Such monitoring would entail both ensuring that suggested measures are implemented and reviewing their results once they have been put into practice.

In 2004, the ***Swedish*** Environmental Protection Agency and the Swedish Energy Agency jointly delivered a basis for the first evaluation of the Swedish Climate Change Strategy adopted in 2002. The checkpoint 2004 examined the trend in emissions in different sectors and the new baseline forecast by 2010. The checkpoint also concluded that Sweden will achieve its commitment under the Kyoto Protocol and the EU Burden-Sharing Agreement, but further policies would be needed to achieve its national target. In addition, the checkpoint assessed the effectiveness of the policy instruments contained in the strategy and proposed additional policies and measures for sectors not covered by the trading sector, including differentiated vehicle taxation based on $CO_2$ emissions, tax on trucks based on kilometres travelled, and increased subsidies to local climate investment programmes.

The ***Netherlands'*** Climate Change Implementation Plan has three packages of domestic policies and measure: the basic package, the reserve package and the innovation package. The basic package contains a wide range of policies and measures ready to be implemented and considered reliable in emissions reduction. The reserve package contains policies and measures that can be taken if things go awry during the run-up to the 2008-2012 period. These measures are being prepared to make them ready for implementation following periodic evaluation. The innovation package mainly aims to develop new technology and new policy instruments. The 2004 in-depth review for the Netherlands commended this approach as flexible and prudent because it will enable the country to immediately embark on the package if it finds itself off track.

# ENERGY EFFICIENCY

Energy efficiency is one of the key policy areas to achieve GHG reduction targets as well as energy security. However, the efficiency gains in member countries have slowed down since the mid-1980s. Stronger policies are necessary to reverse this trend. Member governments have introduced a range of tools to encourage energy conservation and efficiency, including financial instruments to encourage energy efficiency, mandatory minimum efficiency levels, voluntary programmes and so forth. At the 2005 IEA Ministerial Meeting, Ministers committed to reinforcing their efficiency efforts and instructed the IEA to monitor their efforts through the in-depth reviews and to share best practices globally.

## MONITORING IMPACTS

Close monitoring and evaluation of energy efficiency trends are prerequisites for a successful energy efficiency policy. It is a challenging task to identify the impact of energy efficiency measures because energy consumption is not only affected by energy efficiency measures but also by many other economic and social factors. Developing disaggregated energy indicators can be an important tool for monitoring and evaluating progress in energy efficiency. Many member countries already employ energy indicators to follow end-use developments in different sectors of the economy. The IEA has developed a database with indicator data for most member countries, from which important policy insights can be drawn across countries. Increasing the transparency and quality of energy use data is a crucial element of the effective planning and implementation of energy efficiency policies and measures.

In 2001, the ***Japanese government*** carried out a comprehensive analysis of which factors cause an increase in energy consumption and the effect of energy efficiency measures, such as the Top Runner Programme. For example, the transport sector analysis showed that all gains in engine efficiency through the Top Runner Programme were more than offset by increased vehicle weight and driving conditions. It became clear that two-thirds of the increase in fuel consumption and related $CO_2$ emissions in the transport sector could be attributed to increased mileage and the remainder to reduced on-the-road fuel efficiency. Such analysis has enabled Japan to specify the areas where further efforts would be needed to improve energy efficiency in the transport sector.

Following recommendations by the Office of the Auditor General (OAG), ***Canada***'s Office of Energy Efficiency (OEE), Natural Resource Canada (NRCan), has improved the evaluation of energy efficiency performance both in projections and achievements. The follow-up report by the OAG noted improvements in the evaluation of energy efficiency performance (both projections and achievements), which have improved the quality of NRCan's Report to Parliament on energy efficiency based on the 1993 Energy Efficiency Act. The OEE operation has increased the transparency and accountability of Canada's energy efficiency programme. The National Energy Use Database and the publication of the report *Energy Efficiency Trends in Canada* provide a good analytical basis for understanding energy use and efficiency trends in Canada and for priority-setting of sectoral policy initiatives in the end-use sectors. The 2004 in-depth review commended such efforts.

## ENSURING EFFECTIVENESS OF VOLUNTARY AGREEMENTS IN THE INDUSTRIAL SECTOR

Voluntary agreements have been widely set up with industries in member countries to improve energy efficiency and reduce GHG emissions. This policy tool has been favoured partly because of its flexibility and relatively light-handed approach compared with regulations. This is particularly important for industrial sectors exposed to international competition. Several issues need to be addressed to ensure the effectiveness of this tool.

Clear and measurable quantitative benchmarks and effective monitoring are essential to ensure the effectiveness of voluntary agreements. The ***Netherlands*** in 1999 established the Energy Efficiency Benchmarking Covenants for industries using at least 0.5 PJ of energy per year. The covenants followed the successful experience of the Long-Term Agreements on Energy Efficiency (LTA), which had improved the energy efficiency of participating companies by 22.3% between 1990 and 2000, surpassing the target of 20%. Under the Benchmarking Covenants, participating companies pledge to be among the top 10% of the most energy-efficient installations worldwide as soon as possible, but no later than 2012. Moreover, the top performers must be redefined every four years.

In exchange for their participation, the government agreed not to impose additional energy efficiency or $CO_2$ reduction measures on participants. Participating companies also benefited from simplified environmental permit procedures, fiscal incentives and technical assistance. In order to meet the benchmark, members of the covenant must prepare energy efficiency plans and file them with the Benchmarking Verification Agency, an independent bureau established to monitor the practical aspects of the covenant. The plan must be reviewed every four years, when the world leader is redefined. The covenant contains criteria governing the rate of return. Companies must begin with the most cost-effective measures before taking measures that are less cost-effective. The forthcoming EU-ETS encouraged companies to accelerate their efforts because the initial allocation was made on the basis of the performance of the covenant. The 2003 in-depth review commended the good management and careful monitoring of the Benchmarking Covenant and the second generation Long-term Agreement (LTA2) for smaller industries, services and agriculture, which are not eligible to join the Benchmarking Covenant.

The ***United Kingdom***'s Climate Change Agreements require participating energy-intensive industries to set stringent targets to reduce energy consumption or emissions. In return for agreeing to and meeting these targets, these sectors are entitled to an 80% reduction in the Climate Change Levy. The sector performance is tested against the sector target adjusted for exits and entrants, carbon trading under the emissions trading scheme, where applicable, and product mix and/or throughput. If the sector has failed to meet the target, the individual facilities in the sector will not be eligible for the levy discount for the next two-year period. While pointing out elements for further improvement such as the definition of eligible industries and possible "free-riding" by paying for energy efficiency gains that would have been achieved without them, the 2002 in-depth review recognised that this approach is a highly effective way of creating incentives for emissions reductions.

Companies on the outside of such voluntary agreements are often small and medium-sized enterprises which are not subject to stringent measures such as EU-ETS. However, if such companies account for a large share of energy consumption, the impact of voluntary agreements could be partly offset. The wider coverage of voluntary agreements is therefore essential to ensure their effectiveness. In this context, ***Finland*** can be presented as a good example. It has nine energy conservation agreements, which cover not only industry and energy companies but also municipalities, property and building sector, transport (truck, buses and vans) and housing properties. These agreements cover more than 55% of Finland's total energy consumption, which is wider than coverage rates in other IEA member countries. The savings achieved thus far in conjunction with the agreements have been significant. While companies may have pursued some energy efficiency improvement independently, a great deal of these savings can be attributed to the agreements. The 2003 in-depth review commended the comprehensive coverage of Finland's voluntary agreements.

The clarification of the future inter-relationship of voluntary agreements and the framework of EU-ETS is an important issue for EU countries because the sectors covered under the voluntary agreements largely overlap with those covered under the EU-ETS. In ***Belgium,*** both Flanders and Wallonia have implemented voluntary agreements with links to the EU-ETS. In Flanders, large energy-intensive companies with an annual consumption of at least 0.5 PJ and which fall under the EU-ETS have agreed with the government to be among the top world performers in terms of energy efficiency by 2012. To accomplish this, independent experts have developed efficiency obligations for the end of 2005 and 2007. To achieve these obligations, all measures with an internal rate of return (IRR) of 15% after tax must be taken by the end of 2005, at the latest. If these measures are insufficient, less profitable measures down to an IRR of 6% after tax must be taken by the end of 2007, at the latest. Companies that implement energy saving more rapidly than required by their commitments will be rewarded because they will still receive the emissions allowance corresponding to their initially approved energy plan and can sell the excess emissions allowances. Increasing economic support for energy investments by companies participating in the covenants is also under consideration. If implemented, support would be linked to emissions reductions resulting from new energy investments. Like Flanders, Wallonia relies on voluntary agreements with industry to increase energy efficiency. Wallonia has signed voluntary agreements with 117 energy-intensive firms, covering more than 90% of Wallonia's industrial energy consumption or 47% of Wallonia's total energy consumption. These voluntary agreements include individual action plans for each firm and require firms to provide annual information. In return, these firms are granted subsidies for energy accountancy and audits, no additional regulatory regional obligations on energy efficiency, $CO_2$ tax exemptions (should $CO_2$ taxes be implemented in the future), realistic $CO_2$ quota allocations under the EU-ETS, and exemptions from green certificate requirements. The 2005 in-depth review commended this approach.

## STRONGER MEASURES IN THE TRANSPORT SECTOR

In all IEA member countries, energy demand in the transport sector is expanding more rapidly than in other sectors. Furthermore, given that oil accounts for 97% of the energy demand in the transport sector and that the potential for substituting oil is still very limited, this sector is very vulnerable to oil supply disruption. Curbing the growth of energy demand in the transport sector is more challenging than in other sectors, given the large number of players involved. Accordingly, enhanced energy efficiency policies in the transport sector have been recommended for almost all member countries from the viewpoint of energy security and climate change mitigation. Among various policies and measures for improving energy efficiency in the transport sector, the following examples could provide useful insights.

In the field of fuel efficiency standards, ***Japan***'s Top Runner Programme, based on the Energy Conservation Law, sets the most stringent mandatory fuel efficiency standards on vehicles, where the standards are higher than the best performance in each size category. Under this programme, car manufacturers are obliged to improve fuel efficiency by 23% (for gasoline vehicles) and 15% (for diesel vehicles) between 1995 and 2010. The 2003 in-depth review for Japan commended the programme's ambitious and clear targets as well as the ease of enforcement.

***Japan*** also has recently amended the Energy Conservation Law to introduce new regulations on large-scale freight industry (cargo, passengers) and cargo owners within a framework of close co-operation between the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure and Transport. The new regulations oblige large-scale freight industries and cargo owners to formulate energy conservation plans and report the amount of energy consumption every year, and promote the use of public transport. It is noteworthy that the law has thus expanded its coverage to the transport sector where energy consumption is rapidly increasing.

Traffic regulations also work to reduce fuel consumption. For example, new speed limit regulations on motorways introduced in recent years, and their strict enforcement, are expected to reduce fuel consumption as well as bring down the number of accidents. It is expected that stringent speed limit enforcement in ***France*** will reduce GHG emissions by 3 million tonnes (Mt) of $CO_2$ from the business-as-usual (BAU) projection in the transport sector in 2010.

Economic instruments such as tax and charges are also instrumental in managing transport demand. The ***United Kingdom*** significantly reformed company car tax to improve energy efficiency in the transport sector. Previously, employees who had a company car available for private use were liable to pay income tax on this benefit in kind. Company car tax is currently based on the "list price" of the car and annual business mileage. Company car drivers who do less than 2 500 business miles a year are taxed at 35% of the list price of the vehicle, while those doing more business miles pay less tax: 15% and 25% of the list price for annual business mileage over 18 000 miles and 2 500-18 000 miles respectively. Since April 2002, cleaner, more fuel-efficient cars are rewarded by linking the tax charge to the car's exhaust emissions, in particular its carbon dioxide ($CO_2$) emissions. The UK government expects this reform to have multiple impacts on annual $CO_2$ emissions reduction (0.15-0.25 Mt of carbon in 2004, 0.4 MtC in 2010), fuel type (increased diesel sales), business mileage reduction (300-400 million miles in 2002/03) and car sales reduction. ***Switzerland*** has been levying a fee on heavy-duty vehicles since 2001. The fee is calculated on distance, weight and emissions standards. Two-thirds of revenues are used to finance rail infrastructure, including two trans-Alpine tunnels, to promote modal shift. This fee has curbed road freight mileage by 8% since its introduction, after years of an uninterrupted growth.

# STRONGER MEASURES IN THE RESIDENTIAL/COMMERCIAL SECTOR

Like the transport sector, curbing the growth of energy demand in the residential/commercial sector is a challenge for many member countries.

Building codes have been developing apace in many IEA member countries. ***Denmark*** has been progressively tightening the code for new buildings, setting limits on electricity consumption for ventilation and enforcing low-temperature heating systems, each in several stages since 1977. The most recent revision, which reduces the net heating demand from 70 kWh/m$^2$ to 45 kWh/m$^2$, entered into force in 2005. Together with other policies, this has contributed to maintaining the energy demand in the residential/commercial sector in Denmark at the same level as in 1973.

In 2002, the ***European Union*** approved the Energy Performance of Building Directive, requiring each member State to develop minimum efficiency standards for new buildings, energy performance rating schemes, mandatory energy equipment performance inspections and energy performance certification to reduce energy use in new and existing buildings. The directive is now being implemented by the individual EU member States. ***Germany***'s new Energy Conservation Ordinance in 2002 integrated the thermal insulation and heat insulation ordinances within an integrated methodology as required by the EU directive. To complement this effort, a new set of analytical standards are being developed, which for the first time are likely to result in a common basis for calculating building energy performance across Europe.

The energy use of domestic appliances and equipment represents a significant share of energy demand in the residential/commercial sector. Large efficiency improvements through minimum energy performance regulation are technically feasible and highly cost-effective.

***Japan*** has the most comprehensive set of minimum efficiency standards (Top Runner Programme) covering twenty-one products (vehicles, air-conditioners, TV sets, video-cassette recorders, fluorescent lights, copying machines, computers, refrigerators, vending machines, etc.). Unlike conventional energy efficiency standards that are set at the average level in the same product group, the threshold under the Top Runner Programme is set at the level of the most efficient equipment on the national level at the time the policy measure is developed. The manufacturers of the products covered by the Top Runner Programme are obliged to achieve the standard by the relevant target year. With a view to encouraging the achievement of the standard even before the target year, a labelling system for home electric appliances, which displays to what extent each product fulfils the standard, has been in place since 2000. The 2003 in-depth review commended its positive impact on the efficiency of household appliances. Japan has also amended the Energy Conservation Law to oblige retailers of home electric appliances to display information on product energy efficiency.

# DEVELOPING NEW INSTRUMENTS SUCH AS WHITE CERTIFICATES

Some IEA member countries are introducing new market-based instruments, such as white certificates, which gas and electricity distributors are obliged to obtain either by saving energy themselves or purchasing energy-efficiency certificates. While its effectiveness remains to be proven, the IEA, in the relevant in-depth reviews, welcomes such a system because the process of certificate trading concentrates resources and efforts in the areas where they can be most cost-effective. At the same time, the IEA emphasised that many administrative problems would need to be solved for the effective functioning of this new scheme. Since the last in-depth reviews for such countries, there has been some progress in terms of system design and implementation.

In 2002, the ***United Kingdom*** introduced the Energy Efficiency Commitment (ECC), which is scheduled to remain in place until 2011. Gas and electricity suppliers with at least 15 000 residential customers are obliged to meet a combined energy saving target of 62 TWh by 2005. Suppliers have already met more than three-quarters of the saving targets. Targets will be increased to 130 TWh during the period 2005-2008. The trade of energy efficiency certificates is performed by means of bilateral contracts based on saved TWh instead of "liquid" trade by means of white certificates. Trading occurs in the final stage of each target period to reconcile suppliers' performance against their targets.

Although the details of ***Italy***'s scheme were not yet defined at the time of the 2003 in-depth review, there has been further progress in policy design. Energy efficiency certificates (TEEs) are issued by the Market Operator (GME) once it has been certified that a defined amount of energy saving will be attained by project implementation. The Authority for Electric Energy and Gas (AEEG) has issued, as well as energy saving targets from 2005 to 2009 for electricity and gas distributors, guidelines for the preparation, execution and evaluation of projects and for the criteria for issuing energy efficiency certificates. The AEEG will evaluate energy saving associated with eligible projects based on three different methods according to the type of project. About 100 projects have already been submitted to the AEEG for evaluation.

***France***'s Energy Law of 2005 requires the suppliers of electricity, gas, heat and fuel oil to reduce energy consumption by 34 TWh, 10.5 TWh, 1.5 TWh and 7.5 TWh respectively in 2006-2008. These obligations are to be met either by certificates or paying a penalty. All measures initiated by an obliged energy supplier or an eligible consumer in the building, industry and transport sectors can receive white certificates based on their contribution to additional saving. To avoid duplication, installations subject to $CO_2$ quota obligations will be excluded from the white certificate obligations. This could be an effective tool to capture energy saving potential in sectors which are not covered under the EU-ETS, such as building owners, companies, communities, etc. The government expects the certificate price to be around EUR 10/MWh while setting a penalty of EUR 20/MWh. The government is now working on methodologies to identify "additional" energy saving using a "reference consumption" from statistical surveys.

## RENEWABLES

Many IEA member countries have set ambitious targets for the introduction of renewables and taken various measures to support market deployment of renewable energy technologies, ranging from investment incentives, tax measures, incentive tariffs, voluntary programmes, obligations, tradable certificates and so forth. Of these, the feed-in tariff system and the quota obligation with tradable certificates are the two major instruments adopted by many member countries.

### MORE EFFICIENCY IN FEED-IN TARIFF SYSTEM

In the feed-in tariff system, the government sets a premium price to be paid for power generated from renewable energy sources. The price is usually differentiated by technology and is paid by consumers through the utility. Guaranteed prices give strong predictabilities and certainties to investors of renewable energy projects. Countries with significant markets for renewable energy, such as ***Germany*** and ***Spain***, have established guaranteed prices in the form of a fixed feed-in tariff. The German feed-in tariff system has expanded the installed capacity of wind power from 2 395 MW in 1990 to 21 707 MW in 2001, making Germany the world leader in wind power production. High-level feed-in tariff for photovoltaics has boosted their installed capacity from 2 MW in 1990 to 410 MW in 2003. Under the Renewable Energy Sources Act 2004, the levels of feed-in tariff for onshore wind, offshore wind and photovoltaics are EUR 8.7-5.5/100 kWh, EUR 9.10-6.19/100 kWh and EUR 62.4-45.7/100 kWh respectively.

While acknowledging the tremendous effect of the feed-in tariff scheme on renewable energy promotion, recent in-depth reviews have been pointing out its potential shortcomings. The prices to be paid are determined by the government rather than relying on market competition. Such guaranteed prices may not provide a sufficient incentive for cost reduction unless the feed-in tariff is decreased over time in line with the expected learning curve; moreover, the duration of the pay-back period is limited. Some countries that chose the feed-in tariff are making various adjustments to give more incentive for cost reduction.

Before the 2002 in-depth review, feed-in tariffs in ***Austria*** were set by each individual Land, creating inefficient resource allocation. In July 2002 the government changed the system, replacing the regional feed-in tariff which had been set by each Land by national tariffs applying equally in all the Länder. This would induce investors to site plants in locations with optimal conditions rather than in the Land with the highest feed-in tariff and would lower the cost of power generation from renewables. The government is also considering shortening the buy-back period and accelerating the reduction of the feed-in tariff level to lower the overall cost.

***Turkey*** has introduced a feed-in tariff scheme for a transition period up to 2011, assuming that the feed-in tariff will be replaced by the purchase obligation with certificate trading scheme thereafter. Under the new Renewable Energy Law, the amount of purchase obligation of Renewable Energy Sources (RES) certified electricity is determined as the proportion of the previous year's sales of each company to the total amount of electricity supplied by the companies. In case the RES certified electricity is sufficient in the market, the purchase obligation ratio will be set at a level not lower than 8% of the previous year's sales. The fixed feed-in tariff for the RES certified electricity within each calendar year shall be the average wholesale electricity price for the previous year set by the Energy Market Authority (EMRA). This tariff is lower compared to the feed-in tariff applied in some other IEA member countries. Unlike the approach guaranteeing the recovery of the production cost of all kinds of renewable energy sources through differentiated feed-in tariffs, this approach mainly focuses on encouraging renewable energy sources such as small hydro, wind and geothermal where Turkey has comparative advantages and significant remaining potential. This means that the system may not be excessively expensive for consumers, which is a common risk in feed-in tariffs.

## MONITORING EFFECTIVENESS OF CERTIFICATE SYSTEMS

The quota obligation is often coupled with a tradable renewable certificate system to reduce the cost of compliance. While this is more compatible with a liberalised energy market, it is relatively new and its effectiveness depends to a great extent on the system design. Questions have been raised as to whether such a system can actually deliver the desired new installed capacity as efficiently as other instruments or whether it can support a range of technologies rather than just the least expensive technology. Several member countries have already introduced this system and are reviewing its effectiveness after a certain period of implementation.

Since its introduction in 2001, ***Australia***'s Mandatory Renewable Energy Target (MRET) has been successfully delivering new investment. Under this system, liable parties are required to make their own arrangements to meet their obligations. They can either develop their own contracts with eligible renewable energy generators or trade in Renewable Energy Certificates (REC) at a price negotiated on the market. The tax-neutral penalty in relation to the price of REC is around AUD 57/MWh, which is the effective ceiling on REC prices. The government estimates that AUD 1 billion of investment has resulted from MRET to date, with an additional AUD 1 billion either committed or planned. Generation from eligible renewable generators is actually higher than the MRET obligation level at this point. The current certificate price is much lower than the certificate prices or feed-in tariffs in

Europe. These low prices can be attributed to Australia's favourable natural conditions, the sound design and implementation of MRET and the general downward price pressures from Australia's competitive electricity market. Furthermore, MRET has attracted renewable energy technologies with five different energy sources rather than a single technology. In many respects, MRET can be regarded as a successful example and was commended in the 2005 in-depth review.

In the ***United Kingdom,*** the Renewable Obligation, which is set to increase the share of renewable electricity to 10.4% by 2010/11, has provided a strong positive stimulus to the new development of renewable generating capacity since its start in 2002. The 2002 in-depth review commended the government's approach of letting the market decide which renewable energy technology is the most advantageous instead of picking the winners itself. Total installed generating capacity from renewable sources eligible for ROCs (Renewable Obligation Certificates) was 1 452 MW in 2002. To date, 1 501 MW of new capacity has been brought on stream. The renewable generation technologies showing the most substantial growth are wind, landfill gas and biomass co-firing. Ofgem (Office of Gas and Electricity Market) estimates that the Obligation accounts for 2% of an average domestic direct debit electricity bill. The system is currently under review to improve its effectiveness.

The ***Swedish*** Energy Agency has conducted a performance review of the electricity certificate system introduced in 2003, with the aim of increasing the use of electricity from renewable energy sources by 10 TWh/year between 2001 and 2010. One of the major conclusions is the introduction from 2007 of an integrated common electricity certificate market with ***Norway***. The review concludes that renewable energy production objectives can be achieved with better cost-efficiency in terms of total system costs, liquidity and price swings in an integrated market than in two separate markets. This conclusion reflects the view that the full benefits of the electricity certificate system will come only with international trade and that the bigger the market, the more cost-efficient the system will be due to the fact that the same objective can be achieved at a lower overall cost in international markets than in individual countries. The joint initiative could provide useful lessons and insights to broader international certificate trading in the future. The 2005 in-depth review for Norway commended this international approach.

## ENERGY MARKET REFORM

While all IEA member countries have been proceeding with energy market reform (in particular, gas and electricity) over the past decade, progress has been mixed. Successful market reform cannot be achieved overnight. Taking account of specific national circumstances, including the situation before the introduction of market reform, and the complexity of the reform, the recommendations in recent in-depth reviews are more refined and detailed. Many member countries are now addressing the following issues, which have often been raised as necessary elements for successful market reform.

# ENSURING UNDISTORTED, COST-REFLECTIVE PRICES

Undistorted, cost-reflective energy prices – including electricity and gas tariffs and related services – are prerequisites for the efficient functioning of energy markets, as they send the right signals to consumers and investors.

This is a challenging task, in particular for countries undergoing the transition to a market economy, because the general public took for granted heavily subsidised energy prices. In the ***Czech Republic,*** owing to the efforts by the regulator to eliminate subsidies and cross-subsidies for different customer classes, electricity prices for households rose by more than 400% between 1991 and 2003. While tax-inclusive industrial prices have been relatively stable since the early 1990s, more recently these prices also rose by 30% between 2001 and 2003. Cost-reflective pricing ensures greater economic efficiency and encourages efficiency in electricity use. In addition, cost-reflective higher prices are essential for the development of competition because it will be difficult for new entrants to gain clients or capture market share if they have to compete against subsidised prices in one or more customer classes. Given that previous tariffs to different customer groups were not cost-reflective, the 2005 in-depth review commended this increase in regulated tariffs in recent years.

The principle of undistorted, cost-reflective prices faces challenges at a time when prices are volatile. Governments tend to receive strong political pressure to intervene in the market. However, protecting consumers against high risks may cause the disruption of market mechanisms and discourage investment unless it is carefully designed. The following examples show various governments' strong determination to rely on market mechanisms.

The ***Norwegian government*** faced considerable dissatisfaction with record-high electricity prices in the Nord Pool during the winter of 2002/03 due to the combination of very low precipitation levels in the autumn of 2002 and an unusually cold winter. Nevertheless, the government was very much committed to allowing markets to manage the situation without intervention on its part. Government response to the crisis was aimed instead at increasing awareness of the problem and encouraging energy conservation rather than intervening in price setting. The long history of open electricity markets, lower electricity prices over several years and consequent customer confidence in the open and internationally connected electricity market enabled the government to have greater confidence in relying on market mechanisms. In addition, consumers showed responsiveness to higher prices by reducing consumption. This was highly commended in the 2005 in-depth review.

High growth rates in electricity demand in South ***Australia*** in 1999-2000 had led to dependence on imports from neighbouring Victoria and high average spot prices due to tight supply-demand conditions. While high prices were accompanied by more frequent supply disruptions, particularly during extreme peaks and reduced transmission capability with Victoria, the government of South Australia decided not to intervene by capping market prices or by contracting new investment. It simplified its regulatory approval processes and decided to delay retail market opening for the smallest consumers. The consequences of high prices in South Australia led to addition of new peaking capacity, representing a 30% increase in existing capacity. The result was a quite dramatic decrease in peak prices.

## ENHANCING EFFICIENCY IN THE OIL DOWNSTREAM SECTOR

The oil downstream sector has been largely liberalised in all member countries, leading to industry restructuring and increased efficiency. One of the most recent examples can be found in ***Turkey.*** The liberalisation of oil product imports and exports started in 1989 when all retailers and refiners with adequate storage capacities were granted import licences and were allowed to set prices freely. However, the government continued to prescribe annual oil import programmes and oil producers, apart from the state-owned company TÜPRAS, were allowed to sell only 35% of their production. Oil and gas distribution companies were required to acquire at least 60% of their supplies from Turkish refineries. The Petroleum Market Law of 2003 resulted in substantial reorganisation of the oil sector, full liberalisation of oil market activities and removal of quotas on imports of petroleum products. With the removal of the price ceiling mechanism (APM) at the beginning of 2005, the oil sector has been fully liberalised. The 2005 in-depth review commended this development.

## PHASING OUT OF REMAINING COAL PRODUCTION SUBSIDIES

A number of IEA member countries give financial and other assistance to their indigenous coal producers from a pragmatic concern to maintain employment and regional economic activities. In general, the in-depth reviews have taken the position that social and regional policy objectives can be better addressed through other more efficient methods rather than provision of coal production subsidies and that a well-established international coal market can ensure security of supply. Countries which successfully phased out coal production subsidies have been commended, taking into account the political difficulties they faced in doing so.

Until recently, ***Japan*** maintained a small but heavily subsidised coal production industry on the grounds of security of supply. The main form of subsidy was directed at coal consumption by the electric utilities; coal producers received subsidies to cover the difference between market prices and those established under domestic agreements. However, Japan followed a restructuring programme from FY 1992 to FY 2001 addressing mining damages and providing support to structural adjustment (*e.g.* business diversification) instead of providing direct production subsidies. With the expiration of the programme in FY 2001, all public subsidies ceased. The 2003 in-depth review commended the Japanese government's considerable restructuring and business diversification efforts.

Following the significant rise in production costs of hard coal in recent years in ***France,*** the government in 1994 signed the National Coal Pact with the state-owned Charbonnages de France (CDF) with a view to terminating operating subsidy payments in 2004. Ahead of schedule, CDF extracted the final tonne of coal in March 2004. The French government was commended for its long-term planning and effective implementation of the plan in the 2004 in-depth review.

## CREATING A STABLE ELECTRICITY AND GAS REGULATORY FRAMEWORK

Creating a stable regulatory framework is a prerequisite for effective electricity and gas market reform. This is also crucial for sending clear signals to potential investors. EU member countries have a relatively transparent framework due to the ***European Union*** directives on the opening of internal gas and electricity markets. The second EU Directive on Electricity Market was adopted in June 2003, replacing an earlier directive adopted in 1996. Key provisions include free choice of suppliers for business customers in July 2004 followed by free choice for households in July 2007, the legal unbundling of transmission system operators (TSO), and the appointment of a national regulator. The second EU Directive on Gas Market was also adopted in June 2003 amending the earlier directive adopted in 1998. The directive *i)* sets the accelerated timetable for market opening with deadlines of July 2004 for non-household users and July 2007 for all users, *ii)* mandates regulated third-party access (TPA) for transportation and regulated or negotiated access to storage while allowing exemptions under certain conditions, and *iii)* requires the legal unbundling of transmission and distribution activities from the rest of the activities of gas companies. The European Commission is following the situation in each member country through its periodical benchmarking report and is strongly urging the implementation of EU directives, even resorting to a lawsuit, if necessary.

## ESTABLISHING A STRONG AND INDEPENDENT ENERGY REGULATOR

With a view to promoting successful electricity and gas market reform, the role of an independent regulator with sufficient regulatory power, staff and budget is essential to ensure open access to the network, protect the ability of consumers to choose their suppliers and prevent anti-competitive behaviour by the incumbents.

As one of the pioneers of energy market reform, the ***United Kingdom*** has longer experience with an independent regulator than other European countries. In

2000, the UK merged the function of the former Office of Gas Supply (OFGAS) and the Office of Electricity Regulations (OFFER) into OFGEM (the Office of Gas and Electricity Regulation), noting the convergence of the two markets and the increasing share of gas in electricity generation. OFGEM's primary duty is to protect the consumer interests by competition wherever appropriate, whereas OFGAS and OFFER's main concerns had been that the structures allowing competition developed properly. OFGEM has strong oversight of the gas and electricity markets and significant independence from the government. Unlike many other European regulators, OFGEM is also a formal competition authority for the electricity and gas sectors, with decisions subject to judicial review.

***Australia*** is another pioneer in energy market reform. The implementation of electricity market reform in a federal system in which the state governments have substantial power has impressively led to a market with roughly the same rules in the major states and generally greater regulatory consistency than seen in other federal countries. The 2005 in-depth review commended the creation of the Australian Energy Market Commission (AEMC) and the Australian Energy Regulator (AER) because it will further enhance the national scope for rule-making and regulation.

Noting that countries with strong regulators have benefited from increased liberalisation and competition while those with less strong and less independent regulators have lagged behind, the second ***European Union*** Directives of Electricity and Gas Markets in 2003 mandated member states to establish a national energy regulator. These directives led Germany to recently establish an energy regulator. ***Germany*** did not have a sectoral regulator at the time of the 2002 in-depth review and was recommended to establish one.

Given the role that strong regulators play in successful energy market reform, ***Turkey*** established an independent electricity regulator, EMRA, in 2001 at the same time as it embarked on electricity market reform based on the Electricity Market Law (2001). Following the enactment of the Natural Gas Market Law (2001), the Petroleum Market Law (2003) and the LPG Market Law, EMRA's function was extended to the natural gas, oil and LPG sectors. The 2005 in-depth review commended the fact that EMRA has been given considerable powers, such as setting TPA tariffs, providing licences and making decisions that cannot be overruled by the government.

## STRONG AND EFFECTIVE UNBUNDLING AND NON-DISCRIMINATORY THIRD-PARTY ACCESS

For competition to develop in gas and electricity markets, effective unbundling of the electricity transmission/distribution network and of the gas transport network from gas supplies activities, and non-discriminatory third-party access are indispensable. If the incumbents can exclude or limit access to their networks by competitors, the network monopoly will be extended to an effective monopoly in the whole value chain. Unbundling can take different forms, namely, ownership unbundling or divestiture, legal separation and accounting separation. The form of unbundling can be affected by the ownership structure of vertically integrated companies before market reform. For example, divestiture could be legally difficult when vertically integrated companies are privately owned. Experience shows that all successfully liberalised electricity markets have transmission system operators, which are independent from the incumbents.

For example, in the ***United Kingdom,*** England and Wales conducted ownership unbundling of transmission in the first stage of electricity market reform in 1990/91. At that time, the Central Electricity Generating Board was split up into separate entities for generation, transmission and distribution, and supply, creating the National Grid Company (NGC), which owns and operates the transmission system and is responsible for calling up generation plant to meet demand. This eliminated the incentive as well as the ability of incumbents to discriminate, and contributed significantly to the creation of a competitive market. ***Spain, Sweden, Norway*** and ***Finland*** also chose ownership unbundling of transmission in the initial stage of their market reform.

The second ***European Union*** Directives on Electricity and Gas Markets in 2003 strengthened the unbundling requirement from accounting separation to legal separation and mandated the introduction of regulated third-party access to gas and electricity networks. Out of the former EU-15 countries, seven countries even chose ownership unbundling for electricity transmission and two countries have done so for the gas transmission network.

In 2001, the ***Netherlands*** purchased the ownership of TSO, TenneT, and made it the state-owned transmission system operator. This ownership unbundling, which went beyond the minimum requirement of the EU directive, was commended in the 2004 in-depth review. In March 2004, the government requested TenneT to take over the regional power transmission grid. In the gas sector, the Netherlands separated its gas supply (Gasunie Trade & Supply) and transmission company (Gasunie Transport) in July 2005.

***Denmark*** decided to make the government responsible for system operation and overall transmission to ensure that ownership is segregated between overall transmission services and production, and that the conditions for access to the grid are laid down independently of commercial interests. Following the agreement in March 2004, the government took over Eltra, Elkraft System and Elkraft Transmission from the local grid companies. An independent gas transmission system operator, Gastra, was established in the gas sector, being separated from DONG, a state-owned company which had been the owner of oil and gas pipelines. In 2005, Eltra, Elkraft System, Elkraft Transmission and Gastra were merged into Energinet.dk, a state-owned company responsible for ownership, operation and development of the natural gas and electricity transmission grid. The ***Czech***

***Republic*** also chose the same procedure. While TSO, ČEPS was established in 1999 as a 100% subsidiary of the incumbent, ČEZ, through a series of divestitures, the government became the sole shareholder in 2004.

## MINIMISING THE ABUSE OF MARKET POWER

Even though the energy market is fully opened, this does not automatically lead to effective competition. Strong market power of incumbents is a serious obstacle to the development of more vigorous competition. With a view to reducing market concentration, member countries have been taking various measures.

One of the earliest examples can be found in the early 1990s in the ***United Kingdom***. At that time, the three large power generators, PowerGen, National Power and Nuclear Electric, had a combined market share in excess of 80% in the generation market. PowerGen and National Power, which dominated the ownership of mid-merit coal-fired capacity, set the pool price 80% of the time or more. This opened vast possibilities for collusion and gaming to drive up the pool prices. Recognising these problems, the electricity regulator, OFFER, required these two companies to divest 6 000 MW of mid-merit generation power through a leasing scheme in 1993. Currently, the UK has one of the least concentrated generation market structures in European countries and the share of the three largest producers in terms of installed capacity is only 40%. In the field of natural gas, British Gas had been restricted from buying more than 90% of UK's North Sea gas in 1988 to allow the entrance of independent gas suppliers. However, because of a limited impact on competition, British Gas was obliged to make its gas available to the market following the investigation by the Monopolies and Merger Commission and the Office of Fair Trading in 1993. Currently, there are eight major gas suppliers, of which the largest shipper has a market share of less than 50%.

The ***Italian government*** launched an electricity release programme mandating ENEL to reduce its share in power generation from 72% to less than 50% by January 2003. Subsequently, 15 000 MW of ENEL's generating capacity was divested. Furthermore, no shareholder is allowed to acquire or hold stakes in more than one of the new companies created in the framework of the electricity release programme. While ENEL is still able to set prices using its position in the peak generating capacity and while there may be a need for further divestiture of ENEL's generating capacity, the 2003 in-depth review commended this as a positive step because it enabled a number of new participants to enter the market. In the field of natural gas, based on Decree 2000, from January 2002, no single gas operator is allowed to represent 75% of total gas supply (production and imports). This percentage will be reduced per annum until it reaches 61% by 2009. Similarly, no single gas operator is allowed to represent more than 50% of total sales to end-consumers from January 2003. In order to respect the limits, ENI sold an important quantity of gas beyond Italian borders to other Italian resellers, which instead of ENI brought the gas into Italy.

***Spain*** is striving to reduce the market power of incumbents by increasing interconnection with Portugal and France. The number of generating companies is increasing and an important share of the new and expected investment in combined-cycle gas turbine (CCGT) plants is being made by smaller and new entrants, such as gas companies. These developments would reduce the market share of Endesa and the three largest companies from 35% and 81% to 24% and 60% respectively. The 2005 in-depth review commended this as an important development for market efficiency and competition because CCGT plants are likely to set the market price in the future. In the field of natural gas, the government awarded 25% of the natural gas contracted by Gas Natural to six suppliers in order to help new companies to enter the gas market. Gas Natural was also requested to divest 60% of the TSO, Enagas, and to reduce its share to 5% in 2006 to ensure the TSO's independence.

## EXPANDING MARKET SIZE THROUGH REGIONAL INTEGRATION

Expanding the size of electricity and gas markets through enhanced international or inter-regional connection is instrumental to achieving effective competition, providing greater choice for consumers and reducing the market share of incumbents, thus weakening excessive market power. It also contributes to the security of supply. Various initiatives are under way in this direction.

The ***Nordic*** power market, Nord Pool, composed of Norway, Sweden, Finland and Denmark, is a good example of regional integration. Physical market, financial market and bilateral contracts expanded from 44 TWh, 53 TWh and 147 TWh in 1997 to 124 TWh, 1 019 TWh and 2 089 TWh respectively in 2002. Power trade between the Nordic countries makes use of the advantages gained from interconnecting hydropower and thermal power systems because it can reduce the need for costly adjustment of thermal plants and the need to invest in multi-annual water reservoirs. The resilience and effectiveness of these arrangements was demonstrated on occasions such as the 2002/03 winter when the market was able to maintain reliable services despite an extreme combination of a one-in-200-year water shortage and unusually cold winter in Sweden. The creation of the Nordic market also has the advantage of increasing the number of competitors and reducing market concentration in the region as a whole. The recent report by the Nordic competition authorities concludes that the Nordic market as a whole is only modestly concentrated while the individual geographic regions within the market are at risk of being more highly concentrated. In the 2003 in-depth review for ***Sweden,*** the IEA pointed out that a critical factor determining whether the Nordic electricity market can continue to deliver affordable and reliable outcomes is the degree to which it remains an integrated market. For this, the IEA urged that market splitting due to transmission congestion must be overcome because it could undermine effective competition, increase the cost of electricity and create opportunities for market power abuse. In February 2005, the Nordic TSOs committed themselves to undertake five transmission reinforcement projects totalling EUR 1.0 billion, which had been identified by Nordel and would have the potential to substantially alleviate undue congestion on the transmission backbone of the Nordic market. A new sub-sea transmission link between Norway and the Netherlands (the NordNed cable), which will be allocated with market coupling between APX (Dutch power exchange) and Nord Pool has also been announced recently. The 2005 in-depth review for ***Norway*** commended these welcome developments because they will widen trade within and beyond the Nordic market to secure reliable electricity services.

***France, Belgium*** and the ***Netherlands*** signed a memorandum of understanding (MOU) to increase co-operation in cross-border electricity issues in March 2004 and extended this to a joint consultation document. In July 2005, Germany, France, Belgium, the Netherlands and Luxembourg started a joint co-operation in cross-border electricity issues between these five countries. This co-operation will take the form of collaboration between the States' governments, regulators and transmission system operating (TSO) companies to deal with the region's most pressing power issues: congestion management and supply crisis management. It will also deal with trading of cross-border capacity, market transparency, market power and co-operation between regulators. The consultation document shows a real commitment to harmonising and integrating the three markets with a view to reducing inefficiencies along the borders as much as possible, so that customers throughout the expanded region will benefit. The soon-to-be-created Belgian electricity exchange, Belpex, will also be linked to Powernext in France and the APX Exchange in the Netherlands. This positive development towards more regional integration among these countries was commended in the 2005 in-depth review for Belgium.

Energy regulators from ***Ireland*** and Northern Ireland of the ***United Kingdom*** jointly published a High Level Design Decision in June 2005, setting out the high-level principles to govern the proposed new Single Electricity Market (SEM) for the island of Ireland following extensive consultation with industry participants and interested parties. The SEM will establish, for the first time, a single wholesale market in which generators and suppliers of electricity on the island will trade all their electricity on a daily basis regardless of their location on the island. Both regulatory bodies are proposing the construction of further electricity interconnections between North and South, which will enhance system security and reliability and will facilitate the development of the SEM. The Irish government also gave approval to proceed with the development of an electricity 500 MW interconnector between Ireland and Wales. These are positive developments since the last in-depth review, which recommended the development of an all-island electricity market and early decision on the construction of the East-West interconnector in the 2003 In-depth Review.

***Spain*** and ***Portugal*** signed a protocol of co-operation to create the Iberian Electricity Market (MIBEL). Cross-border capacity between Portugal and Spain is to be doubled by the end of 2005. Although its launch in April 2004 was delayed, system operators, regulators, market operators and relevant authorities have been working closely together to resolve technical, organisational and market rule issues so that the MIBEL can start in 2005. The 2004 in-depth review for Portugal and the 2005 in-depth review for Spain commended this as an important step towards competitive markets and encouraged both countries to reinforce their efforts.

In the ***United States***, the Midwest Independent Transmission System Operator (MISO) was established in March 2004. Operating a wholesale power market in fifteen US states and one Canadian province, it is one of the world's largest electricity markets, involving 15.1 million customers, doubling the North American Locational Marginal Pricing. The MISO and PJM (Pennsylvania-Jersey-Maryland) interconnection, operating in thirteen US states and one Canadian province, is the largest competitive wholesale electricity market serving 51 million customers and is working towards effective implementation of a robust, non-discriminatory single energy market covering their collective regions. The goal is to create a common wholesale market with a "one-stop shop" that meets the needs of all customers and stakeholders using the electric power grid in twenty-three US states, the District of Columbia and the Canadian province of Manitoba. In the field of natural gas, the North American gas market has been a typical example of an integrated and competitive regional market based on well-developed transport infrastructures between ***Canada*** and the ***United States***. Canada's transmission network interconnects with the US pipeline system at eight major export points along the US-Canada border. Pipeline links and substantial flows of gas from Canada to the US have effectively created a single gas network, while interconnection between the countries varies among states and provinces. Natural gas is traded on a daily basis with prices reflecting demand and supply factors in both Canada and the US.

## ENHANCING DEMAND-SIDE RESPONSE

Enhanced demand-side response can provide great benefit to the electricity market by reducing price volatility, reducing the market power of incumbents, reducing the need for peak capacities and reducing investment risks by providing more predictable prices to potential investors. Fostering demand-side response in the gas market also needs to be in line with the opening of the household sector to competition.

A recent example of significant demand-side response was observed in the ***Nordic*** market in the 2002/03 winter (see section above on Ensuring Undistorted, Cost-reflective Prices). Due to the price rising to an unprecedented level, temperature-adjusted consumption decreased in ***Norway*** and ***Sweden*** by roughly 3 TWh and 2 TWh respectively from October 2002 to February 2003. In Norway, the main reductions were with large industrial consumers as well as households and electric boilers. In Sweden, the main reaction was with large industrial consumers. This is a good example of demand-side response relying on the market, which is more efficient and effective than any government intervention.

## SECURITY OF SUPPLY

The issue of energy security has been a constant concern to member countries because of the risk of imminent oil supply disruptions due to political, military or social events in producing countries. At the same time, there is a growing recognition that energy policy-makers must address a much broader agenda than near-term supply risks. This includes long-term security of gas and electricity supplies under liberalised markets and growing dependence on oil and gas imports.

### COMPLIANCE WITH THE IEP STOCKHOLDING OBLIGATION

The Standing Group on Emergency Questions regularly reviews IEA member countries' emergency response programmes in order to identify strengths and weaknesses in national policies, including legislation, administrative structures, data collection and emergency preparedness and stockholding procedures.

Strong commitment to and compliance with the International Energy Program's (I.E.P) treaty obligation for member countries which are net oil importers to hold emergency oil reserve stocks equivalent to at least 90 days of net imports of oil is a fundamental facet of the IEA's emergency preparedness. As at 1 April 2005, total stocks in all IEA member countries reached nearly 4 billion barrels of oil, of which 1.4 billion is under direct government control in IEA member countries.

Moreover, ***Australia, the Czech Republic, Finland, Germany, Hungary, Japan, Korea***, the ***Netherlands, Sweden, Switzerland*** and the ***United States***, are net importing countries which hold more than the IEA required amount of stocks. Apart from Australia and Sweden, each of these countries has established a national stockholding agency which is charged with acquiring and maintaining either all or a portion of the country's IEA emergency reserves obligation. In addition, ***New Zealand, Portugal*** and ***Belgium*** recently have been commended for their progress in improving oil security by establishing national stockholding agencies.

### ENHANCING EXPLORATION OF DOMESTIC OIL AND GAS RESOURCES

In-depth reviews have often recommended those countries with domestic oil and gas resources make best use of such resources for the security of oil and gas supplies. The increasing dependence of member countries on oil and gas imports from non-member countries is making this even more important.

In the ***United Kingdom,*** the government policy in upstream production is designed to maximise production from domestic reserves as long as possible. To achieve this end, the licensing system was reformed in 2003 with the introduction of two new licences: *i)* the "promote" licence, at a tenth of the cost of a traditional licence, to attract new smaller investors, and *ii)* the "frontier" licence to ensure the maximum opportunity for appraisal of prospects west of Shetland. The "Promote UK" campaign is targeting potential new investors in the UK Continental Shelf, particularly those from North America. The Brown Fields Initiative is ensuring that operators pursue all economic options available to maximise overall production from existing fields. There have also been a number of tax changes. To remove a barrier to investment in older fields, the government abolished royalties from January 2003. In January 2004, the Petroleum Revenue Tax on all new third-party tariff business relating to the use of pipelines and other infrastructure was also eliminated. To encourage exploration, the government is introducing a new Exploration Expenditure Supplement to reduce barriers to entry for new companies that do not receive the full benefit of the current 100% exploration and appraisal capital allowances.

***Norway*** has recently changed its taxation system to reduce the financial risk to operators should they fail to find exploitable resources in their licence area. Operators are now allowed to reclaim exploration expenses up to the level of the petroleum tax (78%) should they not be in a tax-paying position in Norway, *i.e.* if they have not been successful in discovering resources in their acreage. This encourages new entry into the industry, by removing the risk of facing 100% of the exploration bill in the case of unsuccessful drilling activity. Further changes to taxation include reimbursement of deficits at termination of activity, again a risk-reducing measure for new operators who are unsuccessful in Norway, and changes to the depreciation system for short-life assets. These changes were commended in the 2005 in-depth review.

## FURTHER DIVERSIFICATION OF SUPPLY SOURCES AND ENERGY SOURCES

Diversification of oil supply sources is essential for energy security in those countries endowed with little domestic oil resources. In ***Japan,*** where dependence on the Middle East had been increasing since the mid-1980s to reach 89% (much higher than at the time of the first oil crisis), the government is making efforts to develop oil supplies via pipeline from Eastern Siberia. The 2003 in-depth review commended these efforts for their contribution to lowering dependence on the Middle East.

Diversification of gas supply sources is also essential for the security of gas supply. In particular, EU countries are largely dependent on pipeline gas imports from Algeria and Russia. While both countries have a long-standing record as reliable suppliers, some concerns still remain because neither of these two countries has clear gas upstream or transport regulations and their gas production and exports are managed by companies exercising sovereign rights of the state, which could create potential upward pressure on prices.

***Portugal,*** for example, since the introduction of natural gas in 1997, has been heavily dependent on long-term contracts from a single gas supply source, Algeria. The possibility of importing liquefied natural gas (LNG) has been substantially improved following the commission of the country's first LNG terminal at the end of 2003. Commercial imports of LNG from Nigeria started in January 2004, which has significantly enhanced security of supply both by diversifying supply sources and by providing enough supply capacity for several years. Transgas aims to import half of its supplies via pipeline and half as LNG, a strategy commended in the 2004 in-depth review for its contribution to further security of supply.

Diversification of gas import sources is an important issue for ***Italy,*** which relies heavily on pipeline gas from Algeria (44%) and Russia (33%). Given that dependence on imported gas is projected to rise from 78% in 2001 to 90-95% in 2010, the government intends to further diversify gas supplies from Libya (via pipeline) and Qatar (LNG). To favour supply source diversification, importers of gas from new producing countries are exempted from presenting an investment plan, whereas importers of gas from current supply sources must present an investment plan, thus contributing to the development and safety of the Italian gas system (import infrastructure, storage, distribution network, etc.) corresponding to 2.5%-5% of the annual income from imported gas depending on the share of the country in total imports.

Beyond diversification of supply sources, diversification of energy sources is also essential for ensuring energy security. Excessive dependence on one energy source, especially one which is heavily dependent on imports, should be avoided. In ***Ireland,*** the National Climate Change Strategy proposed the closure of Moneypoint coal power plant in 2008 to achieve the Kyoto target. However, if this plant were to be shut down, by 2010 up to 80% of Irish electricity could come from imported natural gas, which could cause energy security concerns. Following thorough consideration of the advantages and disadvantages of this proposal, the Irish government decided to keep Moneypoint plant in operation. The environmental issues will be addressed by the investments to reduce nitrogen oxides ($NO_x$) and sulphur oxides ($SO_x$) and the purchase of carbon credits through emissions trading. This can be regarded as a pragmatic approach to ensure energy diversification in line with environmental protection.

## FOSTERING INVESTMENT IN GAS AND ELECTRICITY FACILITIES

With a growing share of natural gas in the energy mix and increasing concerns about blackouts, recent in-depth reviews have often addressed how appropriate gas and electricity investment can be fostered under liberalised markets.

## MONITORING INVESTMENT NEEDS

One of the important responsibilities of governments is to monitor investment needs and investment performance and to make the results public. If the market fails to generate the necessary investment on its own, governments should act, *i.e.* to provide additional market incentives while avoiding market distortion.

In ***Australia***, the NEMMCO (National Electricity Market Management Co.) is responsible for publishing an SOO (Statement of Opportunities) annually on 31 July. The SOO includes NEMMCO's assessment of the future supply-demand balance and, since 2004, the Annual National Transmission Statement (ANTS). SOO is intended to assist market participants in assessing the future need for electricity generating capacity, demand management capacity and augmentation of the transmission network to support the operation of the NEM (National Electricity Market). The supply-demand balance presents NEMMCO's assessment of the adequacy of electricity supply to meet projected demand for the next ten years. The assessment begins by defining the minimum reserve levels each state must have to meet the Reliability Standards which mandate meeting 99.998% of customer demand over the long term. Then, comparing with projected demand, the assessment identifies years in which the reliability could be below the Reliability Standards if no action is taken to bring new capacity to the market or to dampen demand below expectation. ANTS provides an overview of the current state and potential development of major transmission flow paths and assesses the need for network capacity over a 10-year time horizon. The SOO approach was commended in the 2005 in-depth review for striking a good balance between government involvement and reliance on market forces.

In the ***United States***, where substantial investment is needed, including in new gas pipelines and LNG importing terminals, the government conducts various analyses of energy infrastructure and identifies regional areas which will need additional infrastructure. In addition, the market is well informed through projections of key market parameters such as growth in demand. The 2002 in-depth review commended such approach and encouraged the continuous review of the adequacy of investment in gas transmission, distribution and storage.

## SENDING THE RIGHT SIGNALS TO INVESTORS

Governments need to ensure that markets can work properly and send the right signals to attract the necessary investment. Creating a more stable regulatory framework is crucial not only for effective electricity and gas market reform, but also for sending clear signals to potential investors. The role of government is to help decrease regulatory risks and thereby improve financial conditions by creating a clear and stable framework for investment. While low probability events may necessitate additional incentives, in general the IEA thinks that market incentives should be sufficient to ensure adequate investment as long as prices reflect real costs. This has been the case in South Australia during the price spikes from 1999 to 2000. In the ***United Kingdom***, Department of Trade and Industry (DTI) and OFGEM set up the Joint Energy Security of Supply working group (JESS) in 2001 *i)* to assess the available data relevant to security of supply, *ii)* to monitor the availability of electricity and gas supply and the adequacy of generating capacity and gas/electricity infrastructure and *iii)* to assess whether appropriate market-based mechanisms are bringing forward timely investment. For this purpose, the JESS group has established a series of indicators to monitor security of supply of gas and electricity within a timeframe of at least seven years ahead. These indicators include: supply and demand forecasts of gas (potential daily gas delivery capability versus peak diversified gas demand during a 1-in-50 winter in the UK, demand duration curves, annual supply and demand); supply and demand forecasts of electricity (generation by fuel type, generation margin, generation profile, load duration of backup fuel supplies); market signals (forward gas and electricity prices); and market response (planned major new gas and electricity projects). These indicators will help consumers, suppliers and producers to see when supplies are relatively plentiful or tight and send appropriate signals to potential investors.

Minimising commercial restrictions on the use of investment is also essential to stimulate new investment. For example, application of regulated third-party access (TPA) to new gas investments such as LNG terminals, import pipelines and storage, which can be contested, may deter new investment and hamper security of gas supply. With this in mind, the second ***European Union*** Directive on Gas Markets includes Article 22, which permits some investment to be exempted from TPA under certain criteria, such as security of supply. In 2002, the ***United States*** Federal Energy Regulation Commission (FERC) authorised the TPA to LNG terminal in Hackberry, Louisiana to be based on mutual market-based agreement instead of regulated cost-of-service rates. The FERC also exempted the company from having to provide open access service. This new policy allows owners of LNG terminals the exclusive use of the entire capacity of an LNG terminal, suppressing the uncertainty faced by LNG terminal developers. The ***United Kingdom*** also decided that exemption from TPA could be given to new plants on a case-by-case basis, recognising the need to be flexible for new regasification terminals.

## STREAMLINING LICENSING PROCEDURES FOR ENERGY INFRASTRUCTURE

In many countries, energy infrastructure projects (refinery, LNG terminal, pipeline, generation, transmission, etc.) are encountering very long lead times for development approval. The existence of several regulatory bodies operating at central and local government levels is one of the contributing factors. Furthermore, licensing procedures by local authorities tend to be very slow because of local opposition and the NIMBY (not in my backyard) or even BANANA (build absolutely nothing anywhere near anybody) phenomena. Member countries are struggling hard to address these issues to ensure security of supply in the coming decades.

In 2002, ***Italy*** implemented a mechanism to streamline the decision-making process for some energy projects through the Sblocca Centrali, the simplified procedure for new plants as well as the modification and re-powering of existing plants. The Sblocca Centrali is a single authorisation process in the Ministry of Productive Activities to replace various separate authorisations, concessions and acts of agreement of local authorities. The introduction of the Sblocca Centrali reduced the risk for investors, provided an added incentive for them to come forward and resulted in more than seventy applications for a total of 67 700 MW of new capacity that were filed for evaluation. As of May 2005, forty-one authorisations for a total of 35 000 MW have already been released since 2002, of which twenty permits under the new legislation framework for a capacity of 15 430 MW. In 2004, Italy also introduced a law (the so-called "Marzano Law") which seeks timely investment in energy-related infrastructure. This law obliges regional authorities to respect a maximum 180-day delay in replying to applications for authorising new energy infrastructure, and if this delay cannot be respected, the law transfers the authority to the government. While the effectiveness of this law remains to be seen, these initiatives were commended as positive steps to address NIMBY issues in the 2003 in-depth review.

## NUCLEAR

There is a marked difference among member countries regarding their position on nuclear power. Some countries wish to retain and improve the nuclear option for the future because nuclear energy contributes to energy diversification and climate change mitigation. Other countries are ruling out or attempting to phase out nuclear options because of perceived safety concerns and continuing uncertainty over long-term waste storage.

### CLARIFYING THE ROLE OF NUCLEAR IN THE LIBERALISED MARKET

Countries attempting to keep their nuclear option and to construct new nuclear power plants face a challenge to ensure investments in nuclear power in a competitive and deregulated market owing to the risk of longer construction lead times and higher capital cost.

In this context, it is noteworthy that the Parliament in ***Finland*** ratified the government's decision-in-principle in favour of the fifth nuclear power plant in 2002 as a key element to meet increased Finnish electricity demand and address global climate change. This is the first nuclear facility to be built in a liberalised electricity sector. It seems feasible that the facility will achieve commercial operation by the end of 2009 as planned, given the preparedness of both industry and STUK (the Radiation and Nuclear Safety Authority) and the authorisations already obtained from the central government and local authorities. The economic advantages of nuclear power in the present Finnish context are stability of costs in the long term (as compared with potential volatility of gas prices, for example) and projected levelised lifetime costs. TVO, the project developer, is an energy company owned 57% by companies that are majority-owned by the private sector and 43% by companies that are majority-owned by the government and municipalities. TVO's largest shareholder is PVO, a co-operative controlled mostly by energy-consuming companies and municipalities. TVO's second-largest shareholder is Fortum Power and Heat Oy, owner of numerous power plants and 61% owned by the Finnish government. TVO has a co-operative structure in that it supplies electricity directly to its shareholders at cost. That co-operative structure reduces investor risks (since the owners will also be the main consumers of the proposed plant's output) and will give TVO access to relatively low interest rates, thus reducing the plant's overall costs. It also should be noted that the owners of TVO are taking certain risks because all electricity will be passed on to the owners even when market prices are lower. The fact that commercial and large-scale market players are willing to take these risks sends an important signal to incumbent utilities which used to be able to pass on all risks to their captive consumers.

In the ***United States,*** the government developed the Nuclear Power 2010 Programme in 2002 as a joint government-industry cost-shared programme to identify potential sites for new nuclear power plants, develop near-term advanced nuclear power plant technologies and demonstrate untested regulatory practices that will lead to decisions by power companies to deploy new nuclear power plants within the next 10-15 years. The Congress passed and the President signed a comprehensive energy bill in September 2005 that will offer incentives to power companies undertaking construction of new nuclear power plants in the form of long loan guarantees; indemnification of certain expenses caused by delaying commissioning and operation when the causes are beyond the control of the power company; and production tax credits for the first 8 years or operation of up to 6 000 MW of new nuclear power plant capacity.

## IMPROVING AVAILABILITY AND LIFE EXTENSION OF EXISTING PLANTS

Improving the availability and life extension of existing plants is instrumental in making the best use of nuclear power plants given that the construction of new plants is becoming more challenging in the liberalised and deregulated markets, as described above.

In the ***Netherlands,*** the availability of the Borssele nuclear power plant has significantly improved after major modernisation work in 1997-1998, reaching up to 96%, one of the top performers compared with the world average of 81%. The availability of nuclear reactors in ***Finland*** and ***Spain*** is also very good at almost 90%. In the ***United States,*** licence extensions are a major source of "new" generating capacity for 2010-2040. Most nuclear plants are expected to be relicensed and to operate for a further twenty years, generating 15 000 TWh of electricity, equivalent to meeting four years of current electricity demand. As of August 2005, the life of 33 units has already been extended to 60 years and applications for a further 16 units have been already submitted to the Nuclear Regulation Commission. Some 25 additional units have indicated that they will be submitting applications. These 74 units represent a very significant proportion of the 104 operating units in the US.

## ENSURING PUBLIC ACCEPTANCE

One of the biggest challenges for countries attempting to keep and enhance the nuclear option is how to improve the level of public acceptance to nuclear.

In the ***United States***, a survey conducted for the industry's Nuclear Energy Institute in July 2001 found that recent increased support for nuclear power held at high levels. Almost two-thirds of US adults support building new nuclear power plants and there is near public consensus on renewing federal licences of existing nuclear power plants that meet federal safety standards. The survey shows a marked change in public opinion. In October 1999, only 42% of US adults supported the construction of new nuclear plants. The 2001 survey suggests that US public opinion is not an impediment to the future development of the industry. This result stands in contrast to the experience in some other nuclear countries, where public opinion is proving to be a major obstacle for policy-makers planning the future role of nuclear power.

In the National Debate on Energies in ***France*** in 2003, the government disseminated information on energy supply/demand balance, environmental constraints and economic and geopolitical issues through a series of national symposia in Paris and the provinces. The symposia involved energy experts and non-governmental organisations (NGOs), "Partner Initiatives" involving NGOs, local communities and public institutions, and publicity (website, leaflets, etc.). As a consequence, the general attitude towards nuclear in France has changed. According to an opinion poll in February 2004, people who are in favour of nuclear (28%) outnumbered those who are against it (17%) and support for maintaining or increasing nuclear capacity has increased from 42% in 2002 to 54% in 2004. Concerns about climate change and oil spills, better information concerning the advantages and risks of nuclear energy and the war in Iraq were identified as major reasons for this shift.

Rejection of two public initiatives for the phasing-out of nuclear in ***Switzerland*** (see General Energy Policy section above) is another example of improved public acceptance of nuclear.

## ADDRESSING NUCLEAR SAFETY AND RADIOACTIVE WASTE

Ensuring nuclear safety and resolving the radioactive waste issue need to be addressed for all the countries with nuclear power, no matter whether they intend to maintain or phase out the nuclear option. All member countries with nuclear energy are making utmost efforts to ensure nuclear safety.

In 2002, ***France*** established a new regulatory organisation, DGSNR (Direction Générale de la Sûreté Nucléaire et de la Radioprotection), merging the former nuclear safety organisation and the radiation protection authority to reinforce the relationship between nuclear safety and radiation protection and to clearly separate the roles of operator and regulator. As part of the reform, the principal technical support organisation of the regulator was separated from the CEA (Commissariat à l'Énergie Atomique) and an autonomous public organisation, IRSN (Institut de Radioprotection et de Sûreté Nucléaire) was created. Furthermore, the government intends to present a new law to Parliament to define principles of transparency and specific measures regarding the availability of information for stakeholders and for the general public. The high nuclear safety standards under the DGSNR control, as well as the government's intention to increase transparency and accountability of regulatory activities, were commended in the 2004 in-depth review.

In ***Spain,*** nuclear safety is measured by long-term nuclear plant performance indicators (average number of automatic critical reactor shut-down, average of safety systems performances, average of significant events, average of safety system failures, average rate of forced shut-downs, average of collective radiation exposure, etc.). Almost all indicators show a decreasing tendency, indicating safer operations during the previous ten years.

The 2003 in-depth review of ***Finland*** commended the government and industry for having taken timely measures towards the implementation of safe solutions for the management and disposal of all types of radioactive waste. The high-level waste repository near Olkiluoto is scheduled to be commissioned by 2020 while a number of laboratory tests remain to be completed before construction and operation licences are issued.

In 2002, the President of ***the United States*** recommended, and the Congress approved, the Yucca Mountain site for development as a geologic repository of high-level radioactive waste. The Department of Energy is now working towards submitting a licence application to the Nuclear Regulatory Commission to construct the repository. In August 2005, the US Environmental Protection Agency published proposed revisions to its radiation protection standards for the Yucca Mountain site. The revisions, in response to a Court decision demanding the 10 000-year time of compliance, add a separate 1 000 000-year standard with a limit of 3.5 millisieverts/year. Once finalised, compliance with the new standard will be addressed as part of the licensing process. In parallel, the department's integrated transportation programme is also moving forward. Based on the Yucca Mountain Final Environment Impact Statement, a rail corridor in Nevada was chosen in April

2004 to support the shipment of radioactive materials to the proposed repository. These decisions will have a positive impact worldwide on future investment in nuclear power. This is significant progress since the 2002 in-depth review which recommended an early and firm decision on the Yucca Mountain repository.

# RESEARCH AND DEVELOPMENT

## ENSURING FUNDING FOR GOVERNMENT R&D

Energy technologies are expected to make a substantial contribution to mid- to long-term solutions of energy policy challenges, namely, energy security, environmental protection and economic growth. Despite these critical roles, government energy R&D budgets in many member countries were reduced between the early 1980s and the 1990s. The role of government energy R&D budgets is becoming more critical given that R&D activities in the private energy sector tend to be reduced as a result of competitive pressure under market liberalisation. It is encouraging to observe a reversing trend in member countries in recent years.

***Canada***'s public R&D spending significantly increased between 2000 and 2003 from CAD 200 million to CAD 240 million, reversing the declining trend throughout the 1990s when the budget was cut from CAD 272 million in 1991 to CAD 169 million in 1999. In ***Spain,*** the public energy R&D budget was increased from EUR 34 million under the 3rd National Plan for Energy R&D Programme (2000-2003) to EUR 42-44 million under the 4th National Plan (2004-2007). ***Norway*** increased its R&D budget substantially from NOK 384 million in 2003 to NOK 441 million in 2004 after a period of sharp decline in the mid-1990s. This budget rose again by 28% in 2005. ***Belgium***'s 2003 energy R&D budget of EUR 76.7 million showed a large increase from EUR 54.6 million in 1999. The in-depth reviews commended these developments. It is noteworthy that ***Japan*** (0.86%), ***Finland*** (0.50%), ***Switzerland*** (0.42%), ***Sweden*** (0.36%), the ***Netherlands*** (0.32%), the ***United States*** (0.27%), ***Canada*** (0.26%), ***Norway*** (0.26%) and ***France*** (0.26%) have relatively higher shares of government energy R&D per thousand units of GDP according to 2002 figures.

## CONSISTENCY WITH NATIONAL ENERGY POLICY GOALS WITH CLEAR PRIORITISATION

Given the stringent budgetary conditions for government energy R&D programmes in many member countries, a coherent energy R&D strategy with clear prioritisation in line with national energy policy goals is essential. Some good practices identified in previous in-depth reviews are presented below.

In ***Canada,*** the PERD (Programme of Energy Research and Development) is planned and conducted with energy policy guidance from Natural Resources

Canada (NRCan), strategic directions from the Interdepartmental Panel on Energy R&D, and external advice from the National Advisory Board on Energy Science and Technology. ***Norway***'s energy R&D is closely aligned with Norwegian energy policy objectives, with the majority of energy R&D spending going to the areas contributing most significantly to Norway's energy supply and wealth. Its OG21 (Oil and Gas in the 21st Century) strategy is successfully delivering the research required to keep the Norwegian Continental Shelf (NCS) an attractive exploration and production area. ***Finland***'s energy R&D programmes are consistent with long-term national policies on industry, energy and technology. Priority is given to technologies that suit Finland's particular characteristics such as energy conservation and bioenergy. With such a focused approach, Finnish energy technology now accounts for 6-7% of all Finnish exports. Under the ***Netherlands***' long-term strategy towards sustainable energy systems, two governmental groups reviewed the energy R&D programmes and priorities. The "energy transition group" undertook a large modelling exercise, running a range of technology scenarios to determine which technologies were the most dominant and robust in each scenario. A second "R&D group" undertook a major stakeholder consultation exercise. Starting from 63 potential technology R&D options as defined by stakeholders, the exercise ended up with 15-20 ranked priority topics based on two criteria: *i)* the contribution to a sustainable energy system in the light of 15 indicators and *ii)* a leading position for the Netherlands in the field of the energy R&D in question. A technology gets priority if it has a high score in both criteria. A high score on *i)* but low on *ii)* means that some knowledge is desirable, mainly to be imported from other countries. Financial support is given to the high priority areas and, to a limited degree, to "import options". ***Australia*** has clearly defined the role of energy R&D in its energy White Paper in June 2004. The Energy Technology Assessments in the White Paper provide a guideline for priority setting for energy R&D. Based on Australia's unique needs and capacities, it assessed a broad range of energy-related technologies and grouped them into three categories: "market leader" where Australia can play a leading role in international R&D efforts, "fast follower" where Australia has a strong position in quickly following international developments and "reserve" where Australia monitors international developments and follows as needed.

## CAREFUL MONITORING OF THE PERFORMANCE OF GOVERNMENT-FUNDED R&D

In addition to proper prioritisation, effective monitoring and assessment of the performance of government-funded energy R&D are also crucial to maximise the cost-effectiveness of the R&D programme. ***Canada*** has been restructuring PERD to improve its efficiency, increase its focus on long-term activities and adapt to respond to climate change policies. The government has been reviewing one quarter of PERD's objectives each year and completed a full cycle over four years at the end of 2003. ***Austria*** invited foreign experts from Germany, Switzerland and the Netherlands to evaluate the sub-programmes of its Austrian Programme on Technologies for Sustainable Development.

## STRONG COLLABORATION AMONG VARIOUS INSTITUTIONS DEALING WITH ENERGY-RELATED R&D

When many organisations carry out energy-related R&D activities, appropriate collaboration is one of the prerequisites for the effectiveness of such activities. The increasing linkage between energy and other research areas further necessitates effective collaboration among research organisations. For example, ***Canada***'s PERD is governed by the Panel on Energy Research and Development composed of assistant deputy ministers and senior officials from the federal R&D departments and agencies which perform or manage energy R&D and which have a policy interest in science and technology. The ***Swiss*** Federal Office of Energy (SFOE) co-ordinates most federally directed energy R&D with advice from the CORE (Commission for Energy Research) composed of representatives from industry, research institutes, funding institutions and cantons. National Energy Research Conferences are held every 3-4 years in Switzerland to bring together industry leaders, representatives of the cantonal and federal agencies, politicians and energy experts to review national priorities and recommend corrections.

## PUBLIC-PRIVATE PARTNERSHIPS

It is increasingly important to improve private-sector R&D activities to facilitate the process of technology deployment. Furthermore, with market liberalisation where private-sector R&D becomes more focused on short-term and applied research, governments also need to redefine their roles and improve their policy measures to stimulate private initiatives more effectively. Some good practices have been identified in previous in-depth reviews.

The ***United States*** is conducting large-scale public-private partnership initiatives such as the FreedomCAR Partnership (2002) and the Hydrogen Fuel Initiative (2003). Together, the extensive multi-year research efforts of these two initiatives are intended to facilitate a decision by industry to commercialise hydrogen-powered fuel cell vehicles by the year 2015. In ***Australia,*** the CRC (Co-operative Research Centres) Programme links researchers and research users in the public and private sectors, supporting both R&D and commercialisation/demonstration. The "Share Cost" scheme in ***Ireland*** engages the private and public sectors through sharing risks of short- to mid-term R&D. Typically, shared cost projects will qualify for support of up to 40% of eligible contract costs. The Green Paper on Sustainable Energy published in 1999 allocated 50% of the total energy R&D budget through the Share Cost scheme. In the ***United Kingdom,*** the government supports collaboration between universities and companies on long-term solutions, in particular in the oil and gas industry. The R&D that receives support is recommended by PILOT, a joint industry-government body setting targets for future offshore production levels, capital investment and employment levels. ***Norway*** also has strong public-private partnerships. OG21 is a successful attempt to closely involve players in the management of research activities. Nine key technologies have been identified and the lead parties, which have been selected among the most important oil companies on the NCS, is working well to ensure that R&D is carried out within these technological areas with a focus on results applicable to the industry. This has led to a high rate of additional spending by the oil industry on a rate of NOK 3-4 spent by industry for every NOK 1 spent by the government.

## MULTILATERAL AND BILATERAL INTERNATIONAL CO-OPERATION

International co-operation, on both a multilateral and a bilateral basis, is an instrumental means to maximise the benefit of energy R&D. Within a context of increasing globalisation and shifts of emphasis away from national R&D, such international collaborative efforts promise better returns on R&D investment through the sharing among participants of financial outlay, workload and results. For example, in 2003, the ***United States*** initiated a ministerial meeting for the Carbon Sequestration Leadership Forum (CSLF) as a framework for international co-operation in research and development for the separation, capture, transportation and storage of carbon dioxide. IEA Implementing Agreements can play a vital role in simplifying international co-operation between national entities, business and industry. ***Canada, Denmark, Finland, Japan, Norway, Sweden,*** the ***United Kingdom*** and the ***United States*** each participate in more than 20 Implementing Agreements of the IEA. In particular, compared with their respective total government budgets, the active participation of Nordic countries in these agreements is remarkable.

# CONCLUSION

Each in-depth review observes that the reviewed countries are making considerable efforts and progress in implementing energy policies in line with the IEA's Shared Goals. On the other hand, the challenges which member country energy policy-makers have to address are becoming increasingly complex.

When the IEA was established in 1974, the primary mission of energy policy-makers was to mitigate the damage from any future oil supply shock. However, in response to changes in energy markets and in the world surrounding them, the mission of energy policy-makers has expanded from oil supply security to broader energy security, including other forms of energy such as natural gas and electricity. Furthermore, broader energy security needs to be compatible with other energy policy objectives, namely, the pursuit of greater economic efficiency in the energy sector and the mitigation of the environmental consequences of energy production and use, neither of which was recognised as a primary energy policy objective in 1974. Achieving all of these objectives simultaneously is a daunting task. While market reforms should, in principle, reinforce energy security, this depends on the design of reforms and incentives for investors. Actions to reduce GHG emissions could have profound implications on energy markets and energy security.

In pursuing energy policies, it is becoming more important to ensure public awareness and visibility of the national energy situation and future challenges. Ensuring public awareness is particularly crucial to address climate change issues because the general public is responsible for the rapid increase of GHG emissions in residential/commercial and transport sectors and to overcome the NIMBY phenomenon in energy-related investments, which are indispensable for future energy security. The cross-sectoral nature of energy policy challenges requires stronger co-operation among relevant ministries and between central and local governments.

Ensuring cost-effectiveness in addressing GHG emissions reduction targets is a challenge that all countries must face. However, assessing the cost-effectiveness of policies and measures does not yet form an integral part of the decision-making process in most countries. Such assessment should lead to a re-evaluation of the current priority of policy mix, if necessary. Emphasis should be placed on market-based instruments. Some policies promoting renewable energies are instrumental, but tend to be costly to the economy. Energy efficiency improvements in the residential/commercial sector and the transport sector often lag behind.

Although energy markets are undergoing liberalisation in all member countries, this does not automatically lead to effective competition. For example, the strong market power of incumbents is a big obstacle in many countries. Expanding market size through regional integration is one viable solution. A strong and independent energy regulator, effective unbundling and non-discriminatory access to facilities are also essential.

Unlike the period when governments managed the energy sector, governments' role in liberalised electricity and gas markets is to define the right framework for market players so that markets can deliver reliable supplies and ensure that market players follow the rules. To fulfil massive investment needs in the coming decades, governments should monitor investment needs and, if markets fail to generate the necessary investment on their own, governments should provide additional market incentives. At the same time, care should be taken that direct intervention by government does not decrease the economic efficiency of the system as a whole.

All of the above illustrates the complexity of the challenges facing energy policy-makers in member countries today. The good practices presented above provide examples of how member countries are trying to address these challenges. While they may not be instantly applicable in other countries, they can provide useful insights and inspiration to energy policy-makers in considering how to address similar challenges in their own countries.

The value of the peer review process could further increase under such difficulties and complexities. Policy-makers could use this process to overcome domestic bottlenecks for implementing more effective policies and could benefit considerably from information exchange with other member countries, taking advantage of learning opportunities from both successful and unsuccessful experiences of their peers in other countries.

## ENERGY DEMAND: OECD

In 2004, the total primary energy supply (TPES) of OECD countries reached 5 497 million tonnes of oil equivalent (Mtoe), an increase of 1.9% over the previous year. TPES rose by 3.2% in OECD Pacific, 2.5% in OECD North America and 1.5% in OECD Europe. In OECD Pacific, Japan recorded a high growth of 3.9% following a period of continuous decrease since 2000. In OECD North America, there was a 1.9% increase in the United States, while in Canada it stayed at the same level. In OECD Europe, with the exception of Austria, Belgium, Denmark, Hungary and Switzerland, all countries recorded positive growth. In particular, relatively high rates of growth were recorded in Norway (14.8%), Spain (5.0%), Turkey (4.4%), Portugal (3.3%), Sweden (3.1%) and Italy (2.7%).

In 2004, oil remained the largest source of energy, *i.e.* 41% of TPES in OECD countries, followed by natural gas (22%), coal (21%), nuclear (11%), non-hydro renewables (4%) and hydro (2%). These shares were almost the same as figures for 2003. The share of oil, gas and coal out of TPES differs among regions. In OECD North America, it was 41%, 23% and 21% respectively. In OECD Europe, the share of each fuel was 37%, 24% and 18%. In OECD Pacific, it was 45%, 14% and 25%, where the share of coal was much higher and that of natural gas much lower than in the other two regions.

In 2004, OECD North America accounted for 50% of TPES of OECD countries, followed by OECD Europe (34%) and OECD Pacific (16%).

In the longer period between 1990 and 2004, the TPES of OECD countries grew by 22%. This growth has been strongest in OECD Pacific (38%), followed by North America (22%) and Europe (15%). The share of natural gas has increased from 19% to 22%, while those of oil and coal have decreased from 42% and 23% to 41% and 21% respectively. This trend was led by OECD Europe, where the share of gas has increased from 16% to 24% at the expense of coal, down from 27% to 18%.

Table 1

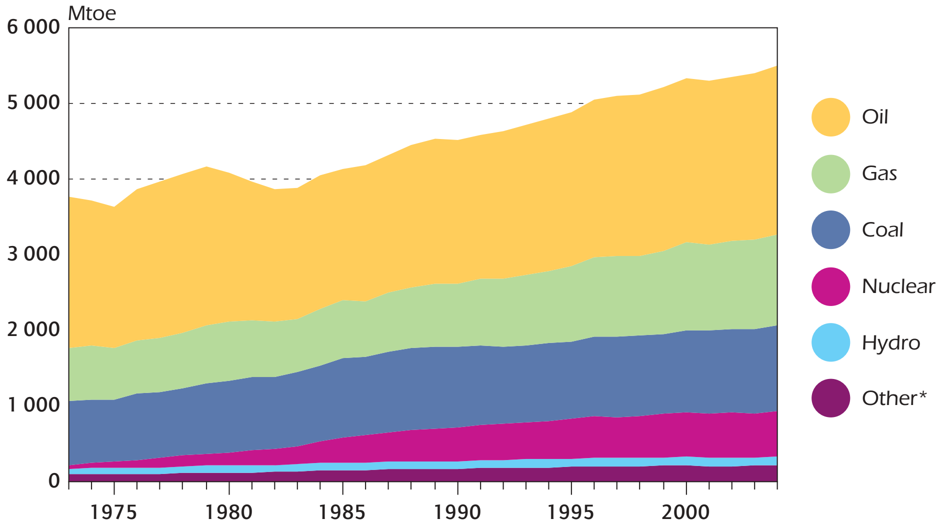
## Total Primary Energy Supply in OECD Regions (Mtoe)

| | *1990* | *2002* | *2003* | *2004*[1] |
|---|---|---|---|---|
| **TPES TOTAL** | | | | |
| Total OECD | 4 523 | 5 350 | 5 395 | 5 497 |
| North America | 2 261 | 2 694 | 2 701 | 2 749 |
| Europe | 1 623 | 1 805 | 1 841 | 1 868 |
| Pacific | 639 | 851 | 852 | 880 |
| **OIL** | | | | |
| Total OECD | 1 899 | 2 171 | 2 197 | 2 235 |
| North America | 931 | 1 079 | 1 105 | 1 138 |
| Europe | 627 | 694 | 691 | 700 |
| Pacific | 341 | 398 | 401 | 397 |
| **GAS** | | | | |
| Total OECD | 841 | 1 169 | 1 189 | 1 194 |
| North America | 517 | 648 | 640 | 633 |
| Europe | 258 | 408 | 429 | 440 |
| Pacific | 66 | 114 | 119 | 122 |
| **COAL** | | | | |
| Total OECD | 1 062 | 1 100 | 1 106 | 1 133 |
| North America | 486 | 579 | 569 | 579 |
| Europe | 437 | 321 | 332 | 332 |
| Pacific | 140 | 200 | 205 | 222 |
| **NUCLEAR** | | | | |
| Total OECD | 450 | 593 | 580 | 604 |
| North America | 180 | 232 | 228 | 238 |
| Europe | 204 | 253 | 256 | 257 |
| Pacific | 66 | 108 | 96 | 109 |
| **HYDRO** | | | | |
| Total OECD | 101 | 109 | 107 | 109 |
| North America | 51 | 55 | 55 | 55 |
| Europe | 38 | 43 | 40 | 43 |
| Pacific | 11 | 11 | 12 | 12 |
| **OTHER*** | | | | |
| Total OECD | 171 | 207 | 217 | 222 |
| North America | 97 | 101 | 105 | 106 |
| Europe | 59 | 86 | 93 | 36 |
| Pacific | 15 | 20 | 20 | 19 |

1. Preliminary data.
* Includes combustible renewables, heat, geothermal, solar and wind.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 1

**Total Primary Energy Supply in OECD Countries, 1973 to 2004**




* includes geothermal, solar, wind, heat, combustible renewables and waste.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

# OIL

In 2004 global oil consumption grew by an unusually strong 3.6% (2.89 mb/d), to 82.29 mb/d. This "demand shock" may be attributed primarily to robust global economic performance and the take-off of the Chinese economy following the severe acute respiratory syndrome (SARS) crisis in 2003. On the whole, non-OECD consumption grew by 6.8% (2.09 mb/d), or over two-thirds of total oil demand growth. Of this, Chinese demand alone grew by an astonishing 860 kb/d in 2004, which accounted for just under one-third of global oil demand growth. OECD oil consumption grew by a comparatively modest 800 kb/d (1.6%) in 2004, to 49.46 mb/d. However, this is the largest incremental oil demand increase the OECD has posted since 1999. OECD consumption growth remained below 100 kb/d over the period 2000-2002, before returning to growth of 690 kb/d in 2003.

OECD consumption growth varied regionally and was generally correlated with 2004 economic performance. North American demand grew by a robust 830 kb/d, while Asia-Pacific demand contracted by 180 kb/d. European demand growth remained flat at 150 kb/d. Looking to 2005, OECD oil demand growth is projected to slow somewhat in the face of relatively high oil prices and more subdued economic growth. North America is expected to remain as the growth leader, accounting for over half of the incremental growth in OECD oil consumption.

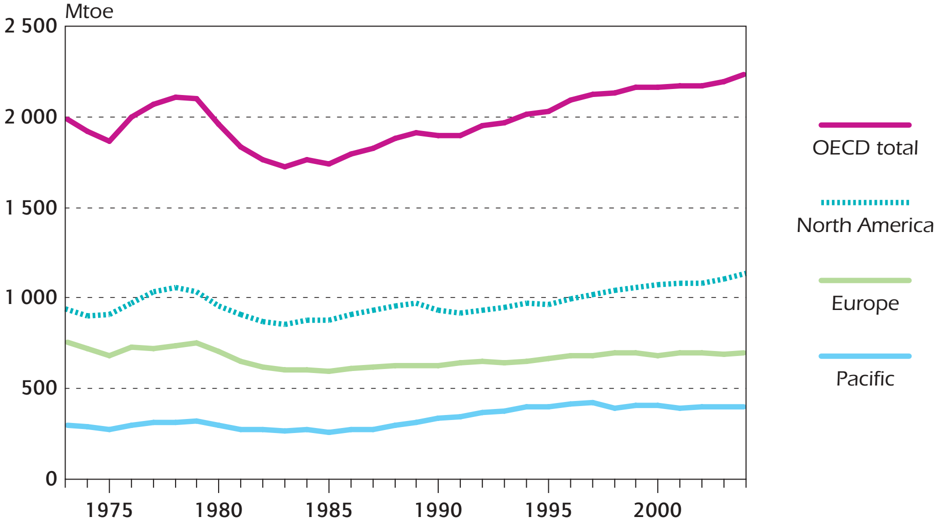
North American demand was boosted by strong economic growth, as the US and Mexican economies expanded by approximately 4.4%. Typically, North American oil product demand growth is driven by gasoline, which accounts for over 40% of total product demand. Although gasoline demand grew by 2.1% in 2004, rapid growth in the consumption of middle distillates also played an important role in the oil product market. Diesel demand grew by 5.4% as truck tonnage increased with economic expansion and increased trade flows. Consumption of jet fuel/kerosene increased by some 4.2% as airlines brought older, less fuel-efficient aircraft back into service to satisfy booming demand for air travel. As was the case in 2003, relatively high natural gas prices contributed to the substitution of fuel oil at the margin, contributing to a 4.9% increase in the demand for residual fuel oil. In 2005, North America's incremental increase in the demand for oil products is projected to slow compared to 2004, largely owing to high product prices and somewhat weaker economic performance.

Although OECD Europe consumption growth was relatively stagnant in 2004, several key trends are having a substantial impact on the global oil product market. Most importantly, Europe is continuing its move towards diesel and away from gasoline in the transport sector. Lower retail prices, improved technology/diesel engine performance and superior fuel efficiency are encouraging consumers to switch from gasoline to diesel. In 2004 European demand for diesel increased by 4.7%, while the demand for gasoline fell by 2.3%. This trend is expected to continue for the foreseeable future, which will contribute to a tightening of the regional middle distillate market and likely lead to increased gasoline exports. Among other products, the demand for jet fuel/kerosene grew by 3.2% with increased air travel. In contrast, the demand for heating oil declined because consumers were reluctant to fill their tanks at high prices. Overall, heating oil demand is expected to continue its prolonged decline as natural gas makes inroads into the market and consumers switch to more efficient boilers. In 2005, OECD Europe oil consumption is projected to remain flat.

The 180 kb/d decline in OECD Asia-Pacific oil consumption in 2004 can be attributed in large part to a 150 kb/d decline in Japanese demand. This reversed a 90 kb/d increase in Japanese demand in 2003. The swings in Japanese demand were in part due to shortfalls in nuclear power generation related to a controversy over nuclear reactor safety rules and practices. As a consequence, Japanese power utilities consumed unusually large quantities of oil in power in 2003, with the demand for fuel oil increasing by 15.4%. By 2004 many nuclear plants had come back on line and the consumption of residual fuel oil declined by 11.4%. In the longer term, Japanese demand for fuel oil is expected to return to a pattern of prolonged decline, and overall Japanese demand for oil products should remain relatively flat. Among other countries in the region, Korean oil demand also declined by approximately 30 kb/d in 2004. This decline may be attributed to high oil prices and the substitution of natural gas for oil products at the margin. In 2005, OECD Asia-Pacific oil demand is expected to return to positive growth.

Figure 2

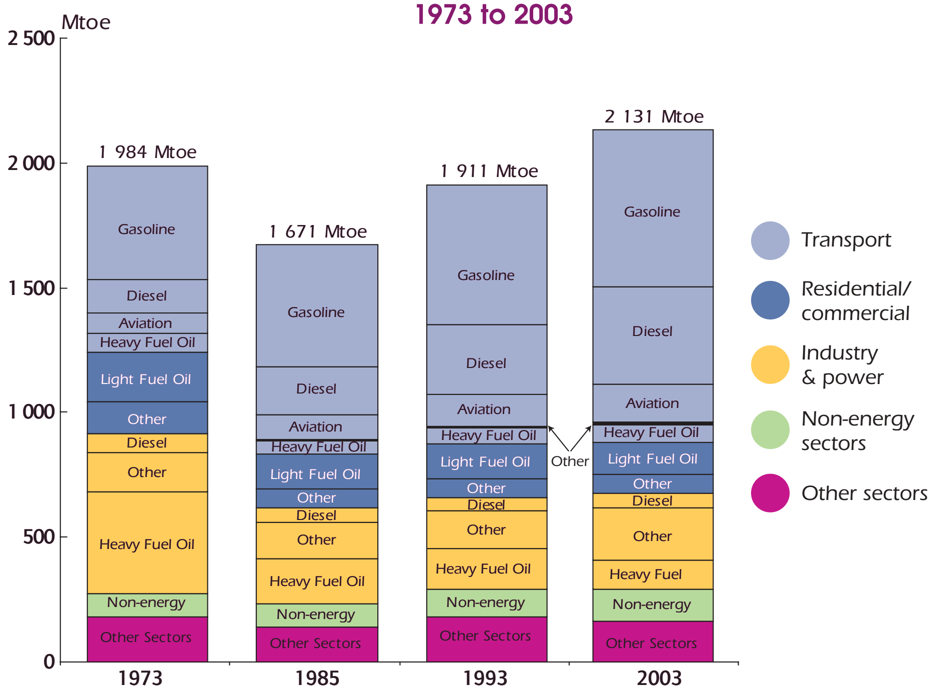
## Oil Demand in OECD Countries by Region, 1973 to 2004




Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 3

## Consumption of Oil Products by Sector in IEA Countries, 1973 to 2003




Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

# GAS

In 2004, natural gas demand in OECD countries was 1 194 Mtoe, up by 0.4% from 2003.

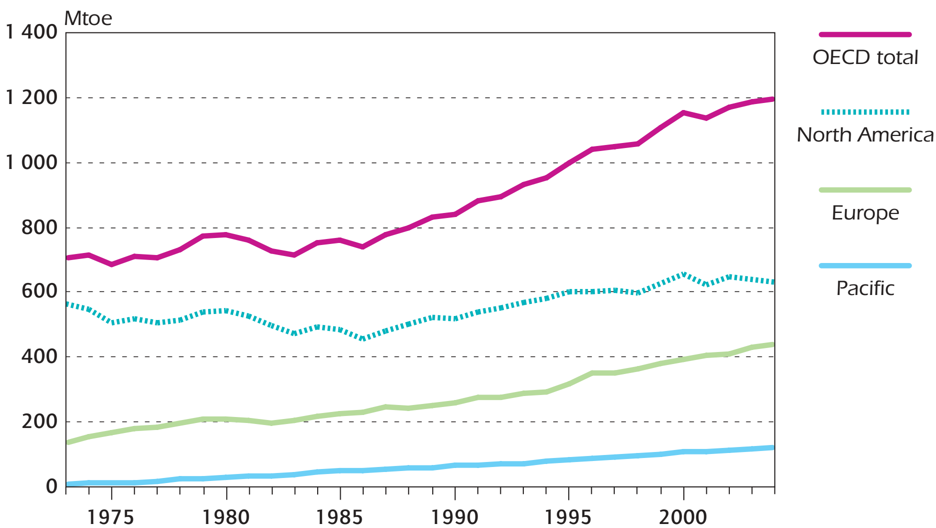
In OECD North America, gas demand decreased by 1.1%. Reflecting gas price spikes during 2004, consumption in the United States and Canada decreased by 0.8% and 7.2% respectively. This decrease in demand is likely to be repeated in 2005 given the high prevailing prices since the two major hurricanes, Katrina and Rita, in August and September.

OECD Europe recorded an increase of 2.6%. Spain, in particular, marked a sharp increase of 17.7% due to the rapid introduction of CCGT plants. The development of electricity market liberalisation, which favours more flexible power supplies, enhanced the competitiveness of natural gas. This factor was augmented by the relatively low investment costs for gas-fired power generation, the increasing efficiency of CCGTs and the need to reduce $CO_2$ emissions to comply with the Kyoto target.

OECD Pacific gas demand rose by 2.5%. The Korean market showed strong growth of 15.0% due to rapid growth in electricity demand to cope with the summer peak, which is supplied by gas-fired power. In 2004, gas consumption in Japan slightly decreased by 0.7% although this was a reaction to the exceptional increase of LNG imports in 2003 to cope with nuclear plants outage.

Figure 4

**Natural Gas Demand in OECD Countries by Region, 1973 to 2004**




Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

In 2004, OECD North America accounted for 53% of total OECD gas demand, followed by Europe (37%) and Pacific (10%). Between 1990 and 2003, demand growth was strongest in OECD Pacific (85%), Europe (71%) and North America (22%).

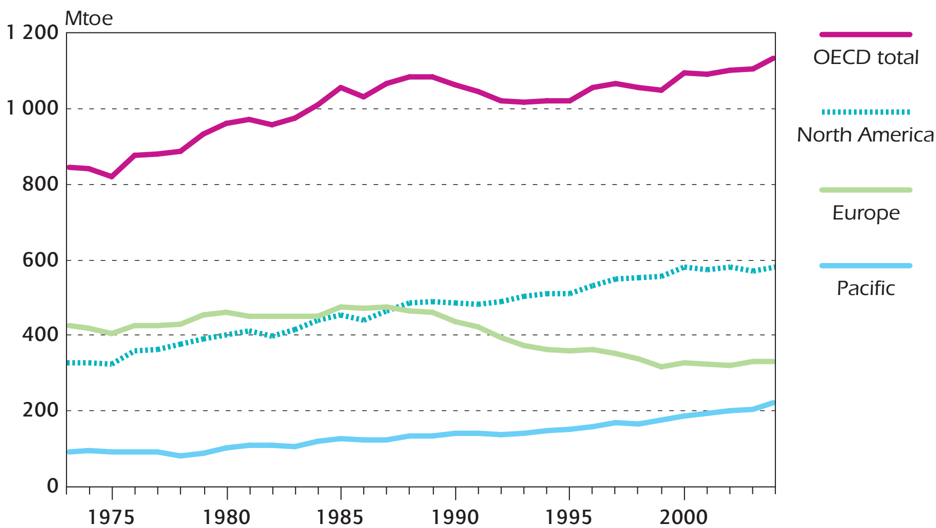
## COAL

In 2004, coal demand in OECD countries was 1 133 Mtoe, up by 2.4% from 2003. Coal demand in OECD North America and OECD Pacific increased by 4.3% and 8.3% respectively while it remained stable in OECD Europe. In general, coal demand in Europe had been decreasing since the mid-1980s as a result of increased environmental constraints, growing natural gas penetration and pressure from the European Union to reduce subsidies related to domestic coal production. In OECD Pacific, Japanese consumption increased by 11.4%, despite the gradual return of nuclear plant following regulatory shut-down; high oil prices, a hot summer and buoyant demand for coking coal all contributed to the rise.

In 2004, OECD North America accounted for 51% of the total OECD coal demand, followed by Europe (29%) and Pacific (20%). The overall demand growth since 1990 was notably strong in OECD Pacific (59%), followed by North America (19%), while European coal demand fell by 24%.

**Figure 5**

**Coal Demand in OECD Countries by Region, 1973 to 2004**




Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

# ENERGY CONSUMPTION BY SECTOR: OECD

Total final consumption (TFC) in OECD countries was 3 754 Mtoe in 2003, 1.8% up from 2002. OECD North America and OECD Europe marked increases of 1.6% and 3.0% respectively while the TFC in OECD Pacific was almost stable.

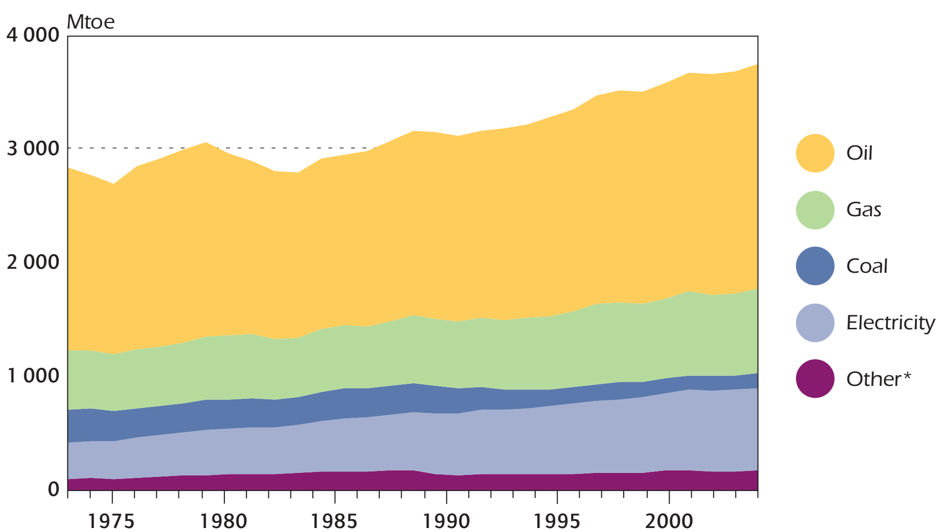
Petroleum products accounted for the largest share in TFC in 2003, with 53%, followed by gas (20%), electricity (19%) and coal (3.4%). Combustible renewables and waste, solar, wind and geothermal accounted for 3.3% altogether. While these fuel shares remained almost unchanged from 2002, there have been certain changes since 1990 when the shares of oil, gas, electricity and coal were 52%, 19%, 18% and 7% respectively.

Electricity consumption in OECD countries was 729 Mtoe, up 1.3% from 2002. OECD North America, OECD Europe and OECD Pacific registered increases of 0.8%, 2.5% and 0.8% respectively. North America accounted for 49% of total OECD electricity consumption, followed by Europe (34%) and Pacific (17%).

In the longer term, TFC increased by 20% over its 1990 level. The growth was strongest in OECD Pacific (37%), followed by North America (20%) and Europe (14%).

Figure 6

**Total Final Consumption in OECD Countries by Source, 1973 to 2003**




* includes geothermal, solar, wind, heat, combustible renewables and waste.
Source: *Energy Balances of OECD Countries,* IEA/OECD Paris, 2005.

## Table 2

### Total Final Consumption in OECD Regions (Mtoe)

| | *1990* | *2001* | *2002* | *2003* |
|---|---|---|---|---|
| **TFC TOTAL** | | | | |
| Total OECD | 3 127 | 3 663 | 3 686 | 3 754 |
| North America | 1 556 | 1 817 | 1 836 | 1 865 |
| Europe | 1 148 | 1 281 | 1 271 | 1 309 |
| Pacific | 424 | 565 | 579 | 580 |
| **INDUSTRY** | | | | |
| Total OECD | 1 101 | 1 226 | 1 236 | 1 248 |
| North America | 501 | 564 | 567 | 567 |
| Europe | 421 | 427 | 426 | 436 |
| Pacific | 179 | 235 | 242 | 244 |
| **RESIDENTIAL/COMMERCIAL** | | | | |
| Total OECD | 1 037 | 1 214 | 1 207 | 1 241 |
| North America | 478 | 553 | 553 | 568 |
| Europe | 432 | 490 | 477 | 500 |
| Pacific | 128 | 170 | 176 | 173 |
| **TRANSPORT** | | | | |
| Total OECD | 989 | 1 223 | 1 244 | 1 265 |
| North America | 578 | 700 | 716 | 730 |
| Europe | 294 | 363 | 367 | 373 |
| Pacific | 117 | 160 | 161 | 162 |

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table 3

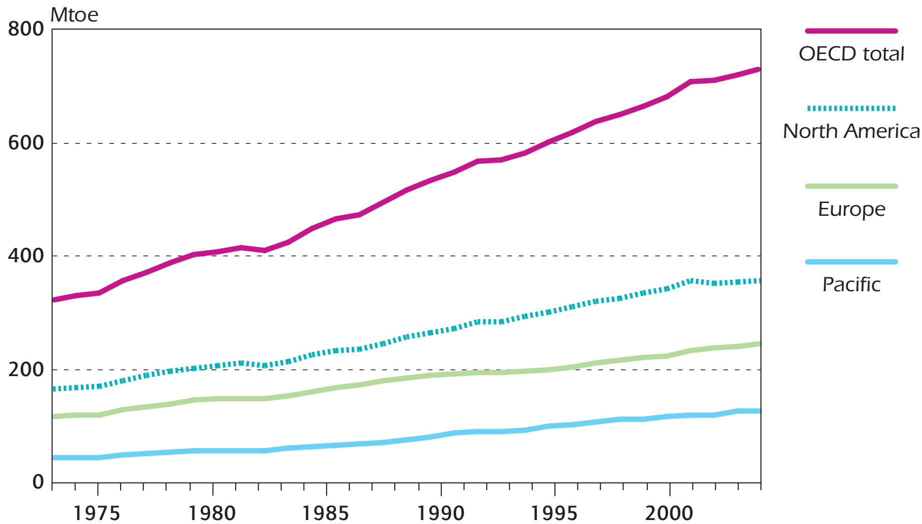
### Electricity Consumption (Mtoe)

| | *1990* | *2001* | *2002* | *2003* |
|---|---|---|---|---|
| Total OECD | 548 | 710 | 720 | 729 |
| North America | 271 | 353 | 354 | 357 |
| Europe | 190 | 238 | 239 | 245 |
| Pacific | 86 | 120 | 126 | 127 |

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 7

**Electricity Demand (Final Consumption) in OECD Countries by Region, 1973 to 2003**




Source: *Energy Balances of OECD Countries, IEA/OECD Paris, 2005.*

## INDUSTRY SECTOR

In 2003, OECD energy consumption in the industry sector was 1 248 Mtoe, up 1.0% from 2002. While it was stable in North America, OECD Europe and OECD Pacific showed increases of 2.3% and 0.8% respectively.

From 2002 to 2003, gas consumption in the industrial sector decreased by 0.9%, led by a 3.4% decrease in OECD North America, reflecting the rising price of gas. On the other hand, oil and coal consumption increased by 4.1% and 1.5% respectively.

In 2003, the industry sector accounted for 30% in OECD North America, 33% in OECD Europe and 42% in OECD Pacific.

In 2003, petroleum products accounted for 38% of industrial energy consumption, followed by natural gas (24%), electricity (22%) and coal (8.9%). However, the structure of energy use differed between regions. In OECD North America, the share of petroleum products was the largest (36%), followed by gas (29%), electricity (21%) and coal (5.9%). OECD Europe has a similar structure with petroleum products (35%), gas (26%), electricity (23%) and coal (9.7%). On the other hand, in OECD Pacific, the share of petroleum products was much higher (49%), followed by electricity (23%), coal (14%) and gas (9.8%).

In 2003, OECD North America accounted for 45% of industry TFC of OECD countries, followed by Europe (35%) and Pacific (20%).

In the longer period between 1990 and 2003, consumption growth was stronger in OECD Pacific (36%) and OECD North America (13%) compared with OECD Europe (3.6%).

## RESIDENTIAL/COMMERCIAL SECTOR

In 2003, energy consumption in the residential/commercial sector in OECD countries was 1 241 Mtoe, up by 2.8% from 2002. OECD Europe showed the strongest growth of 4.8% reflecting the cold winter, followed by North America (2.7%). OECD Pacific experienced a decrease of 1.7%.

In 2003, the residential/commercial sector accounted for 30% in OECD North America, 38% in OECD Europe and 30% in OECD Pacific.

The structure of fuel use in 2003 also varied considerably between regions. In OECD Pacific, the share of petroleum products was the largest (41%) followed by electricity (40%) and gas (16%). On the other hand, electricity accounted for the largest share (42%) in OECD North America, followed by gas (39%) and petroleum products (15%). In OECD Europe, gas held the largest share (34%), followed by electricity (27%) and petroleum products (22%).

In 2003, OECD North America accounted for 46% of total OECD consumption in the residential/commercial sector, followed by Europe (40%) and Pacific (14%).

From 1990 to 2003, consumption growth was strongest in OECD Pacific (35%), followed by OECD North America (19%) and OECD Europe (16%).

## TRANSPORT SECTOR

In 2003, TFC in the transport sector in OECD countries was 1 265 Mtoe, up 1.7% from 2002.

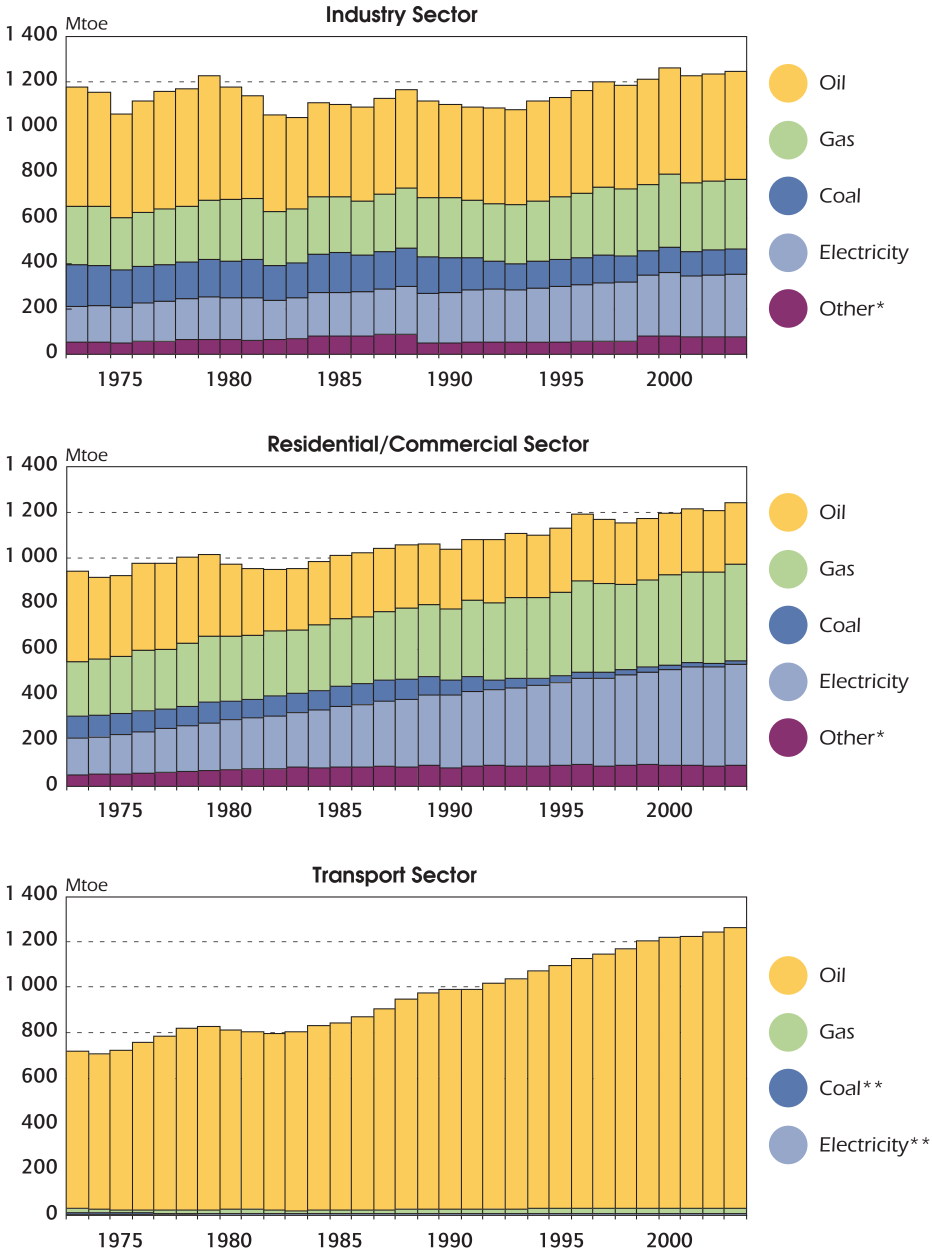
The share of oil has remained at 97% and the shares of gas and electricity were 1.7 % and 0.7% respectively. Penetration of natural gas was strongest in OECD North America, at 2.7%, while it was very weak in other regions. On the other hand, electricity had shares of 1.8% in OECD Europe and 1.2% in OECD Pacific, while it only had a 0.1% share in OECD North America.

In 2003, OECD North America accounted for 58% of total OECD consumption in the transport sector, followed by Europe (29%) and Pacific (13%).

In the longer term, between 1990 and 2003, the growth of consumption was strongest in OECD Pacific (38%), followed by OECD Europe (27%) and OECD North America (26%).

Figure 8

**Final Consumption by Sector and by Source in OECD Countries, 1973 to 2003**




* includes geothermal, solar, wind, combustible renewables and waste.

** negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

# WORLD ENERGY PRODUCTION

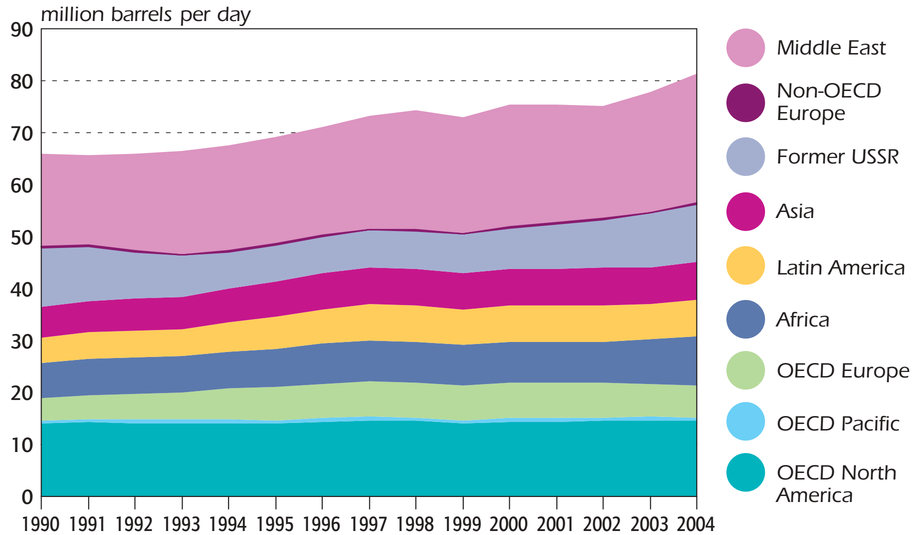
## OIL

Total world oil production averaged 83.1 mb/d in 2004, an increase of 3.4 mb/d, or 4.2%, compared to 2003. OPEC crude supply increased by 1.9 mb/d, while OPEC other liquids supply rose by 0.4 mb/d and 1.1 mb/d of the increase came from non-OPEC producers. Trends in non-OPEC supply showed variations both geographically and over the course of the year. The former Soviet Union (FSU) accounted for 64% of non-OPEC growth in 2004, with a strong increase in Russian supply persisting through the first half of the year. Africa also saw production rise by 365 kb/d, with rising supplies from Chad, Angola and Equatorial Guinea. Overall, non-OPEC supply growth versus the previous year was sharpest in the first half of the year, averaging 1.4 mb/d, but slowed sharply to 1.0 mb/d in the third quarter and 350 kb/d in the fourth quarter. The slow-down persisted into the first quarter of 2005, but growth shows signs of picking up again and could accelerate further in the second half of this year. Behind the marked slow-down in late-2004/early-2005 were a number of what may prove to be temporary factors affecting OECD production, deferred new field start-ups in non-OECD economies and a lower contribution from Russia. The after-effects of hurricane Ivan in the US Gulf, and unscheduled field outages affecting Australia, Norway and Canada all played a part in curbing supply growth. New field developments amounting to 0.5 mb/d of capacity originally scheduled for mid-2004 start-up in Brazil were delayed into late-2004 and early-2005. Political and regulatory uncertainty has undermined investment levels in Russia, sharply reducing earlier double-digit production growth to levels now running well below 5% annually.

The combination of sharply above-trend global demand growth in 2004 and shortfalls compared to expectations from non-OPEC producers in the second half of the year prompted a significant supply response from OPEC. From a low of 27.7 mb/d in February 2004, supply reached 29.8 mb/d in October 2004, its highest level since late-2000. First quarter increases from OPEC derived largely from Iraq and the African OPEC producers. By spring 2004, net Iraqi production had recovered to a post-war peak of 2.4 mb/d, although performance through the year proved volatile within a range of 1.6 mb/d to 2.4 mb/d. Continued attacks on pipelines and refineries, plus southern production equipment problems have restricted Iraqi output to around 1.8 mb/d in the first half of 2005. Later in the year the balance of OPEC growth swung towards Saudi Arabia and other Persian Gulf producers. Notably, in the third quarter, Saudi Arabia and other Persian Gulf producers added some 950 kb/d to supply compared to the previous quarter. However, the ability of OPEC to help meet surging demand growth in 2004 came at the expense of diminished spare capacity. Having dipped below 2 mb/d in early-2003 in the aftermath of the Iraq war, the Venezuelan strike and ethnic unrest in Nigeria, spare capacity fell further to below 1 mb/d in the second half of 2004. Incremental capacity has subsequently become available from Saudi Arabia and others, taking spare capacity above 2 mb/d once again. However, expectations are that the margin of supply-side flexibility could remain below historical levels for some time to come.

Figure 9

**World Oil Production, 1990 to 2004***




* 2004 = estimates.
Note: Excluding refinery processing gains.
Source: *Oil Market Report,* IEA.

# GAS

World production of gas grew to 2 794 billion cubic metres (bcm) in 2004, up 2.9% from 2003. Russia and the United States continue to be the largest producing countries in the world, accounting for 22% and 19% of the total world production respectively.

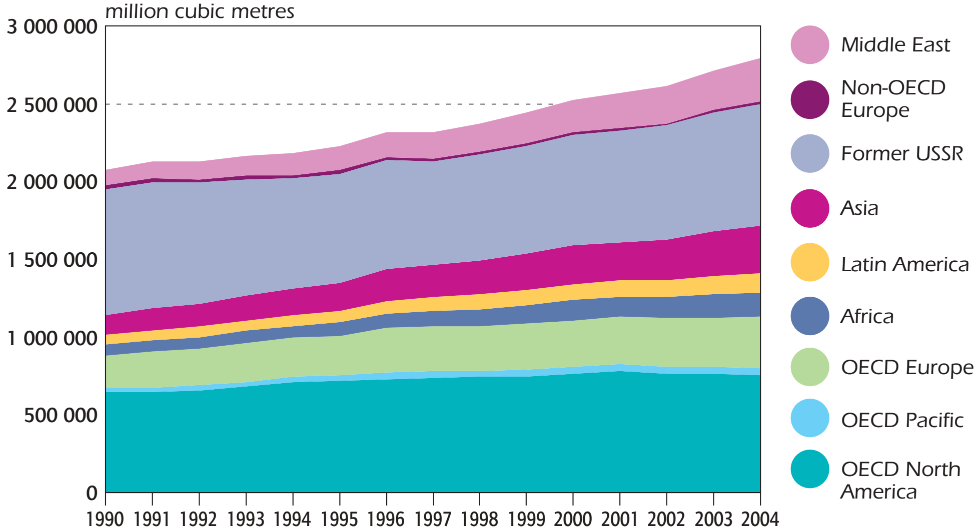
Gas production in the United States decreased by 1.7% to 532 bcm despite its high drilling activities in response to record high prices at the well-head of USD 5.49/million cubic feet on average during 2004. Production in Canada remained at almost the same level as 2003.

In 2004, the growth of gas production in OECD Europe was 3.2 %, reaching 327 bcm. Norway and the Netherlands played the major role in European gas production by increasing their production by 6.5% and 18% respectively. This offset the ongoing decline of 6.8% in the United Kingdom.

Gas production in the former Soviet Union (FSU) grew by 2.6% to 786 bcm in 2004. For the third consecutive year, production in Russia recorded a growth of 2.0% to 620 bcm. Uzbekistan and Kazakhstan gas production also soared by 3.7% and 31.7% to 60 bcm and 20 bcm respectively.

Figure 10

**World Natural Gas Production, 1990 to 2004***




* 2004 = estimates.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005, and *Energy Statistics of Non-OECD Countries*, IEA/OECD Paris, 2005.

Gas production in Asia grew by 6.1% to 301 bcm. China in particular marked solid growth of 20% to 47 bcm. In response to growing LNG exports and domestic demand, gas production in the Middle East also increased by 7.5%.

In 2004, FSU accounted for 28% of world natural gas production, followed by OECD North America (27%), OECD Europe (12%), Asia (11%) and the Middle East (10%).

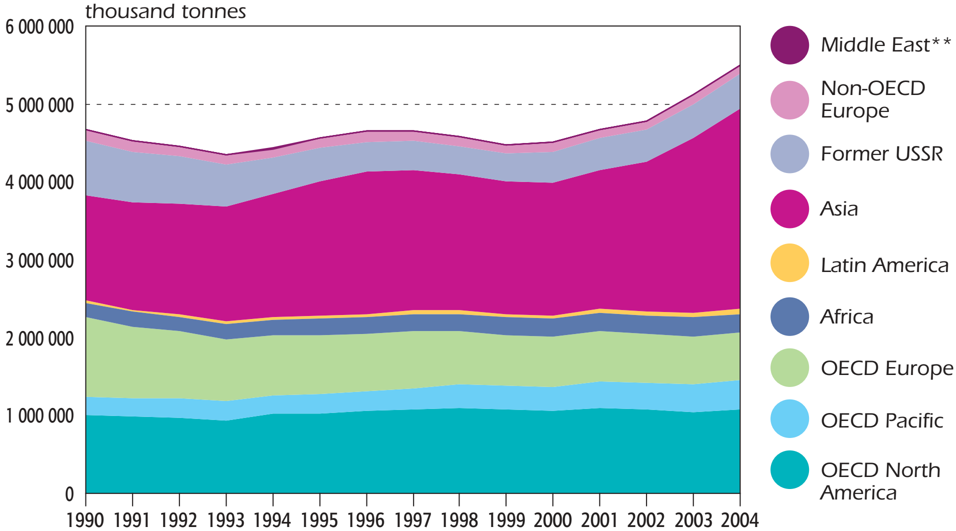
## COAL

In 2004, world coal production was 5 505 million tonnes (Mt), up 7.6% from 2003. Chinese coal production soared by 17% following successive increases since 2001; growth was apparently unhindered by the Chinese authorities' measures to restrain some mines and limit surplus from others on safety grounds. Production in the FSU recorded an increase of 4.5%. OECD North America and OECD Pacific marked increases of 4.0% and 3.5% respectively, while the declining production trend in OECD Europe continued with a decrease of 1.1%.

In 2004, Asia accounted for 47% of world coal production, followed by OECD North America (20%), OECD Europe (11%), FSU (8.1%) and OECD Pacific (6.6%).

Figure 11

World Coal Production, 1990 to 2004*




* 2004 = estimates.

** negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005, and *Energy Statistics of Non-OECD Countries*, IEA/OECD Paris, 2005.

## ELECTRICITY: OECD

In 2004, electricity generation in IEA countries was 10 056 TWh, up 2.0% from 2003. Shares in electricity generation in OECD countries were as follows: coal 38%, nuclear 23%, gas 18%, hydro 13%, oil 5.2%, other renewables 2.8%.

From 2003 to 2004, natural gas-fired generation rose by 5.3% while coal-fired generation and oil-fired generation dropped by 0.5% and 11% respectively. Nuclear power, which dropped by 2.0% mainly owing to nuclear power outage in Japan in 2003, increased again by 4.3%. In Japan, nuclear power generation increased by 14.4% due to the restart of operations in some nuclear power plants, which had been in outage owing to data falsification problems. After the dry winter in 2002/03, hydropower generation increased again by 1.9% in 2004. While electricity generated from other renewables grew by 8.0%, its share remains marginal at 2.9%.

Over the last decade, the share of gas in IEA electricity generation increased sharply. This trend is apparent in OECD Europe, particularly in the United Kingdom and Italy where the share of gas increased from 16% to 42% and from 18% to 43% respectively. In Japan and Italy, generation from coal has almost doubled in the last decade. Dependence on coal in the United States and Germany is still much higher than the OECD average.

Table 4

## Electricity Generation by Source, 1994 and 2004[1] (TWh)

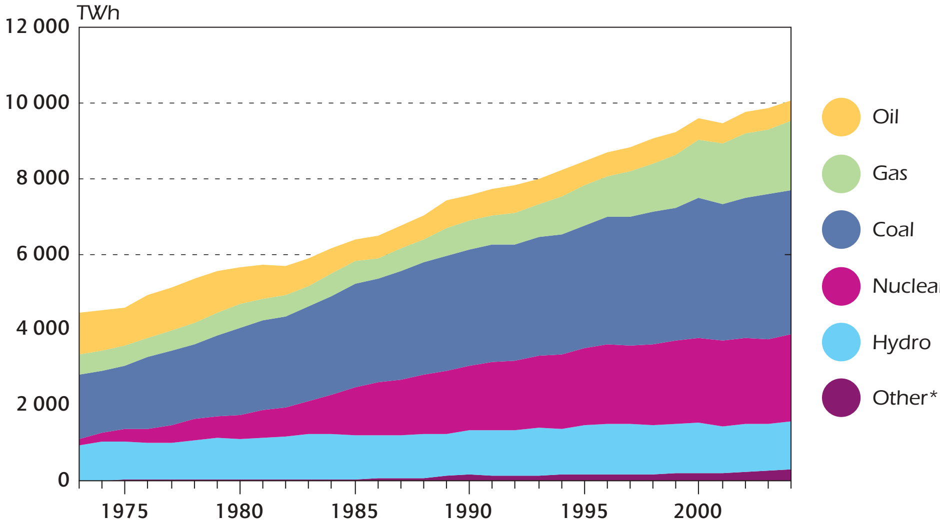
| | France | | | | Germany | | | | Italy | | | | Japan | | | | United Kingdom | | | | United States | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1994 | | 2004 | | 1994 | | 2004 | | 1994 | | 2004 | | 1994 | | 2004 | | 1994 | | 2004 | | 1994 | | 2004 | |
| | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % | Output | *share* % |
| Coal | 24 | *5* | 28 | *5* | 297 | *57* | 304 | *51* | 23 | *10* | 53 | *18* | 155 | *17* | 287 | *28* | 161 | *50* | 129 | *34* | 1813 | *53* | 2085 | *51* |
| Oil | 6 | *1* | 7 | *1* | 9 | *2* | 4 | *1* | 116 | *51* | 59 | *20* | 243 | *26* | 107 | *10* | 15 | *5* | 7 | *2* | 121 | *3* | 135 | *3* |
| Gas | 4 | *1* | 18 | *3* | 40 | *8* | 62 | *10* | 41 | *18* | 127 | *43* | 187 | *20* | 238 | *23* | 53 | *16* | 158 | *42* | 492 | *14* | 722 | *17* |
| Nuclear | 360 | *76* | 448 | *79* | 151 | *29* | 167 | *28* | 0 | *0* | 0 | *0* | 269 | *29* | 286 | *28* | 88 | *27* | 74 | *19* | 679 | *20* | 813 | *20* |
| Hydro | 79 | *17* | 60 | *11* | 20 | *4* | 21 | *3* | 45 | *20* | 41 | *14* | 67 | *7* | 94 | *9* | 5 | *2* | 5 | *1* | 263 | *8* | 272 | *7* |
| Comb. renewables | 3 | *1* | 6 | *1* | 8 | *2* | 41 | *7* | 4 | *2* | 13 | *5* | 15 | *2* | 16 | *2* | 2 | *1* | 9 | *2* | 85 | *2* | 98 | *2* |
| **Total** | **475** | ***100*** | **567** | ***100*** | **525** | ***100*** | **600** | ***100*** | **229** | ***100*** | **293** | ***100*** | **935** | ***100*** | **1 028** | ***100*** | **325** | ***100*** | **381** | ***100*** | **3 452** | ***100*** | **4 125** | ***100*** |

1. Preliminary data.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 12

**OECD Electricity Supply by Source, 1973 to 2004**




*includes geothermal, solar, wind, combustible renewables and waste.
Source: *Energy Balances of OECD Countries,* IEA/OECD Paris, 2005.

# ENERGY PRICES

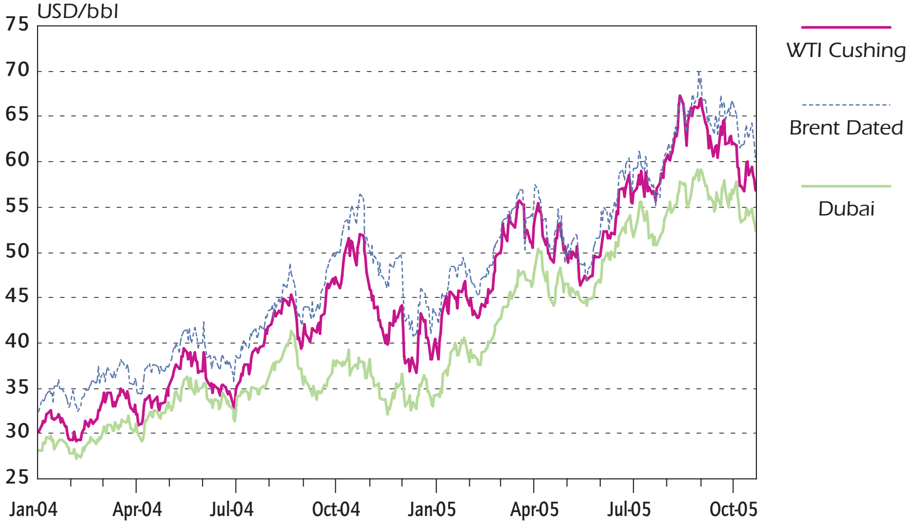
## CRUDE OIL

Physical crude oil prices during 2004 pursued a steady upward trend for most of the year, peaking at historical records in October before falling back in the fourth quarter. The increase in the price of crude oil benchmarks, however, was not uniform. Trends in the light sweet benchmarks Brent and West Texas Intermediate (WTI) diverged with that observed for medium sour Dubai by the end of August. Dubai trended broadly sideways for the remainder of 2004 while the prices of Brent and WTI held their upward momentum into mid-October, breaching a previously unattained level of USD 50/bbl. On 22 October, WTI closed at USD 56.42/bbl and Dated Brent ended at USD 52.03/bbl while Dubai trailed behind at USD 37.98/bbl. By the end of the year, prices for WTI and Brent fell back to under USD 45/bbl as demand weakened relative to seasonal expectations due to relatively mild temperatures in the Northern hemisphere.

The evolution of crude prices for the reference benchmarks in 2004 marked a repeat of the strong gains seen in 2003. The increase in prices against the previous year's level was roughly even across the benchmarks. Average crude oil prices in 2004 were about USD 7-10/bbl higher than in 2003, representing an increase of about a third in the case of WTI and Brent and 25% for Dubai. For the year 2004 as a whole, Dated Brent averaged USD 38.21/bbl, WTI averaged USD 41.41/bbl and Dubai averaged USD 33.64/bbl.

Figure 13

**Spot Benchmark Crude Oil Prices, January 2004 to October 2005**




Source: *Oil Market Report,* IEA.

In 2004, the key drivers behind the rise in crude prices were strong demand for light products and emerging capacity constraints in the supply chain as a whole. Strong growth in the GDP of the US and China was the leading contributor to world oil demand. Synchronous economic growth across the globe generated strong demand growth, in particular for light products used as transport fuels (gasoline, diesel, and jet fuel). Power generation shortages in China also added a further component to oil demand growth, with increased usage of fuel oil and diesel. Year 2004 turned out to be a "demand shock", with world oil product demand growing by 3.6% on a year-on-year basis, significantly above the historical long-term trend of about 1.7%.

With oil demand growing significantly above its long-term trend, spare capacity in the oil complex tightened rapidly, effectively putting upward pressure on prices. Capacity constraints became readily apparent both in the upstream sector (production of crude oil) and the downstream sector (refining and transformation of crude oil into the oil products consumed). The marginal barrel available to the market became heavier and more sour, while at the same time refining capacity to absorb and convert this type of crude oil into light products was diminishing. The effects of diminishing refinery conversion capacity were amplified in 2004 by the changes to product specifications. More stringent constraints in the Atlantic Basin in 2004 and again in 2005 also contributed to upward pressure on prices. Mandated reductions in sulphur content in gasoline and diesel led refiners in the Atlantic Basin to embark on extensive maintenance programmes aimed at the removal of sulphur. In addition to the need to meet light product demand, refiners bid up incrementally sweet crude oil such as Brent and WTI (low in sulphur) relative to sour ones like Dubai (high in sulphur) until such time that capacity was installed and operational to meet these new mandates. Moreover, the need to meet light product demand worldwide, alongside more stringent product specifications, impacted the "quality" price differentials between benchmark crudes.

As such, the oil market became "product-driven" where, due to strong demand, the increase in product prices led to increases in crude oil prices. The tighter situation in terms of oil supply and demand fundamentals also, by implication, made the market more sensitive to geopolitical risk and weather-related uncertainties – hurricane Ivan was a notable example, disrupting oil and gas supplies in the Gulf of Mexico at the end of 2004 with lasting effects into 2005.

2005 saw continued upward pressure on crude prices. For the first three quarters of 2005, crude prices were on average 35-45% higher than in calendar year 2004. WTI averaged USD 55.45/bbl, Dated Brent averaged USD 53.71/bbl, and Dubai averaged USD 48.27/bbl. In August, WTI peaked at USD 69.91/bbl, Dated Brent reached USD 67.33/bbl and Dubai was as high as USD 59.18/bbl. August's high prices reflected a lack of spare capacity in the upstream, plus consumers' desire to hold higher stocks as a hedge against this lack of spare capacity. The market's expectation of strong demand growth in the fourth quarter of 2005 and the prospect of Gulf of Mexico oil production being lost due to hurricanes were further contributory factors to this rise in prices.

The hurricane season of 2005 was one of the worst on record. The Gulf of Mexico hurricane disruptions exposed the low level of spare capacity in both the upstream and downstream oil industry sectors, contributing to high product prices. The loss of oil and gas production and refinery throughputs on the US Gulf Coast will have long-lasting effects well into 2006. At the peak of disruption, 5 mb/d of refining capacity, 1.5 mb/d of oil and 8 bcf/d of gas production were shut in.

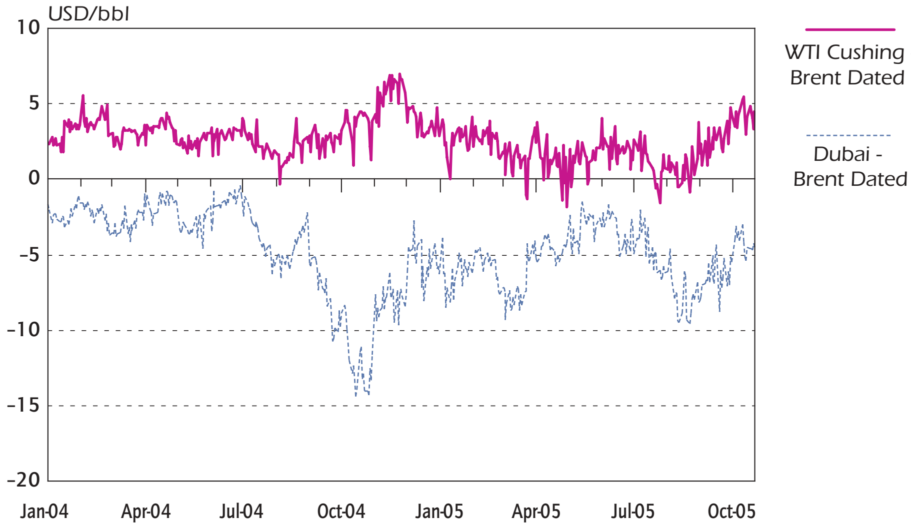
To alleviate the disruption to oil supplies, on 2 September 2005, the IEA activated an emergency response equivalent to the release of 60 million barrels of oil to the market. The volume of the response would equate 2 mb/d for an initial period of 30 days, with the possibility of further action if necessary. In the weeks following the release of the oil, crude prices retraced to pre-hurricane levels as US product demand fell sharply in the face of logistical supply problems and continued outages in Gulf Coast refinery capacity reduced crude demand.

It is expected that substantial amounts of upstream oil and gas production will remain offline into early 2006, with numerous platforms permanently lost to the storms. However refineries have been able to resume crude throughputs earlier than initially anticipated, mitigating some of the fears of product tightness over the winter months. However, the duration of product tightness will very much depend on the degree to which September's demand reduction is sustained. 2005 demand growth is currently expected to be 1.5%, slightly lower than the long-term average.

The premium of Brent over Dubai, which has historically traded in the range between USD 1.00 to USD 3.50/bbl, began to increase significantly at the start

Figure 14

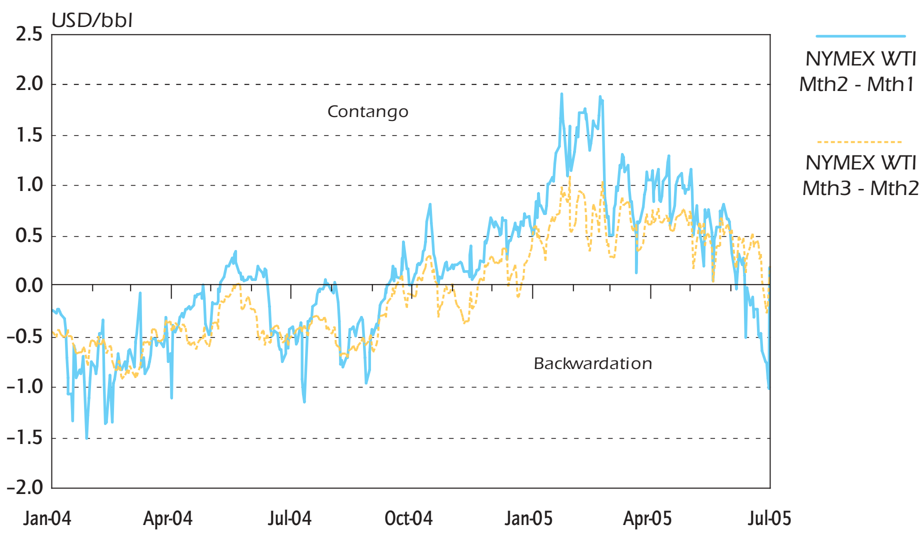
**Spot Benchmark Crude Oil Price Differentials, January 2004 to October 2005**




Source: *Oil Market Report,* IEA.

Figure 15

**Futures Price Differentials for Light Sweet Crude on NYMEX, January 2004 to October 2005**




Source: *Oil Market Report,* IEA.

of July, reaching USD 14.36/bbl by 14 October. To a large extent, this sharp widening of the sweet/sour spread was related to heavy buying of light, sweet crude by European refiners ahead of the introduction of low-sulphur fuel regulations. This differential, however, returned into its historical range during the second quarter of 2005 as the extensive refinery maintenance and upgrades in the autumn of 2004 and the first quarter of 2005 have given greater flexibility to Atlantic Basin refiners in their choice of crude slate. The third quarter of 2005 saw a widening of the spread as limited availability of sweet light North Sea grades pushed Brent values up to a par with WTI. Refiners have a limited appetite for medium sour crude grades unless supported by positive hydro skimming margins. These were not present until late in the third quarter and hence Dubai prices struggled vs. Brent, only closing the gap at the end of the period.

Prices for light sweet crude oil traded on futures markets (WTI on the New York Mercantile exchange and Brent on the International Petroleum Exchange of London) mirrored those of their physical counterparts in 2004 and in the first half of 2005. More interesting, however, was the change in pricing relations in the near month delivery contract and the long-dated contract prices. Prompt month prices (where market liquidity is concentrated) shifted from a backwardation structure (today's price above tomorrow's prices) to a contango structure (tomorrow's price above today's price). The shift into a contango structure generally reflects a loosening of prompt supplies. This has been the case in the second half of 2004 and in the first quarter of 2005 as OECD industry crude stocks moved above their five-year range at the end of May. However, this contango is occurring at an unprecedented absolute level of USD 50/bbl, indicating that concerns over future availabilities of crude supplies in relation to anticipated demand remain in place, and in turn a greater need for higher inventories.

The long-dated price (the 5-year contract price in Figure 16) can arguably be viewed as a proxy for the cost of adding an extra barrel of oil supply. This notional price is often used by oil companies in evaluating returns for their exploration and production expenditures. Before 2004 this price was relatively stable at around USD 20 to 25/bbl. The convergence of this price with the prompt month price at above USD 50/bbl reflects the market assessment of a lack of investment in energy infrastructure, and in the upstream in particular. Poor returns in the energy sector in general have led to divert investment into other areas of the economy. A casual inspection for US returns on capital employed for the sectors of oil and gas drilling, exploration and production, and refining shows a systematic under-performance relative to average returns for the US economy as a whole in the last two decades. While capital spending in 2005 has increased significantly in a much delayed response to higher long-dated prices, it will need to rise further to meet demand over the next ten years. Effective spare production capacity is only expected to recover modestly in 2005 and 2006, keeping long-dated prices at high levels.

On a historical basis, crude oil prices in real terms (adjusted for inflation) have been stable since the early 1990s. Using 1972 as the base year, the real price of oil has

Figure 16

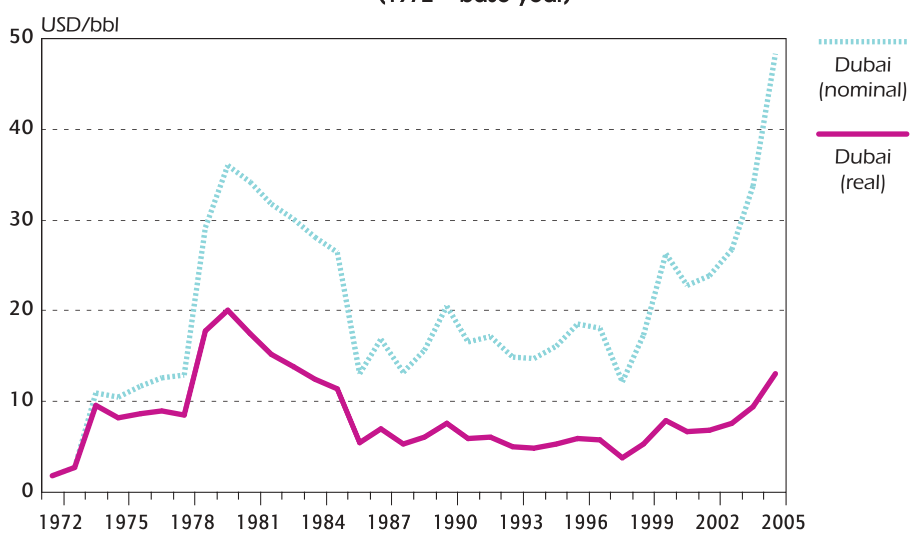
## Futures Prices for Light Sweet Crude on NYMEX, January 2004 to October 2005


Source: *Oil Market Report*, IEA.

Figure 17

## Nominal vs Real Crude Oil Prices, 1972 to 2005

**(1972 = base year)**




Note: Crude oil prices are annual averages of Arabian Light (1972-84) and Dubai first month (1985-2005). Real oil price is based on 1972 dollars. Real price for 2005 data point is estimated by year to date average price divided by the 2005 US GDP deflator.

Source: *Oil Market Report*, IEA.

trended around an average USD 5.60/bbl for the 1990s, shifting higher from 2000 to 2003 to an average of USD 7.3/bbl. Although the real price has risen since 2003, it remains below the highs reached during the second oil shock in the 1979-1981 period. Gains in crude oil prices in 2003 and again in 2004, combined with relatively modest inflationary pressures both in the US and in Europe (which benefited from a strong euro exchange rate vis-à-vis the dollar), led to an increase in the real price of crude in 2004 to USD 9.4/bbl from USD 7.6/bbl in 2003.

Stable inflationary pressures in 2005 are expected to support a further rise in real prices, barring any significant pull-back in terms of nominal prices. As mentioned above, the real price level remains comparatively modest in relation to the level reached in the early 1980s. This partly explains a cushioned impact of 2003 and 2004 nominal price increases on economic growth, allowing income effects of a growing world economy to dominate negative prices effects, and support further growth in oil demand.

## GASOLINE IN MAIN INTERNATIONAL MARKETS

Demand for road transport fuels saw strong growth in 2004, drawing support from a robust economic environment. Gasoline prices traded in a wide range in 2004, with trends in prices set by developments in the US. The US saw further changes in product specifications for gasoline in 2004 with the states of New York and Connecticut

Figure 18

**Premium Unleaded Gasoline Price – Selected Markets, January 2004 to October 2005**

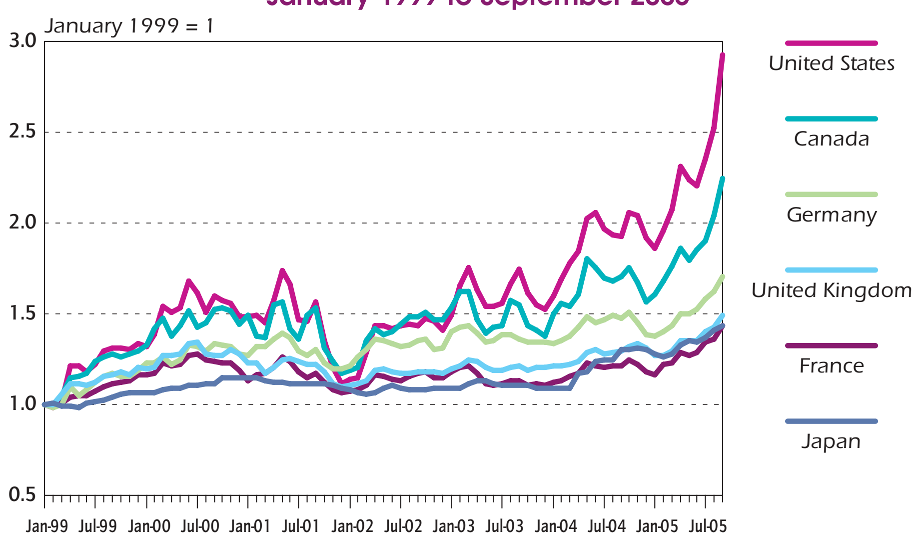

Source: *Oil Market Report*, IEA.

adopting a ban on the use of MTBE (a blendstock) in the production of reformulated gasoline. Prices in the early part of the year followed a steady upward trend during the first quarter at a relatively modest pace. By the beginning of the second quarter, refinery maintenance in the US, combined with a turnover of stock ahead of product specification changes, saw US finished gasoline stocks fall to very low levels. This led forward-demand cover to fall below its normal range. Together with concerns over the ability of traditional gasoline suppliers like Europe and Venezuela to deliver the new product specifications, this led prices in New York Harbour to rally above USD 60/bbl. The strength of the US market pulled prices across the international markets. In Europe, demand pull from the US, as well as from Nigeria, also supported higher prices.

For the rest of the year, uncertainties about the sufficiency of US supplies to meet strong gasoline demand growth during the summer driving season supported the market. Refinery maintenance in the US had proven deeper and more protracted than expected, leading to a slow resumption in runs and weaker product yields for gasoline than seasonally expected. Coupled with a slow uptake in gasoline imports, this helped to keep prices range bound between USD 40 and USD 60/bbl through November in New York Harbour. Strong US prices drew arbitrage supplies both from Europe to the Atlantic Coast and from Asia to the US West Coast. US gasoline prices eventually fell back by the end of the year to USD 40/bbl as stocks built rapidly in the fourth quarter with demand declining seasonally and supplies increasing with high refinery runs. The fall in US prices led gasoline prices to drop across the globe.

Figure 19

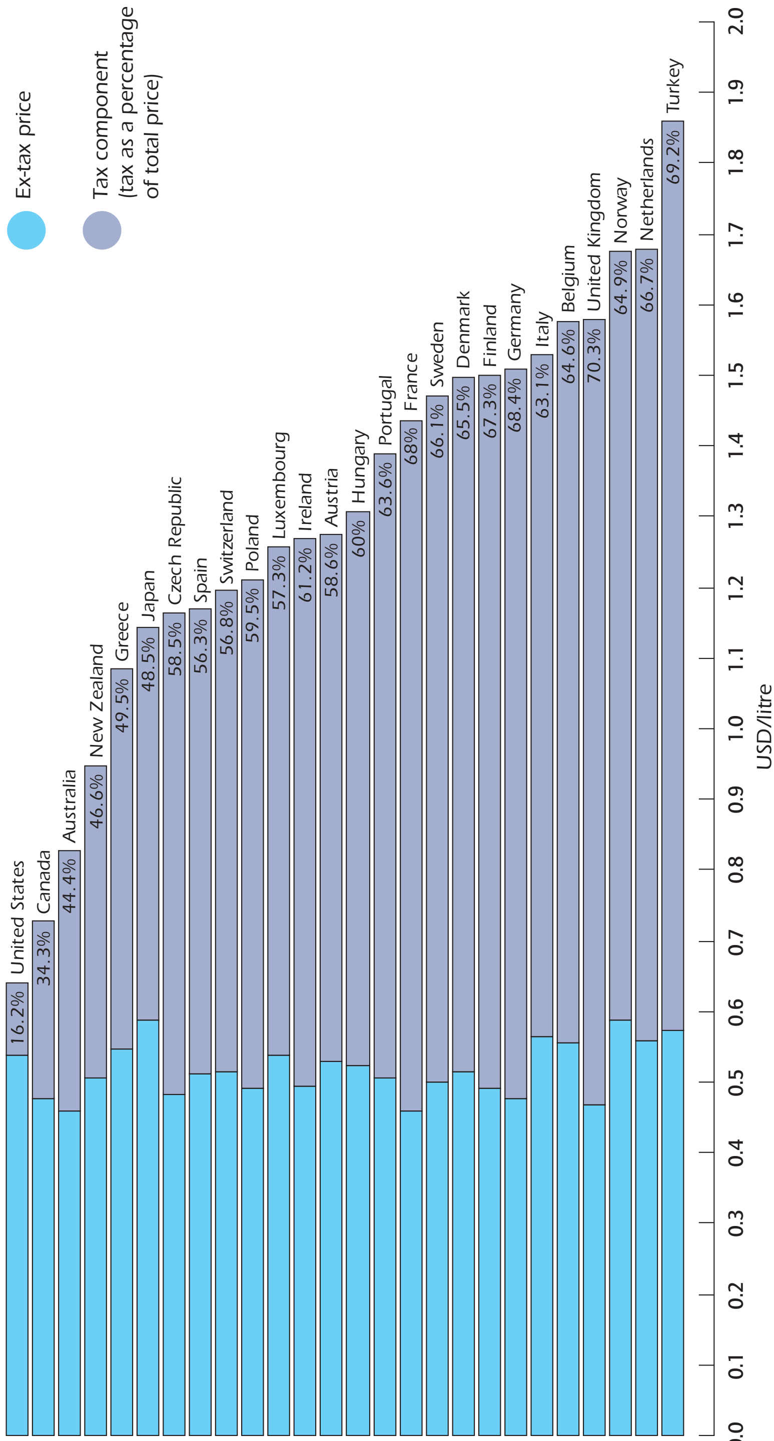
**Gasoline Price Trends in Selected IEA Countries, January 1999 to September 2005**




Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 20

**OECD Unleaded Gasoline Prices and Taxes, Second Quarter 2005**




Note: data not available for Korea, Mexico and the Slovak Republic.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

2005 saw gasoline prices resume their upward trend, reaching USD 65/bbl by the end of the first quarter and then USD 70/bbl by the end of the second quarter in New York Harbour. The increase, supported by strong momentum in the US economy, once again drove prices higher in other markets. In addition to seasonal shipments to the US, prices in Europe received further support from deliveries into the East Mediterranean region, Nigeria and Iran. US gasoline prices peaked in the third quarter of 2005 at over USD 100/bbl on fears of shortages due to a peak outage of 5 mb/d of refining capacity caused by hurricanes Katrina and Rita. However, a sharp downturn in US gasoline demand, prompted by high prices and supply constraints, offset some of these concerns in September. Stock release from IEA member countries, together with record refining margins and high price differentials encouraged a sharp increase in exports from Europe and other regions, helping to rebalance the market. Interestingly, the second (post-hurricane Rita) spike in gasoline prices on the US Gulf Coast was only partially seen in New York Harbour prices, with high post-Katrina imports assuaging short-term supply concerns.

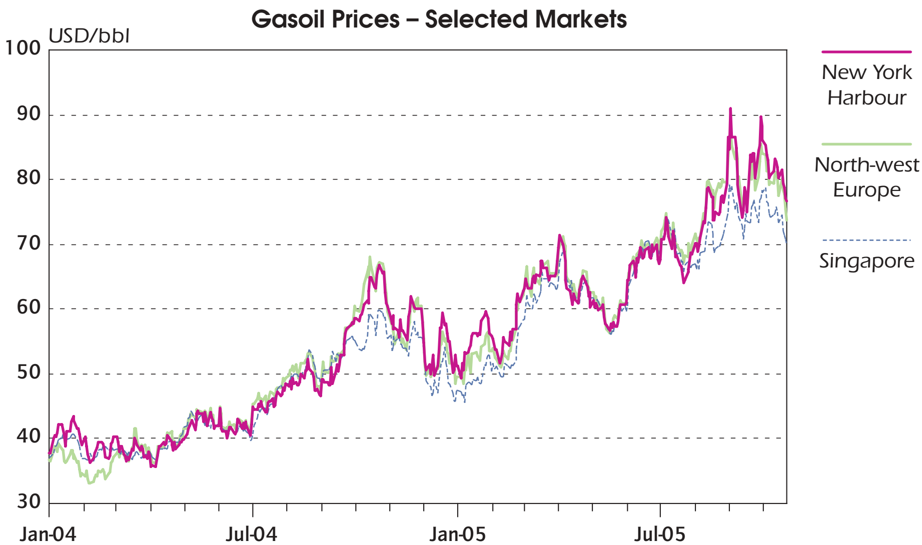
## DISTILLATE PRICES IN MAIN INTERNATIONAL MARKETS

Jet fuel and diesel, the transport fuel components of the middle distillate product category, rose in tandem with prices of gasoline in 2004, supported in their upward trend by robust economic growth. Heating oil prices held down prices of other distillates in the early part of the year. This followed on from the reversal of a number of factors that had supported winter demand in 2003. Temperatures across the northern hemisphere in 2004 were milder, while problems affecting natural gas supplies in the US and power generation in Europe and Japan eased in comparison to 2003.

By the second quarter of 2004, distillates prices followed an upward trend until the third quarter, building on the strength of transport fuels, before falling back at year end. In contrast to gasoline prices, which retrenched somewhat to near their levels at the beginning of the year, prices for distillates by the end of December closed roughly USD 10/bbl higher than in early January. Strong jet fuel demand, intimately linked with robust economic conditions, lifted prices higher. More significantly in Asia, growth in jet fuel demand recovered lost ground from 2003's abnormally depressed level (related to the outbreak of SARS disease), building on strong Chinese economic growth and the growing airline activity of low-cost carriers in Asia. Diesel also proved to be in strong demand in the US where, in its on-road version, it serves for the transport of merchandise. The strength of the US economy in 2004 led to a growing volume of imported goods, increasing delivery activity via truck and rail from main ports on the US West Coast to inland distribution centres. Demand for diesel was not solely confined to transport purposes. Import demand from China for use in private power generation units also contributed to demand growth. In 2004, China experienced important power shortages as installed capacity failed to keep up with demand. This led to increased use of oil-fired power generation, lifting demand for fuel oil by hitherto mothballed utilities alongside diesel for use in private generators.

Figure 21

## Price Developments of Gasoil and Jet/Kerosene





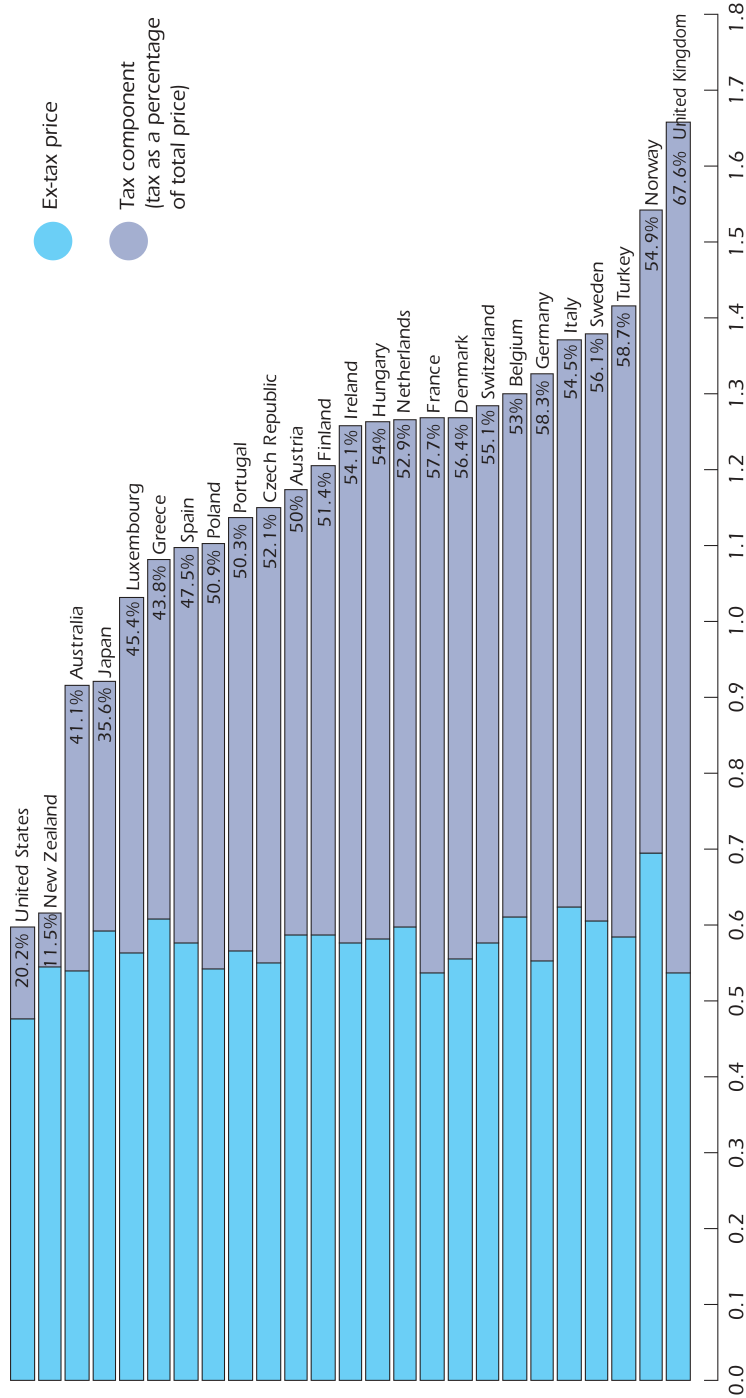
Source: *Oil Market Report*, IEA.

After trending sideways in the early part of the 2004, prices of fuels destined for space heating (heating oil and gasoil in the Atlantic Basin and kerosene in Asia) trended higher through the course of the year. The strength in these products, despite seasonally weaker demand due to mild temperatures, was due to the overall strength in the distillate complex. Strong gains on the IPE (International Petroleum Exchange) gasoil and NYMEX heating oil futures contracts leading physical prices higher in the Atlantic Basin, and higher forward swaps prices in Singapore played a similar role. This gain came without any exceptional behaviour where heating demand is concerned. In effect, consumers in the main heating oil markets of Europe such as Germany, Switzerland, and France often remained on the sidelines. Barge deliveries from the main north-west European market in the Amsterdam-Rotterdam-Antwerp area to traditional importing countries were often thin. Buying patterns were mainly driven by hand-to-mouth decisions, as local domestic refinery production could meet demand with very competitive prices. German consumers, who have large private storage for heating oil, were reluctant to refill their tanks in 2004 in the face of higher prices. Normally, refilling of heating oil tanks occurs during the summer as gasoil prices seasonally decline. By the end of the third quarter of 2004, German consumer tanks reportedly refilled to only 60% of their capacity or below their five-year range. 2005 was a repeat of 2004. Again, colder temperatures only came late in the first quarter, temporarily boosting demand above the seasonal norm. Heating oil prices in the US focused on relatively low combined inventories of diesel and heating. The strength of diesel led heating oil prices, despite there being no significant issues related to heating oil supply or demand. In Europe, German consumers continued to minimise their heating oil holdings with consumer stocks falling to under 45% capacity by the end of the winter. In Asia, kerosene prices in the winter of 2005 were pushed up by their jet fuel counterpart, this in spite of relatively comfortable inventories in the region and relatively normal heating demand patterns.

In 2005, distillate prices like those of gasoline resumed their upward trend. The US market remained concerned over distillate availabilities for the winter season in light inventories trended at the bottom of their normal level, and demand projection for the fourth quarter showed robust growth. This led to a reversal of seasonal price trends with gasoline (typically in seasonal demand), trading at a discount to heating oil. In Europe, there appeared to be no evidence of supply shortages, while in Asia, Chinese import demand slowed considerably compared to the previous year. Similar price activity to gasoline was evident in distillates following the impact of hurricanes Katrina and Rita in the third quarter of 2005. New York Harbour jet/kerosene prices spiked to around USD 100/bbl in early September, while #2 heating oil reached nearly USD 91/bbl. But unlike gasoline, distillate prices mirrored the second price rise seen at the end of September on the Gulf Coast after hurricane Rita closed 60% of Gulf Coast refining capacity. Diesel, and more particularly jet kerosene production, is more closely tied to crude throughputs and has been more severely impacted by the loss of refining capacity on the Gulf Coast. The strength in jet/kerosene prices across the Atlantic Basin is also a reflection that refiners are focusing on maximising gasoline and diesel output, but at the expense of jet/kerosene supplies.

Figure 22

**OECD Automotive Diesel Prices and Taxes, Second Quarter 2005**

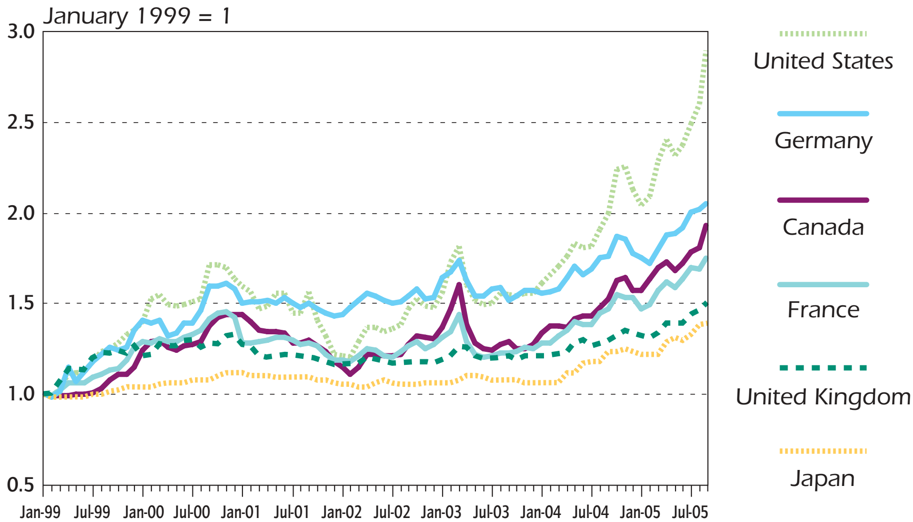



Note: data not available for Canada, Korea, Mexico and the Slovak Republic.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 23

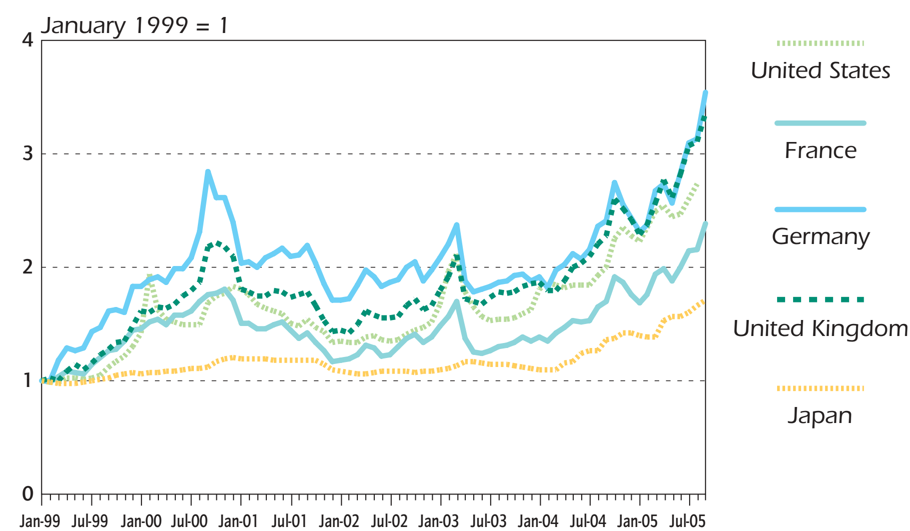
## Diesel Price Trends in Selected IEA Countries, January 1999 to September 2005




Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 24

## Space Heating Oil Price Trends in Selected IEA Countries, January 1999 to September 2005




Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

# NATURAL GAS

In 2004, the average price of natural gas imported into the United States was USD 5.66/million British thermal units (MBtu), compared with an average price of USD 5.05/MBtu in 2003. The price of pipeline gas increased by 11% during this period while LNG prices rose by 22%. Import prices are based on the evolution of prices on the US spot market (Henry Hub) and therefore reflect its volatility. In 2004, spot prices at Henry Hub remained high throughout the year. With a peak of USD 8.12/MBtu in October 2004, they averaged USD 6.09/MBtu in 2004, 12% higher than their average of USD 5.44/MBtu in 2004, which was already up 63% from the 2002 level. The major factors for this high level of natural gas prices were high oil prices, a continuing tight natural gas supply-demand balance, strong economic growth in North America and the expectation of a cooler winter in key heating regions. In the first three quarters of 2005, natural gas spot prices in the US averaged USD 7.80/MBtu, again responding to stronger oil prices and a tight demand-supply balance. More dramatically, however, the impact of hurricanes Katrina and Rita caused a price spike to USD 14 MBtu as they disrupted some 20% of US daily production in September 2005. Prices are expected to remain high throughout the winter of 2005/06.

Average gas import prices by pipeline in the EU also increased by 36% from USD 3.20/MBtu in 2003 to USD 4.34/MBtu in 2004. The vast majority of gas imports into Europe are linked to six- to nine-month average oil price formulae. This means that the European gas import price tends to follow the pattern of oil products which are the key components of the formula, with a six- to nine-month time lag. LNG tankers bringing liquefied natural gas (LNG) to Europe also tend to use the same pricing methodology, but more and more cargoes are now trading the Atlantic, meaning that the US Henry Hub prices are starting to influence LNG-importing countries, particularly Spain, which relies on spot cargoes for a large part of its LNG supply.

In Japan and Korea, imported LNG prices also increased. In Japan, LNG import prices amounted to USD 5.23/MBtu on average, compared with USD 4.82/MBtu in 2003, an increase of 8.5%. Prices are based on the Japanese crude cocktail (JCC) and reflect the evolution of JCC with a short time lag of around one month. The mechanism of

Table 5

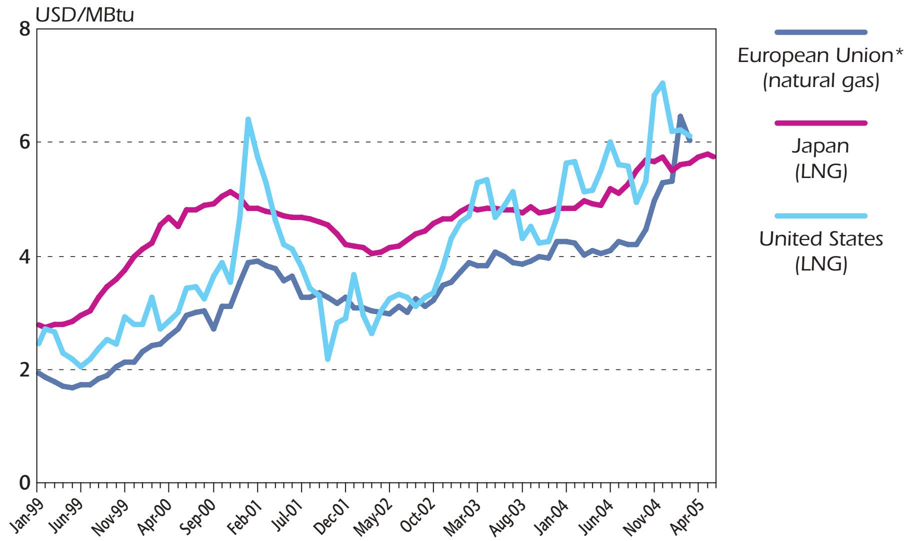
**Quaterly Natural Gas Price Indices**

| | *OECD* | *North America* | *Europe* | *Pacific* |
|---|---|---|---|---|
| 2Q 2004 | 119.3 | 132.2 | 105.3 | 101.0 |
| 3Q 2004 | 125.8 | 143.1 | 107.0 | 101.5 |
| 4Q 2004 | 122.4 | 134.5 | 109.9 | 101.6 |
| 1Q 2005 | 123.4 | 132.8 | 114.3 | 102.1 |
| 2Q 2005 | 128.8 | 142.6 | 114.9 | 101.3 |

Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2005.

Figure 25

**Gas and LNG Import Prices in the European Union, Japan and the United States, January 1999 to June 2005**

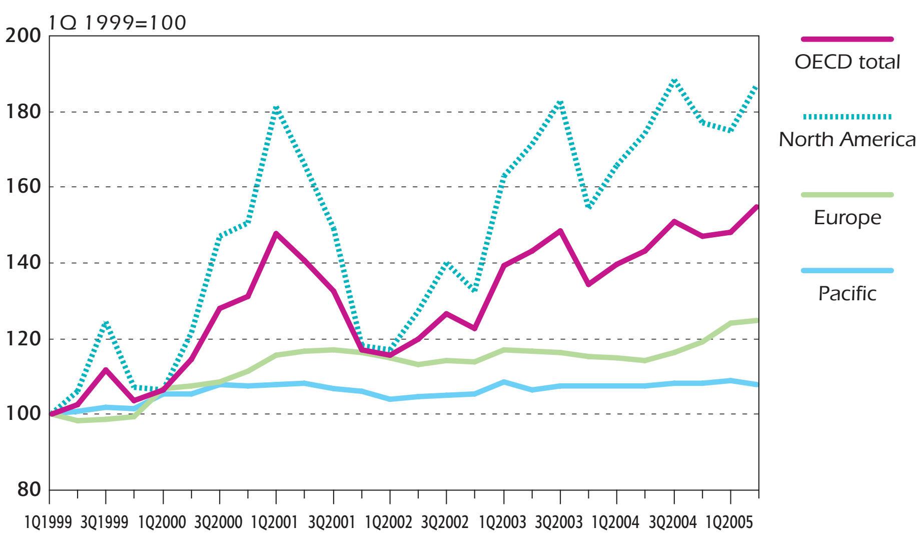



* average import prices. Calculated average prices may not be comparable from one month to the other due to differing components.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 26

**End-use Gas Prices by OECD Region, First Quarter 1999 to Second Quarter 2005**

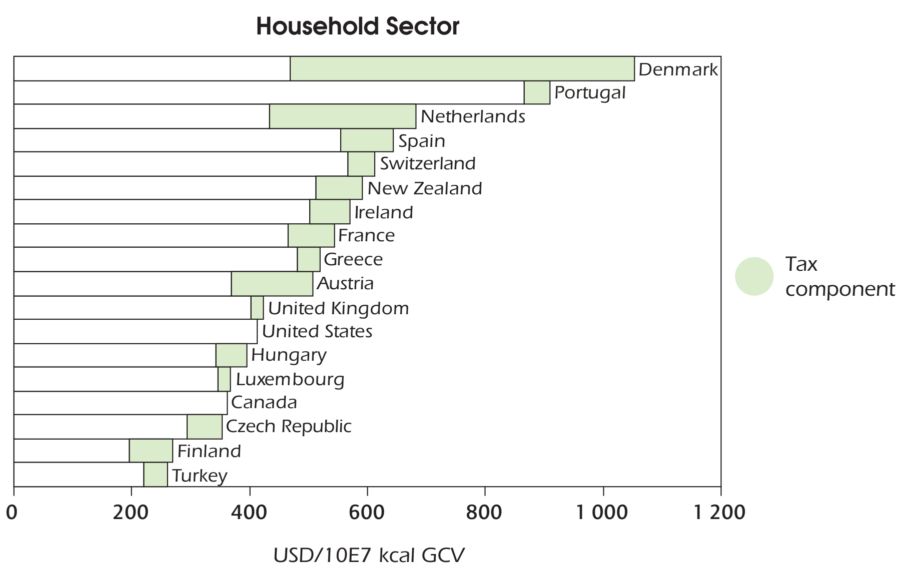



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 27

## Gas Prices in IEA Countries, 2004


Note: Tax information not available for the United States. Data not available for Australia, Austria, Belgium, Denmark, Germany, Italy, Japan, Korea, Luxembourg, the Netherlands, Norway and Sweden.




Note: Tax information not available for the United States. Data not available for Australia, Belgium, Germany, Italy, Japan, Korea, Norway and Sweden.

"S" curve included in the indexation formulae has capped the increase in LNG prices and led to a "decoupling" of oil and gas prices. In Korea, which has a portfolio of long- and medium-term contracts and spot purchases, imported LNG prices in 2004 increased by 15% compared to 2003 from USD 5.03/MBtu to USD 5.80/MBtu.

End-use prices for natural gas in the US increased by 7% throughout the year 2004, while end-use prices in OECD Europe rose by 3.5%. End-user prices in OECD Pacific were almost stable because of the cap in their long-term contracts for LNG.

## COAL

Following the trend in crude oil import costs, average OECD steam coal costs have increased substantially since the beginning of 2003, peaking in the fourth quarter of 2004. The total OECD steam coal import cost for the fourth quarter of 2004 was 54.5% higher than the previous year. The increase was greatest in Japan which saw a rise of 60.6%, followed by EU-15 of 48.9% and the US with 29.7%.

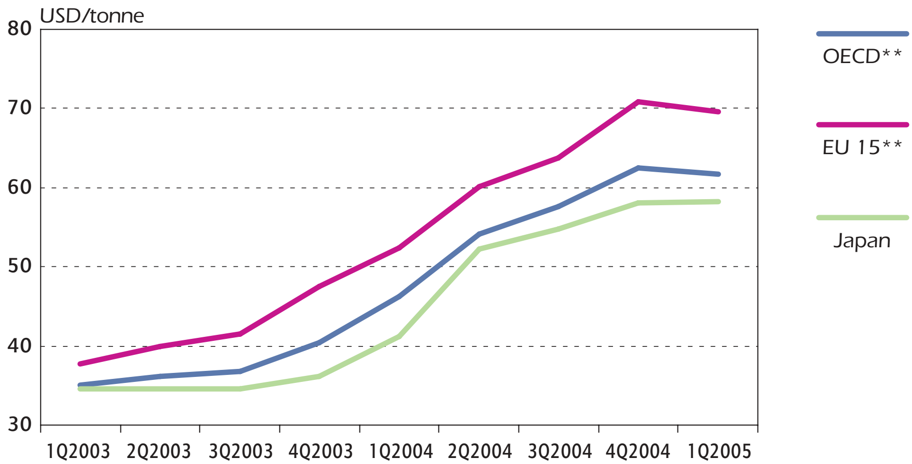
In the Pacific steam coal market, the rise in spot prices can be attributed to various factors. In September 2004, Chinese coal imports soared by over 50% compared to the same period in 2003. Strong domestic demand, logistical bottlenecks for domestic transportation of coal, and mine closures for safety reasons in Shanxi province following underground explosions in August 2003, contributed to this trend. In India, steam coal imports rose to 16 million tonnes in the financial year ending March 2005, a figure that may double over the next couple of years as indigenous producers fail to meet the growing demand from utilities. Following heavy rains in 2004, Indonesian steam coal exports have grown substantially in 2005 and are expected to overtake Australian exports to become the world's largest source of seaborne steam coal. Port and rail capacity constraints in Australia added to pricing pressures due to worsening congestion; where possible, producers diverted port capacity to higher-margin metallurgical coals.

The European market was also tight as South Africa struggled to maintain volumes and, contrary to expectations, the EU Emissions Trading Scheme did not dampen coal demand. Production growth in Colombia and Venezuela was insufficient to match steady demand growth in the Atlantic market with rising US imports. In fact, robust demand in the United States absorbed much of Colombia's increased production and took an increased share of South African exports, the latter having suffered some constraints due to poor delivery performance on the rail system to the key Richards Bay terminal and an appreciating rand. Russian exporters have been faced with port and cost limitations, halting the large growth seen in 2004.

The increase in seaborne freight rates, partly due to the massive build-up of demand for vessels to import iron ore to China, also accentuated the price spike in these markets. Another contributing factor was the steady fall in the value of the US dollar since early 2002, so US dollar denominated prices and transport rates increased to reflect this fall in value.

Figure 28

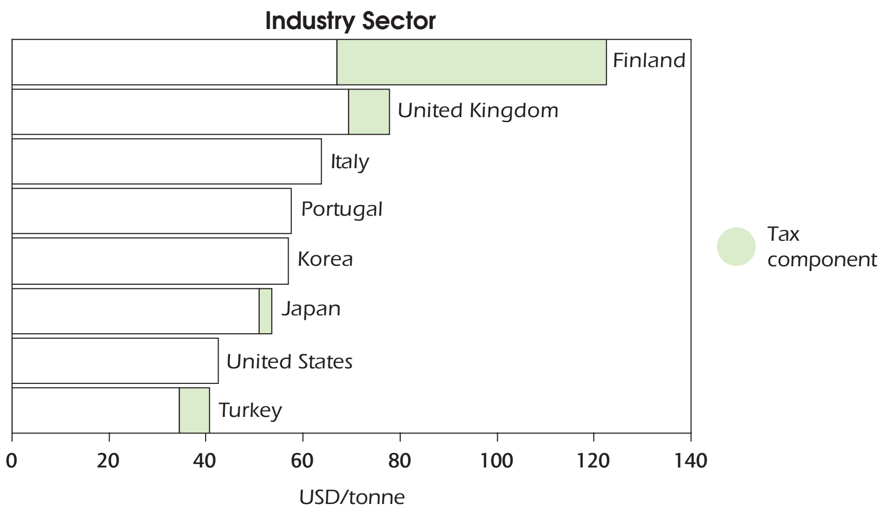
**Steam Coal Import Costs*, First Quarter 2003 to First Quarter 2005**
(average unit value, CIF)




Note: Excludes the Czech Republic, Hungary, Iceland, Korea, Mexico, New Zealand, Norway, Poland, the Slovak Republic, Switzerland and Turkey.
* excluding intra-EU trade. ** weighted average of individual countries using import volumes as weights.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 29

**Steam Coal Prices in IEA Countries, 2004**




Note: Data not available for Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, France, Germany, Greece, Hungary, Ireland, Luxembourg, the Netherlands, New Zealand, Norway, Spain, Sweden and Switzerland.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

# ELECTRICITY

Average electricity prices in the OECD regions have been on a declining trend throughout the past two decades, but this trend has been stagnant during the past four years. From 1Q to 4Q of 2004, higher fuel prices (oil, gas and coal) have created upward pressure in OECD countries. In OECD North America and OECD Pacific, price trends tend to peak in 3Q, reflecting peak summer demand.

Table 6

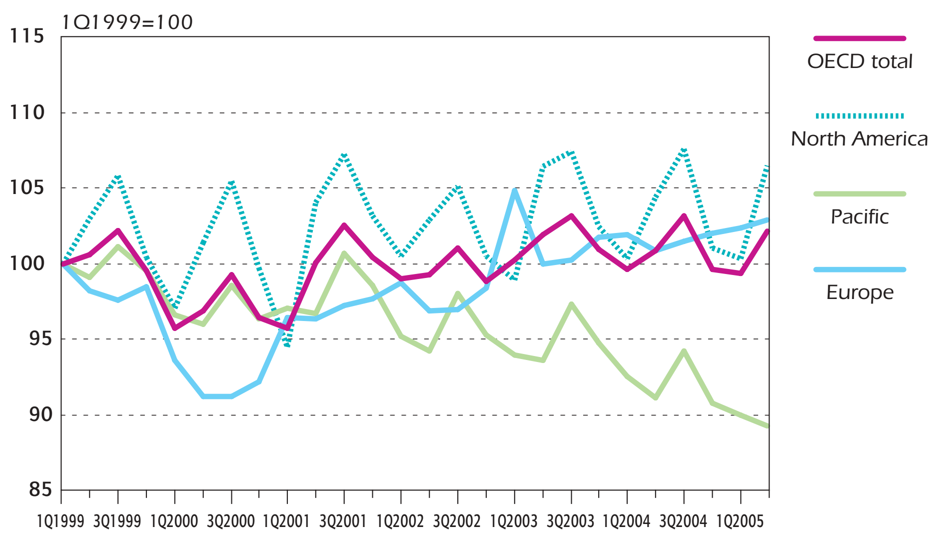
**Quaterly Electricity Price Indices**

| | *OECD* | *North America* | *Europe* | *Pacific* |
|---|---|---|---|---|
| 2Q 2004 | 104.0 | 103.8 | 109.4 | 94.0 |
| 3Q 2004 | 106.3 | 107.0 | 110.1 | 97.3 |
| 4Q 2004 | 102.7 | 100.4 | 110.7 | 93.7 |
| 1Q 2005 | 102.4 | 99.8 | 111.1 | 92.8 |
| 2Q 2005 | 105.5 | 106.0 | 111.7 | 92.1 |

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 30

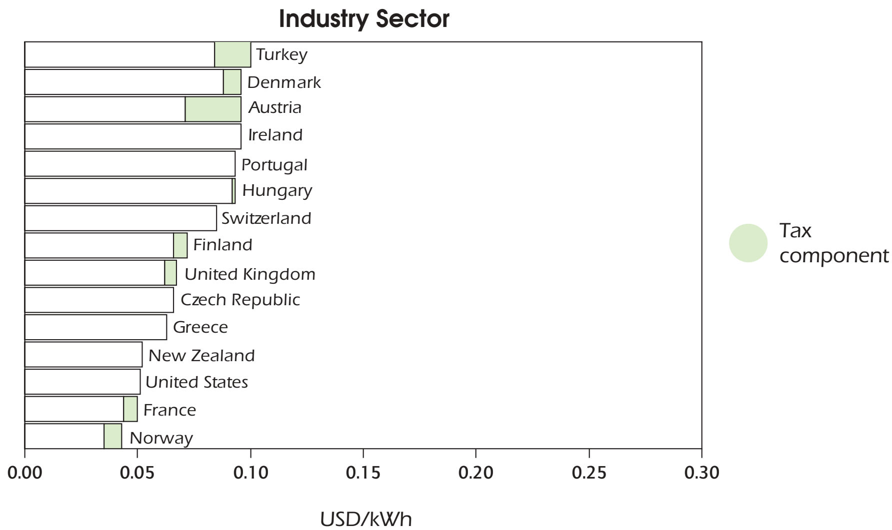
**End-use Electricity Prices by OECD Region, First Quarter 1999 to Second Quarter 2005**



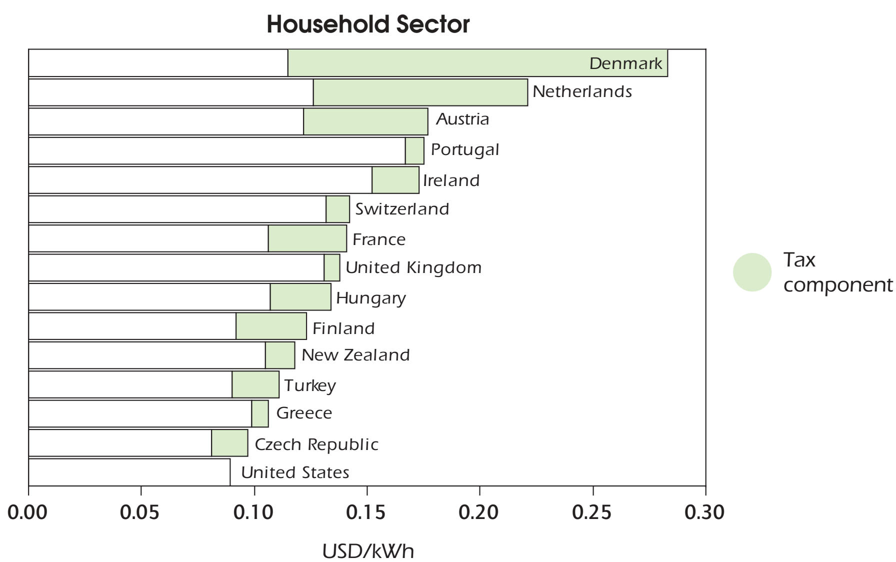

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 31

## Electricity Prices in IEA Countries, 2004




Note: Price excluding tax for the United States. Data not available for Australia, Belgium, Canada, Germany, Italy, Japan, Korea, Luxembourg, the Netherlands, Spain and Sweden.

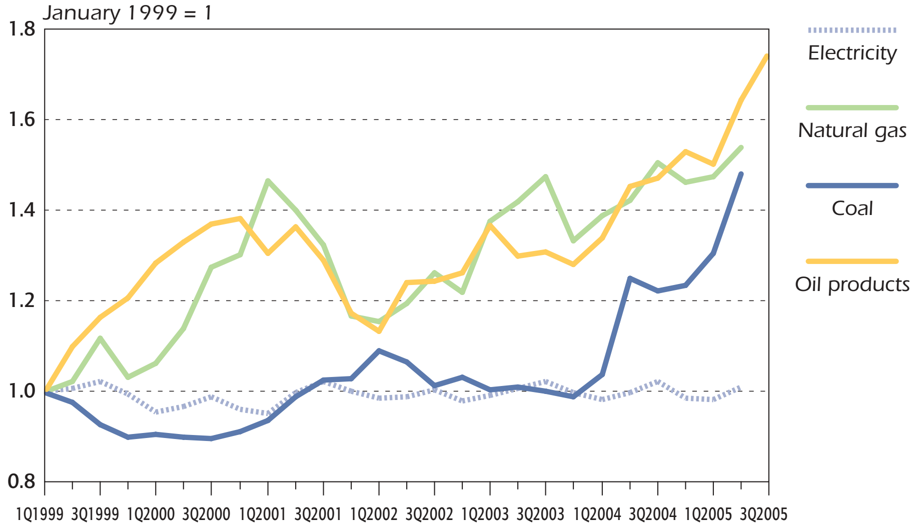



Note: Price excluding tax for the United States. Data not available for Australia, Belgium, Canada, Germany, Italy, Japan, Korea, Luxembourg, Norway, Spain and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 32

**Indexed Fuel Prices, First Quarter 1999 to Third Quarter 2005**




Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

## ENERGY INTENSITY AND $CO_2$ EMISSIONS

### ENERGY INTENSITY

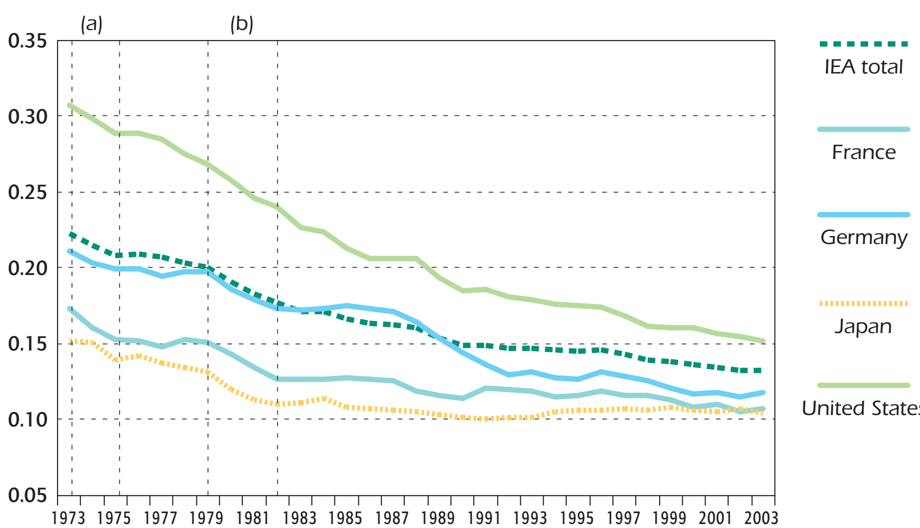
In IEA member countries, energy intensity in 2004 expressed as total primary energy supply (TPES) divided by gross domestic product (GDP) at 2000 prices and purchasing power parities (PPPs) fell by 5% from its 2003 level. In the recent ten-year period, average energy intensity decreased by 1.2% per annum between 1998 and 2002 compared to a 0.7% per annum drop between 1992 and 1997. In OECD North America, it fell by 1.6% per annum in 1992-1997 and by 1.8% in 1998-2003. In OECD Europe, it fell by 0.6% in 1992-1997 and by 1.0% in 1998-2003. On the other hand, in OECD Pacific, it increased by 1.6% in 1992-1997 and fell by 0.4% in 1998-2003. From a long-term perspective, it fell by 39% from the 1973 figure.

While such overall improvement of energy intensity can be observed, the rate of decline varies between countries. Energy intensity in the United States decreased by 45% between 1973 and 2004, while in Germany, Japan and France, it dropped by 44%, 27% and 23% respectively during the same period. Many factors influence the development of energy per GDP, including improvement in energy efficiency and changes in the level of energy services that consumers and businesses demand relative to GDP.

The level of energy intensity varies significantly among countries. Despite the considerable decline, the United States' energy intensity in 2004 was still 15% higher than the IEA average. Some of the other IEA countries not shown in Figure 33 diverge even further from the average. While part of the difference reflects variations in energy efficiency, it would be misleading to rank energy efficiency performance according to a country's energy per GDP measure since that ratio is affected by many non-energy factors such as climate, geography, travel distance, home size and manufacturing structure. Understanding energy efficiency developments requires a closer look at how energy service demand and energy intensities disaggregated by end-use and sector have evolved, as presented in *Oil Crisis and Climate Challenges; 30 Years of Energy Use in IEA Countries* (OECD/IEA 2004).

Figure 33

**Energy Intensity in Selected IEA Countries, 1973 to 2003**
(toe per thousand USD at 2000 prices and purchasing power parities)




a) corresponds to the first oil shock (end 1973) and macro-economic recession induced by this shock.
b) corresponds to the second twin oil shock (early 1979 and end-1980) and the macro-economic recession induced by this double shock.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005 and *National Accounts of OECD Countries*, OECD Paris, 2005.

# $CO_2$ EMISSIONS

During 2003, energy-related $CO_2$ emissions in IEA countries grew by 1.2% compared to 2002, reaching more than 12.1 billion tonnes, up 17% compared to 1990 levels. In 2003, IEA North America represented 52% of total IEA energy-related $CO_2$ emissions; IEA Europe 31%; and IEA Pacific 17%. This increase is greater than the 2001-2002 increase in energy-related $CO_2$ emissions (0.7%). However, the escalation was not homogeneous among regions. The 2002-2003 increase in IEA Europe and IEA North America was 3.5% and 1.6% respectively, while there was a decrease of 0.2% in IEA Pacific. Since 1990, aggregate emissions for IEA Pacific have risen by 34%, in IEA North America by 19% and IEA Europe by 6.5%. In all regions, the two main reasons for increased energy-related $CO_2$ emissions are the rising demand in road-based transport and an increase in power generation.

Energy-related $CO_2$ emissions grew in all sectors (industry, residential/commercial, transport and other sectors) in IEA North America and IEA Europe, whereas IEA Pacific recorded a decrease of 3.6% in the residential/commercial sector.

$CO_2$ emissions related to industry represented on average 15% of total energy. related emissions of IEA countries (*i.e.* 1 796 Mt $CO_2$). While $CO_2$ emissions related to industry decreased by 3.5% between 1990 and 2003 as a whole, they decreased by 6.2% in IEA North America and by 9.0% in IEA Europe whereas they increased by 14% in IEA Pacific.

$CO_2$ emissions related to transport represented on average 27% of total emissions of IEA countries (*i.e.* 3 323 Mt $CO_2$). They have grown by 26% between 1990 and 2003. The growth was most marked in IEA Pacific (37%) followed by IEA North America (26%) and IEA Europe (23%).

Energy production has remained by far the largest component, 38% in total energy-related $CO_2$ emissions in IEA countries (*i.e.* 4 612 Mt $CO_2$). Its relative importance varied between IEA countries, ranging from 57% for Australia where coal plays a dominant role in the production of electricity, to 3% for Norway where hydroelectricity plays a dominant role. The carbon content per kWh from electricity and heat generation in IEA countries has remained stable over the past decade. Total emissions from energy production have grown by 28% since 1990. The growth was most rapid in IEA Pacific (54%) followed by IEA North America (30%) and IEA Europe (11%). IEA North America is the main contributor to $CO_2$ emissions from energy production in the IEA total, representing 55%.

The residential and commercial sector accounts for 13% of total IEA energy-related $CO_2$ emissions. Emissions from this sector increased by 7.4% between 1990 and 2003. The growth was most steep in IEA Pacific (15%) followed by IEA North America (14%). IEA Europe, on the other hand, recorded negative growth (-0.7%).

Table 7

## Energy-related $CO_2$ Emissions in IEA Countries
(excluding international marine and aviation bunkers)
(million tonnes of $CO_2$)

| | 1990 | 2003 | % change 1990-2003 | 2010 | % change 1990-2010 |
|---|---|---|---|---|---|
| Canada | 430 | 553 | 28.62 | 620 | 44.02 |
| United States | 4 842 | 5 729 | 18.32 | 6 849 | 41.45 |
| **North America** | **5 272** | **6 282** | **19.16** | **7 468** | **41.66** |
| Australia | 260 | 347 | 33.67 | 414 | 59.55 |
| Japan | 1 013 | 1 201 | 18.62 | 1 096 | .. |
| Korea | 226 | 448 | 98.24 | .. | .. |
| New Zealand | 22 | 33 | 48.70 | 32 | 46.61 |
| **Pacific** | **1 521** | **2 030** | **33.47** | .. | .. |
| Austria | 57 | 75 | 30.18 | 66 | 15.74 |
| Belgium | 109 | 120 | 10.62 | .. | .. |
| Czech Republic | 154 | 117 | -23.93 | 103 | -33.22 |
| Denmark | 51 | 56 | 10.98 | 55 | 8.17 |
| Finland | 55 | 73 | 31.97 | 63 | 14.54 |
| France | 355 | 390 | 9.64 | 423 | 19.03 |
| Germany | 966 | 854 | -11.60 | .. | .. |
| Greece | 71 | 94 | 33.32 | 118 | 67.65 |
| Hungary | 71 | 58 | -18.21 | 53 | -24.55 |
| Ireland | 30 | 41 | 37.87 | 44 | 49.16 |
| Italy | 400 | 453 | 13.31 | 464 | 15.86 |
| Luxembourg | 11 | 10 | -6.08 | .. | .. |
| Netherlands | 158 | 185 | 17.05 | 178 | 12.76 |
| Norway | 29 | 36 | 24.59 | .. | .. |
| Portugal | 40 | 59 | 48.78 | 66 | 67.43 |
| Spain | 207 | 313 | 51.54 | 365 | 76.71 |
| Sweden | 52 | 54 | 3.61 | 49 | -5.12 |
| Switzerland | 42 | 44 | 6.39 | 44 | 6.48 |
| Turkey | 129 | 203 | 57.51 | 330 | 156.16 |
| United Kingdom | 560 | 540 | -3.59 | 550 | -1.83 |
| **IEA Europe** | **3 544** | **3 774** | **6.50** | .. | .. |
| **IEA TOTAL** | **10 336** | **12 085** | **16.92** | .. | .. |

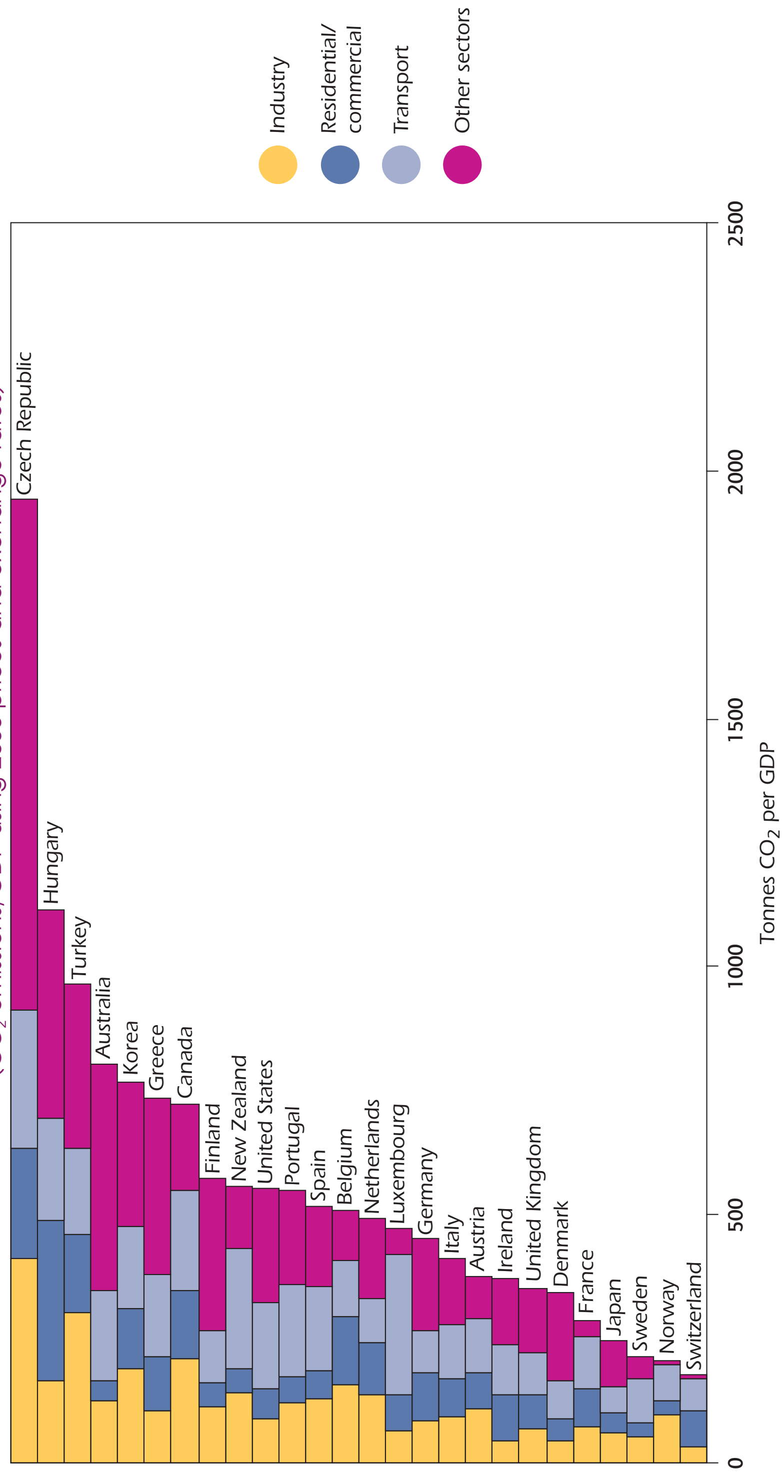
Note: "Energy-related $CO_2$ emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2003 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

Source: *$CO_2$ Emissions from Fuel Combustion*, IEA, Paris 2005, and country submissions.

Figure 34

**$CO_2$ Emissions per GDP by Sector in IEA Countries, 2003**

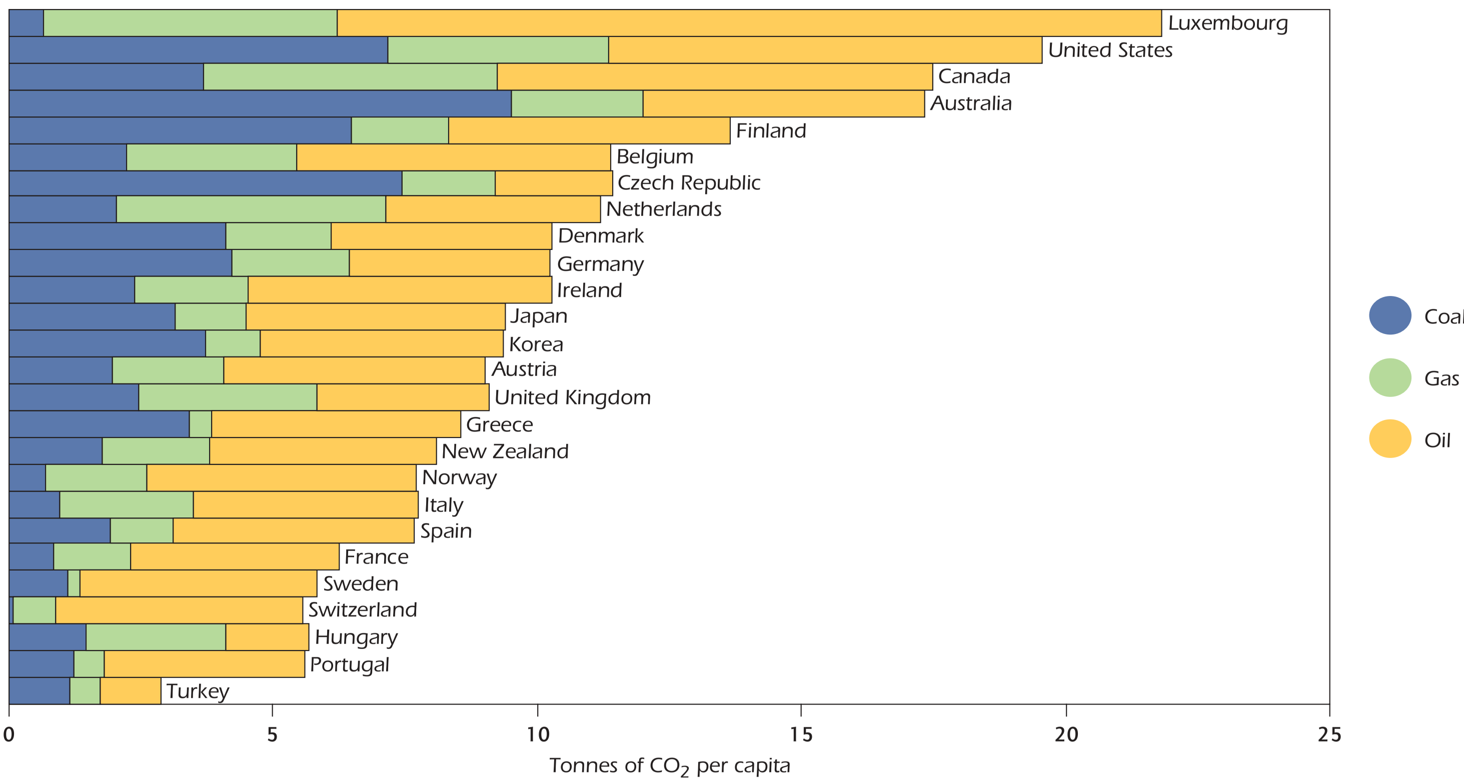
($CO_2$ emissions/GDP using 2000 prices and exchange rates)




Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005, and *National Accounts of OECD Countries*, OECD Paris, 2005.

Figure 35

**$CO_2$ Emissions per Capita by Fuel in IEA Countries, 2003**

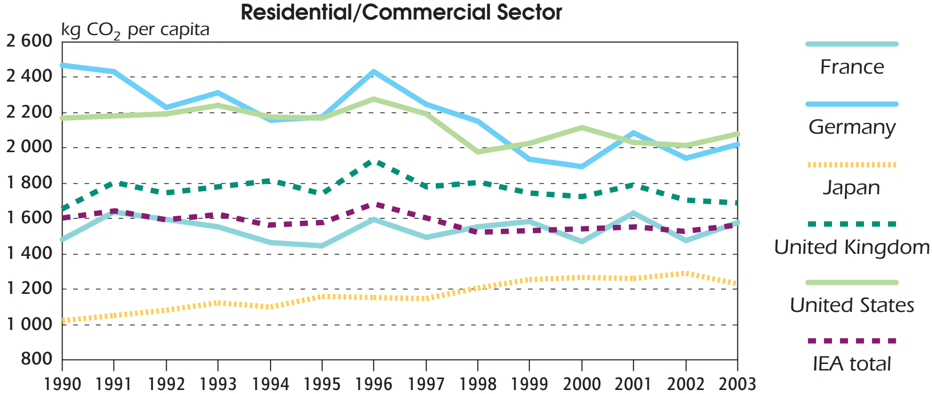



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005, and *National Accounts of OECD Countries*, OECD Paris, 2005.

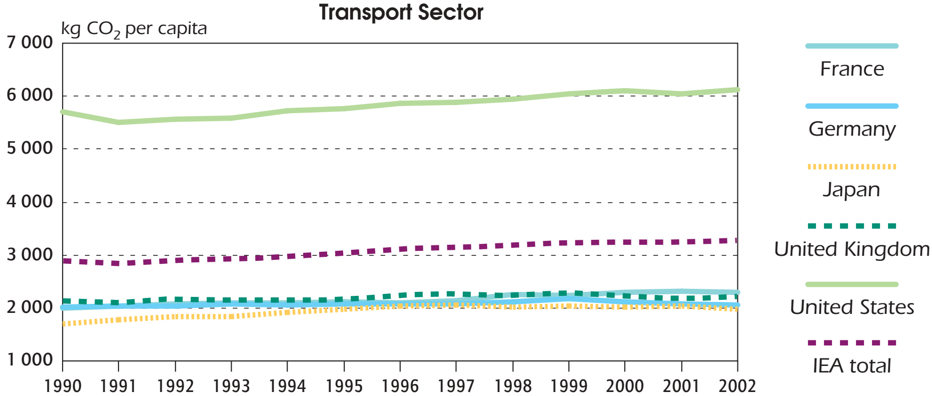
Figure 36

## Energy-related $CO_2$ Emissions by Sector in Selected IEA Countries, 1990 to 2003

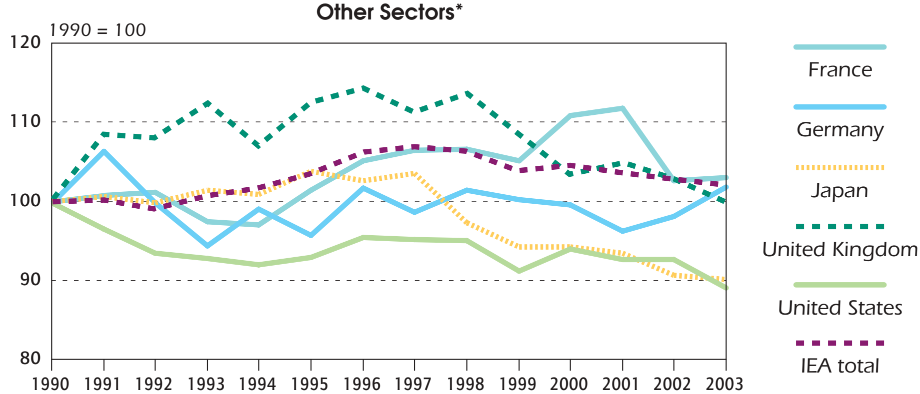
### Residential/Commercial Sector




### Transport Sector



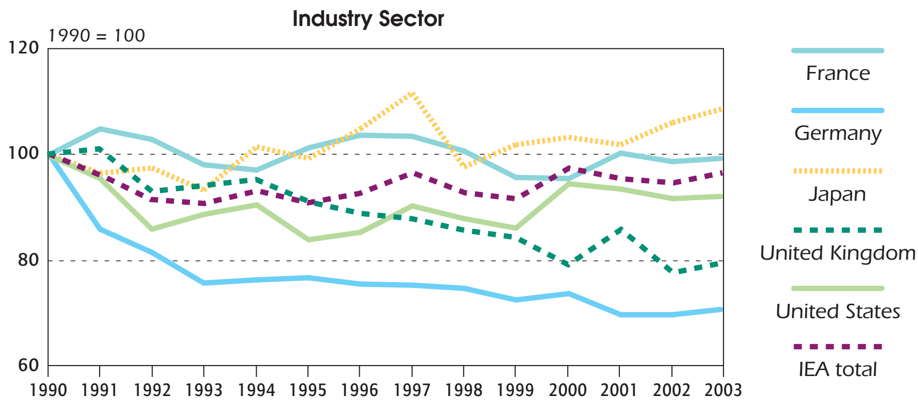

### Other Sectors*

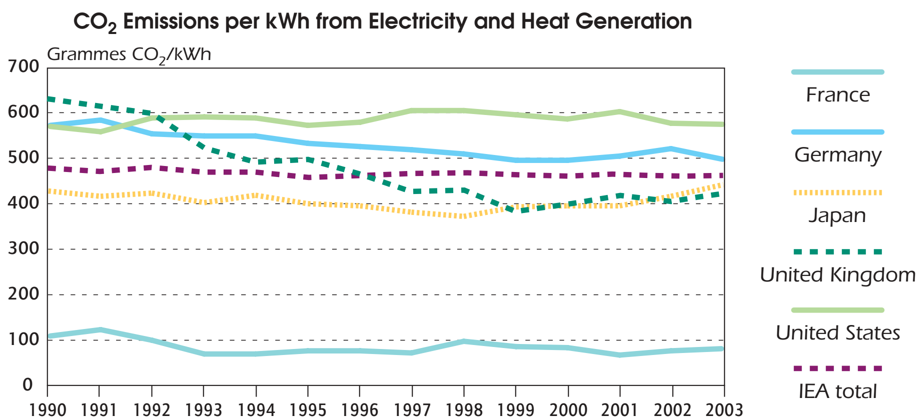



* includes other energy industries, agricultural sector, other non-specified sectors and non-energy use in other sectors.

Figure 36 (continued)

**Energy-related $CO_2$ Emissions by Sector in Selected IEA Countries, 1990 to 2003**

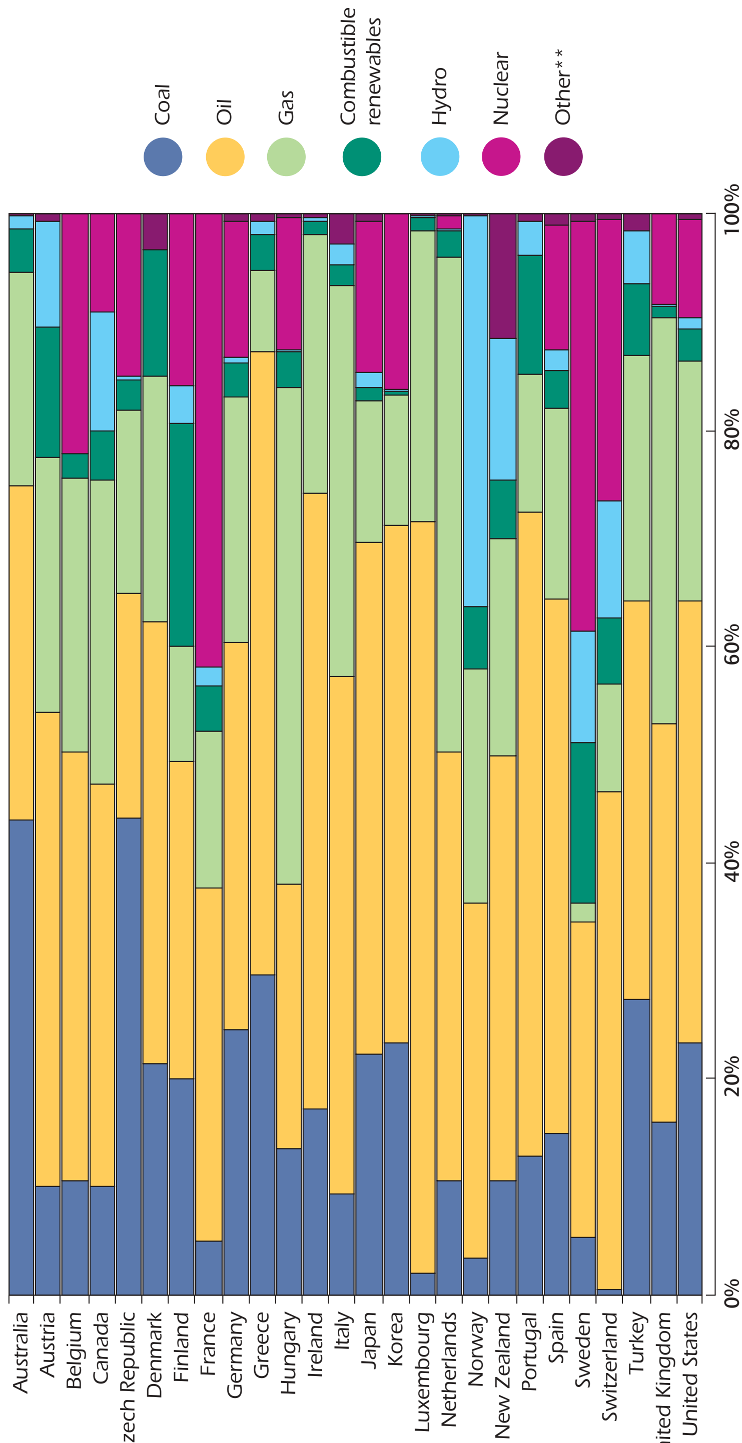



Sources: *$CO_2$ Emissions from Fuel Combustion*, IEA/OECD Paris, 2005 and *National Accounts of OECD Countries*, OECD Paris, 2005.

Figure 37

**Total Primary Energy Supply in IEA Countries, 2004***




* preliminary data.

** includes geothermal, solar, wind, and ambient heat production.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## ENERGY SECURITY IN A DANGEROUS WORLD

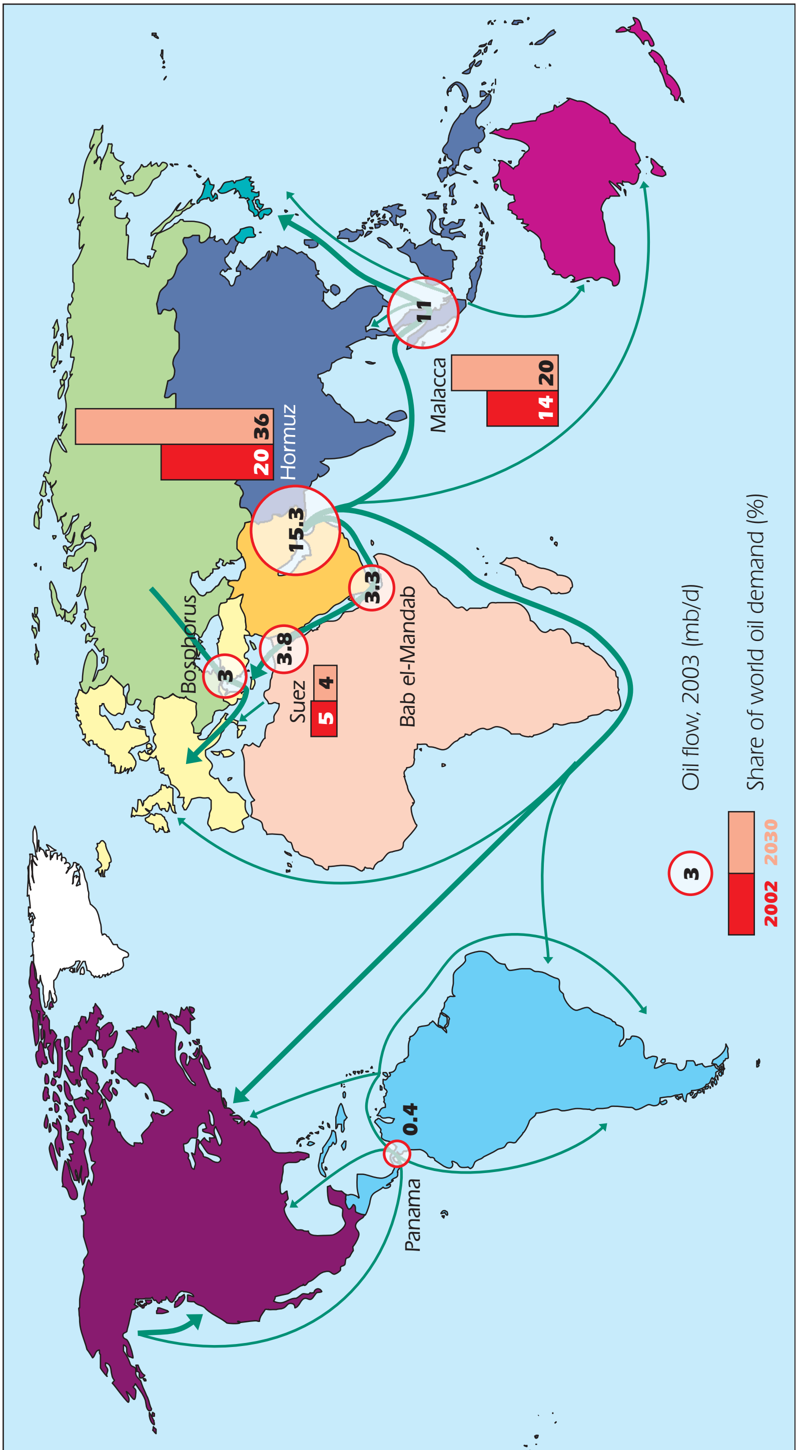
Recent energy market and geopolitical developments, including rapid growth in demand, diminishing spare oil production capacity and surging oil prices (as well as rising gas and coal prices), have thrust energy security back to the top of many countries' policy agenda. The terrorist threat combined with political instability and conflict in key producing regions, notably the Middle East, has brought home to everyone the danger of becoming overly reliant on imports of oil. Rapidly growing trade in natural gas, power failures in both North America and several European countries, and incidents at nuclear reactors have reminded us that other forms of energy are not immune to security concerns. This serves as a clear reminder that governments have a central role in ensuring reliable supplies and investment. Long-term energy trends suggest that these concerns will become more urgent and will call for stronger policy responses on the part of IEA member countries and the rest of the world.

### RISKS OF OIL SUPPLY DISRUPTIONS WILL MOUNT

Oil prices have risen dramatically and oil markets have been increasingly volatile in recent years. Strong growth in demand, shrinking spare production capacity, bottlenecks in refining and transportation capacity, and geopolitical uncertainties have been contributing to high prices while the lack of market transparency has amplified volatility. The world's vulnerability to oil supply disruptions will only increase as demand becomes more and more rigid, international trade expands, and reliance on imports from a decreasing number of large oil-producing nations grows. According to the IEA's *World Energy Outlook 2004* (WEO-2004) Reference Scenario, in the absence of new government policies, global primary oil demand is set to expand by 1.6% per year, reaching 121 mb/d in 2030. Demand will continue to grow most quickly in developing countries. The bulk of the growth in global demand will have to be met by imports. Oil use everywhere will become ever more concentrated in transport in the absence of readily available substitutes.

Oil supply will also become less diversified and less flexible. A small group of countries with large reserves, primarily Middle East members of OPEC and Russia, have the reserves to meet the global increase in oil demand. If current trends continue, OPEC could supply well over half of the world's oil needs in 2030 – an even larger share than in the 1970s. Net inter-regional oil trade will more than double to over 65 mb/d in 2030, or more than half of total oil production. All

Figure 38
**Oil Flows and Major Chokepoints, 2003**




Source: *World Energy Outlook 2004.*

the world's largest oil importers – including most OECD member countries, China and India – will become even more dependent on imports, while Indonesia, recently an exporter, will become a major importer. OECD member countries' oil imports are set to rise from 63% of total demand in 2002 to 85% in 2030.

Booming international oil trade will strengthen the interdependence among exporting and importing countries. But it will also exacerbate the risks that wells, pipelines or sea-lanes could be closed or blocked by terrorism, piracy or by accidents at critical chokepoints. Each day, 15 million barrels pass through the Straits of Hormuz and 11 million transit the Straits of Malacca in Asia. Traffic through these and other vital channels will more than double over the next two-and-a-half decades. A disruption in supply at any of these points could have a severe impact on global oil markets, especially at times when there is little spare production capacity. It is clear that maintaining the physical security of international sea-lanes and pipelines will take on added urgency.

## THE SECURITY OF GAS AND POWER SUPPLIES MAY BE JEOPARDISED

Increasing dependence on imports of natural gas in Europe, North America and other regions will similarly heighten concerns over gas supply security. IEA member countries' gas import dependence is expected to double from the current rate of 20% to over 40% in 2030. Europe in particular is highly import-dependent on only two sources, Russia and Algeria. The recent disruption in liquefied natural gas supplies from Indonesia demonstrated the risks of relying on imports of gas from politically sensitive regions. On the other hand, the expected expansion of international LNG trade could alleviate some of the risks of long-distance supply chains if it leads to more diversified supplies. Increased short-term trading will also make LNG supplies more flexible.

The LNG market is gradually moving from three isolated regional markets to a global one. Although this trend is generally positive, greater competition for supplies could create uncertainties. The recent tight gas supply in some European markets illustrates this risk, as cargoes were bid away by other buyers. In some cases, interruptible contracts with power generators have been triggered, causing a domino effect on the electricity sector. It could be opportune to review emergency protocols for natural gas in view of the increasing share of natural gas in power generation.

The 2003 blackouts in North American and Europe demonstrate the need to strengthen regulatory frameworks to improve system operation in emergencies. Improved vegetation management, better training and system management tools combined with better communication and co-ordination between system operators could help to minimise the risk of future emergency situations and improve emergency responses in cases of power failure.

The liberalisation of downstream gas and electricity sectors has clearly brought important economic benefits, but it can also have consequences on energy security. In promoting efficiency, increasing the size of the market, and diversifying supply, market reforms will reinforce energy security only if sufficient incentives are built into the design of those reforms. Investors need to be motivated to provide the degree of security demanded by consumers through investments in additional capacity. Over-emphasis on reducing costs could ultimately compromise security. With careful market design and the right incentives, liberalised markets are a powerful tool to attract sufficient investment and bolster security of supply.

## LONG-TERM ENERGY SECURITY HINGES ON ADEQUATE AND TIMELY INVESTMENT

Long-term supply security will depend on whether the investment needed to expand energy supply capacity will be forthcoming in a timely manner. The *World Energy Outlook 2004* estimates that USD 16 trillion of cumulative investment will be needed from 2003 through to 2030 to maintain and expand energy supplies – almost USD 10 trillion will be required in the electricity sector alone. The bulk of the projected USD 4 trillion of upstream oil and gas investment will be needed simply to maintain existing production capacity. Most investment, especially in the power sector, will be needed in developing countries, where access to capital is difficult and risks are high. This investment is unlikely to materialise without more attractive returns than are currently available to draw a huge increase in capital from industrialised countries. Conversely, access of capital to oil and gas reserves is restricted or difficult in many of those countries where the bulk of the world's reserves are located. Furthermore, information about reserves is, in many cases, deficient. If the required investment is not forthcoming, supply will lag demand, bottlenecks will emerge and energy prices will inevitably rise.

## GOVERNMENTS MUST ACT

These developments point to a need for IEA member countries to exercise leadership worldwide in dealing with the energy security risks. Measures to address short-term supply emergencies or price shocks will have to be improved. Relations with energy suppliers will also need to be strengthened. Governments will have to look anew at ways of diversifying their fuels, as well as the geographic sources of those fuels and mode of transport (pipelines, ships, etc.). But, now and in the future, stronger demand-side policies are essential to reduce energy use through conservation and improved efficiency. Governments will also need to devise new, cost-effective approaches to securing reliable gas and electricity supplies within a competitive market framework. In particular, they will need to lower regulatory and market barriers and ensure that the investment climate is sufficiently attractive within a stable and transparent market framework. Worldwide, not-in-my-back-yard (NIMBY) resistance to energy-related investments is increasing.

## IEA'S COLLECTIVE ACTION TO THE HURRICANE KATRINA DISRUPTION OF OIL SUPPLY

The year 2005 saw IEA's second co-ordinated stock release in its history since 1991, at the time of Gulf War. During the months leading up to hurricane Katrina in the US Gulf of Mexico, the global oil market had been very tight with historically low spare oil production capacity. Oil prices had been pushed upward in mid-August 2005 by geopolitical issues, including the death of King Fahd in Saudi Arabia, tensions over the Iranian nuclear programme and ethnic unrest in Nigeria, as well as by downstream disruptions caused by fires and accidents at some US refineries. The trend was further exacerbated by US gasoline stocks falling to the low end of the 5-year range.

On 31 August 2005, the IEA Executive Director notified the Governing Board representatives that, as the impact of hurricane Katrina could be severe and could cause a significant supply disruption, the IEA might need to recommend activation of the emergency response plan and release stocks.

On 2 September 19:00 Central European Time, the IEA Executive Director announced the activation of an emergency response equivalent to the release of 60 million barrels of oil to the market. This agreement was achieved in less than ten hours from the time that the IEA Secretariat sent the initial assessment of the situation recommending the activation of an emergency response. The IEA also consulted with major producers and the OPEC President, who also stated OPEC's commitment to make incremental oil available to the market. All of these illustrated the flexibility and well-preparedness of the IEA in handling an international energy crisis.

The volume of the response would average 2 mb/d over an initial period of 30 days, with a review of the collective action by the IEA Governing Board after two weeks. Member countries were reminded that oil products, in particular gasoline, would be the most useful contribution. The stock-draw was to be released using market mechanisms to allocate the oil where it was most needed.

Net importing IEA member countries are required to hold at least 90 days of net imports but have flexibility in meeting this requirement. Countries may meet this obligation by holding stocks of crude and finished products (owned directly by the government, held by industry or held/managed by stock-holding agencies). Many European IEA countries are also members of the EU. These countries, according to EU directives, hold stocks in three product categories (gasoline, middle distillates and residual fuels) and thus, a significant portion of their IEA stockholding obligation is met by products.

When the IEA decides to activate an emergency response, IEA member countries may use various emergency measures to participate in the collective action. The share of an IEA member country's response is proportionate to its share of the IEA group's total consumption over the previous four quarters. The stock-draw may be implemented by the release of publicly held stocks or, alternatively, by reducing stockholding obligations imposed on industry. A small percentage of the measures will be in the form of demand restraint, thereby freeing oil elsewhere in the supply chain. Other emergency measures which countries may use include raising levels of indigenous production.

By mid-September 2005, member countries had pledged to make available to the market some 64 million barrels over the initial period of 30 days, the equivalent of 2.1 mb/d. The majority of member countries opted to draw down emergency stock; 94% of the total volume of the response was to be achieved through the draw-down of either industry or government stocks, 3% by demand restraint, and 3% by increased indigenous production. Within the total amount of stocks to be released by member countries, 65% was to be crude oil and 35% products.

By end-October 2005, approximately 54 million barrels would have been made accessible to the markets from IEA member countries' emergency stocks and increased indigenous oil production. This included stock volumes made available by the lowering of stockholding obligations on industry, as well as sales and loans from publicly held emergency stocks.

## TRANSMISSION SYSTEM RELIABILITY

Substantial electricity supply disruptions involving a failure of generation plant and transmission services affected a number of IEA countries in North America, Europe and Australia during the second half of 2003 and 2004.

The largest supply disruption in North American history occurred on 14 August 2003, affecting eight US states and the Canadian province of Ontario. Between 60 000 MW and 65 000 MW of electricity load was lost over a 9 300 square mile area. Around 50 million people were disconnected initially. While most services were restored in the United States within two days, in some areas it took up to four days to restore services, while parts of Ontario suffered rolling blackouts for over a week until services were fully restored. Estimates of the cost of this blackout ranged between USD 6 billion and over USD 12 billion.

On 23 September 2003, the Nordic transmission system experienced its worst disruption in 20 years at around 12.35 p.m. Southern Sweden lost around 4 700 MW of supply, while Denmark lost around 1 850 MW of supply. About 4 million people were disconnected, including disruption of services to Copenhagen. Transmission services in southern Sweden were restored within an hour, with complete services restored within a few hours. Even given the short duration of the outage, costs are estimated at USD 310 million.

On 28 September 2003, the worst supply disruption in over 50 years struck Italy. Around 19 600 MW of electricity load was lost over a 277 000 square kilometre area. Nearly 56 million people were disconnected, with services restored within 24 hours.

On Friday 13 August 2004, a series of equipment failures led to a loss of around 3 100 MW, about 14% of the National Electricity Market in Australia. Widespread load shedding took place, but services were restored in all regions in less than two hours.

A common feature of these supply failures was the collapse of transmission networks over large areas. Supply disruptions of this magnitude clearly demonstrate the fundamental importance of networks to the efficient and secure operation of electricity markets, and highlight the vulnerability of electricity markets to network failures.

Large blackouts have happened in the past, covering entire regions and causing considerable economic loss. Nonetheless, these most recent blackouts, particularly in North America and Italy, affected a very large number of users, and combined with their duration, inflicted high costs on the affected economies. This in turn created concern among policy-makers, practitioners and the general public about generation and particularly transmission network performance, with implications for the efficient and reliable operation of electricity markets. Growing public sensitivity to supply disruptions reflects the increasing dependence of modern economies on reliable and efficient electricity supplies, and adds to the pressure on governments to effectively address these issues.

It has been claimed that the impact of these disruptions has been amplified by electricity market reform, because, so it is argued, such reform has brought unbundling and independent, decentralised decision-making. As a result, decisions relating to network use and investments affecting network operation and performance that were once made in a centrally co-ordinated way within vertically integrated utilities are now made by a number of independent market participants. Decentralised decision-making has fundamentally changed the utilisation of transmission networks. In general, the assets are now used more efficiently and effectively, but previously stable and relatively predictable patterns of network use have in many cases been replaced with less predictable usage, greater volatility of flows, and greater use of long-distance transportation, reflecting growing inter-regional trade. These fundamental changes to the nature and pattern of transmission usage have created new challenges for market participants and policy-makers in maintaining reliable transmission services and maximising transmission network performance.

A number of investigations have been conducted into these events. Although the individual circumstances surrounding these disruptions were unique, none of these investigations have indicated that electricity market reform was the root cause. Findings have generally been limited to the specific circumstances of these events, with none proposing definitive solutions to prevent future blackouts. However, these investigations suggest some common causes, including:

*i)* The inherent vulnerability of alternating current transmission networks to multiple breaches of operational reliability contingencies where they occur within the period normally allowed for the system to recover from a single breach.

*ii)* Poor communication and co-ordination of real-time system operation where markets span more than one system operator's responsibility.;

*iii)* Inadequate transmission capacity and maintenance of diagnostic equipment and network infrastructure (especially management of vegetation).

*iv)* Inadequate training and lack of experience among system operators.

*v)* A more dynamic and challenging network operating environment, reflecting the erosion of excess capacity under economic regulation, and greater volatility of flows, increased inter-regional trade resulting from electricity market reform, and possibly poorly managed trade.

*vi)* The continuation of pre-reform operating procedures which were not designed to accommodate the new demands placed on the network as a result of electricity market reform.

*vii)* The inability to enforce voluntary reliability standards.

These observations raise some key questions for policy-makers and practitioners in the context of liberalising markets:

- How has reform affected transmission network reliability and performance?
- Do reliability standards need to be changed to reflect the more demanding environment of reformed electricity markets?
- Does system operation need to be changed to meet the new challenges?
- Will existing policies deliver efficient, timely and adequate investment in transmission and network expansion and, in particular, is the regulatory framework able to promote appropriate investment across jurisdictional (especially national) borders?

In response to these issues, the IEA has undertaken a project to examine network performance and reliability, designed to:

*i)* Identify and analyse the key issues affecting the development and performance of transmission networks serving competitive electricity markets.

*ii)* Promote understanding of these issues among policy-makers and regulators.

*iii)* Facilitate debate and exchange of views between stakeholders about these issues and how best to address them.

*iv)* Suggest actions by government and other players to improve outcomes.

The project included two workshops in 2004. The first of these workshops focused on transmission network reliability in competitive electricity markets, with around 80 participants from Europe, North America and Australasia representing member governments, regulators, system operators, transmission network owners and market participants. The second workshop focused on transmission network performance in competitive electricity markets, covering:

- The policy context for improving transmission performance in competitive electricity markets.
- The challenges and options to improve transmission reliability and planning outcomes.
- Encouraging timely and efficient network investment to improve transmission performance.
- Regulation to reduce risk and strengthen transmission performance in competitive markets.
- The potential for greater integration of transmission networks and competitive electricity markets to strengthen incentives for superior transmission performance.

Some preliminary conclusions from this work are set out below.

Transmission and electricity market reform have a high degree of interdependence. A high performance transmission grid is essential to member country economies to enable the provision of competitively priced, reliable electricity supply. In several jurisdictions, expanding inter-regional transmission capacity has been a prerequisite for effective competition. Conversely, electricity market reform is strengthening transmission system security. Market reform has led to increasing regional trade and the development of more efficient, integrated regional electricity markets incorporating many independent decentralised decision-makers. This trade has had considerable economic benefits, through competitive prices flowing through to users, more effective reserve sharing arrangements within and between systems, and more efficient capital expansions.

However, because transmission capacity is more fully utilised, networks are more vulnerable to cascading failures, which affect wider areas. In this environment, an event affecting a relatively distant part of an integrated transmission network has the potential to quickly interrupt the delivery of electricity throughout a large interconnected network and severely disrupts the operation of electricity markets. Supply disruptions in North America and Europe during the summer of 2003, and in Australia in 2004, illustrate the potential impact of these disruptions on competitive electricity markets. A key question is how to accommodate the interface between transmission network reliability and electricity markets.

Common lessons from the four blackout case studies can be summarised as the 3Ts:

- *Tools:* system operators need new tools to monitor and assess a wide area and to evaluate actions.
- *Training:* system operators need to improve their capacity to manage increasingly large and complex network environments in real time.
- *Trees:* effective and efficient vegetation management is essential to minimise the risk of tree flashover.

Governments need to set minimum standards in these areas, and ensure they are achieved. 3Cs (co-operation, co-ordination and communication) have been identified as central to help reduce the potential for cascading failures in the future, particularly where regional markets span more than one system operator's area of responsibility. Where different system operators work in a common integrated region, jointly prepared and agreed protocols for co-ordinated action in the event of disruption have considerable potential to minimise the extent of emergencies and mitigate their consequences. Consistency of rules for system security across jurisdictions also seems an important factor in lessening the likelihood and impact of blackouts. Rapid and unambiguous communication between and among system operators was seen as a key factor in limiting the spread of a blackout, and reducing the time of its duration and hence impact. Conversely, lack of rapid communication was shown to exacerbate already difficult situations. Having multiple transmission system operators in the same meshed network is likely to create problems for policy-makers. In this regard, perhaps the Australian NEM has arrived at a solution that may provide a useful model for others, namely a single organisation that can mobilise resources from different areas within the network quickly and effectively.

System restoration following a blackout is crucial, given that the impact of a disruption can be reduced from an economic and societal viewpoint if electricity supplies can be restored speedily. Given the extent and geographical spread of the IEA case studies, it is generally agreed that restoration was relatively quick, although in some parts of Canada full restoration took over a week. The success of these efforts raises questions about the cost-effectiveness of potential options to improve transmission network reliability through means that would require a substantial additional capital investment, such as increasing deterministic reliability standards from, say, N–1 to N–2*. A key question in this context is the extent to which users' willingness to pay for transmission network reliability can be captured in a private property right. If cost-effective options to reduce restoration times can be identified, however, (for example, ensuring that generating stations switch reliably to in-house mode when networks are disrupted) the impact of potential blackouts could be correspondingly reduced.

* N–1 refers to the network being able to maintain a secure/reliable operating state in the absence (failure) of a single network element. N–2 refers to maintaining a secure/reliable operating state in the absence (failure) of two network elements (e.g. going-down of two transmission lines within a single control area).

Common rules and institutions within a given control area are important, but determining the key features of those rules across jurisdictions will be difficult. This is a first-order problem of market design. Markets operate within the framework and rules created by governments. Care needs to be exercised. Experience to date shows that market participants will respond quickly and efficiently to the incentives created by market rules, sometimes with unintended consequences.

A common theme of the IEA case studies was the need for more clearly defined responsibilities, notably for transmission system operators, but also generators. A balance has to be struck on the issue of liability; complete liability exemption is inappropriate, since some exposure should strengthen incentives to effectively manage system security. But complete exposure may discourage information exchange and transparency.

The North American and European case studies highlight the importance of complying with reliability rules. In most cases, however, the existing rules were developed during the era preceding market liberalisation, often based on voluntary industry standards, raising the issue of whether the existing rules are adequate and appropriate for the new era of electricity market reform, and even whether they can be enforced credibly. Improved governance, regulation and enforcement, founded on a clear, strong, contemporary legal basis, is a theme in several of the case studies, notably that of North America. The issue of mandatory standards for system security features in the 2005 US Energy Bill; US regulators have also been active in enforcing industry standards.

It may be possible to employ more sophisticated analytical approaches to determining reliability standards, such as probabilistic risk assessment or refined system analysis. However, these alone may not be sufficient. Deterministic and probabilistic approaches are complementary. N-1 is a relative standard which provides a suitable tool for flexibly determining transmission network reliability standards.

New technologies provide an opportunity to improve system reliability and operation in real time, especially visualisation tools of the kind being developed in the United States. However, such technologies may also create new risk exposures associated with the potential failure of electronic management/diagnostic equipment. Technology provides a means of assisting system operators, but it is unlikely to replace them. New technology can also assist in providing more transmission capacity within the same existing footprint, minimising NIMBY issues.

US experience indicates that nodal pricing (locational marginal pricing) of transmission network services seems to be superior to other pricing approaches. In particular, zonal or regional pricing by definition provides an averaged approximation of nodal price signals, which can distort incentives for transmission network use and locational signals for infrastructure investment. Zonal price structures are not sustainable, reflecting the physics of electricity flows and the dynamism of electricity markets. In practice, the additional costs associated with managing intra-regional network constraints may greatly exceed information/transaction costs associated with a nodal pricing regime.

There appears to be mixed views about the need for capacity mechanisms to stimulate new investment. Such mechanisms exist in the US, but they have little support among market participants. Capacity mechanisms are not consistent with efficient market-driven investment, and essentially represent re-regulation of the investment decision-making process.

There may be a need for some type of independent information mechanism that embraces the entire region of the meshed AC network, extending beyond political and jurisdictional boundaries, if efficient transmission is to be encouraged. This mechanism should consider both reliability and economic (competitiveness) factors. Such a mechanism should not be the basis for undermining competitive markets (for example by favouring generators in certain locations) and should to the greatest extent possible reflect markets and market price signals. It should be easily capable of accommodating private third-party projects, and should promote, not erode, the prospects for such projects. The "Transmission Statement of Opportunities" by the Australian system operator is one possible model.

Further investigations are warranted into the scope for market-based approaches to complement, and over time possibly replace, regulatory methods for addressing system security. Demand-side participation also has the potential to support more flexible, innovative and efficient delivery of system security, potentially providing a more flexible and acceptable alternative to existing load shedding.

There is a clear need for extensive evaluation and analysis of different international and regional approaches to balancing competitive markets with high levels of system security at acceptable costs, keeping in mind that governments cannot guarantee 100% supply reliability, and that cost effectiveness also needs to be part of this equation. There is considerable scope for further learning from the experiences of different regions and countries in this regard, particularly as competitive markets evolve, and the next generation of electricity supply and transmission investment takes place. The IEA will continue to be active in this area.

In summary, a sound, consistent (at the very least harmonised) stable regulatory framework across a given network is essential if efficient network operation and investment are to be maintained, consistent with contemporary reliability standards. Ideally, a single system operator seems to offer considerable advantages. In the presence of multiple jurisdictions, achieving these objectives will be difficult, but some regions have managed to construct such entities, with improved outcomes. Co-operative bodies of system operators in a given region may prove helpful in advancing this evolution and improving co-ordination and communication. Structural separation and independence of system or transmission operators from other players is also a common feature of more successful systems. A clear legal basis for all parties' roles and responsibilities also appears essential to achieving high levels of system security in contemporary markets.

In the past, major blackouts have occurred in IEA member countries, for example in North America in the 1970s; relative to the size of interconnected networks and consumption, these were quite severe. They triggered substantial work on the issue, leading to major reforms, including for example reliability councils and N-1 reliability criteria. Then, as now, it can be argued that developments in the use of transmission systems have outrun the development of operational skills. The recent blackouts have provided a timely warning that modern economies are heavily dependent on reliable electricity supplies. It is incumbent on governments to examine fully the causes of, and proposed remedies for, these supply interruptions, and ensure, in co-operation with industry (and particularly transmission system operators) and regulators, that all appropriate and cost-effective measures have been implemented to improve reliability of supply.

## PRODUCER-CONSUMER DIALOGUE

The IEA has long valued its involvement in the Producer-Consumer Dialogue and sees this as an essential part of its outreach activity. Interaction takes place at different levels: on a policy level, the IEA actively participates in the structured form of the dialogue as a key player in the establishment of the International Energy Forum Secretariat in Riyadh and a member of the new Secretariat's Executive Board.

Looking back, the Producer-Consumer Dialogue owes its current form to the French and Venezuelan initiative in late 1991 to convene a ministerial meeting on producer-consumer relations; the meeting proved the participants' willingness and ability to take the interests of the other party into account. This event was complemented later on by the IEA which convened experts from energy-exporting and importing countries to discuss oil market and security of supply issues at the technical level. Since then, IEA activities have been punctuated annually by the Producer-Consumer Dialogue, which reached a milestone at the 7$^{th}$ International Energy Forum (IEF) held in Riyadh in November 2000. There, HRH Crown Prince Abdullah of Saudi Arabia proposed the establishment of a permanent Secretariat for the IEF to be based in Riyadh. The principal objective of this Secretariat would be the promotion and facilitation of a sustained dialogue between oil- and gas-producing and consuming States with the main objective of facilitating exchange between main players as well as providing organisational support for future IEF meetings. At the 9$^{th}$ IEF, which took place in Amsterdam in May 2004, Ministers stressed their support for the newly established International Energy Forum Secretariat (IEFS). The IEF emphasised its commitment to the Joint Oil Data Initiative (JODI) exercise with the IEF Secretariat gradually establishing itself as the co-ordinator of the JODI World Database as well as of other activities linked to the development and promotion of the initiative.

The Executive Board of the IEFS meets regularly with the IEA Secretariat as a permanent, non-voting member along with its counterpart OPEC.

Producer-consumer interaction is also undertaken through various forums including the IEA-sponsored Energy Experts Meetings which serve as a biennial platform for exchange where a wide range of topics are covered. The IEA has so far hosted eight such energy experts meetings bringing together representatives from government, international organisations, academia and industry, and continues to be an essential link in the Dialogue as it explores topics of immediate consequence and maximises direct interaction among participants. This working level interaction remains a platform and a conduit for debate, addressing policy issues at the academic, technical and policy development level. It continues to be an essential link in the Dialogue as it explores topics of immediate consequence and maximises direct interaction among participants. Typically, no press representatives are admitted and discussions remain off-the-record under "Chatham House" rules of confidentiality.

The scope of participants and the focus of Dialogue–related meetings are both currently evolving: while energy security and better exchange of information remain key topics, there is recognition among players that critical gaps can be narrowed best when an understanding of one another's needs is improved and solutions of mutual interest found. Thematically, regional and development issues, which to date have been the concern of only a few specialised organisations, have also taken on a fast-growing dimension.

Workshops involving both the IEA and OPEC Secretariats have moreover become regular and are in the process of establishing themselves as necessary "reality checks" for respective member countries. So far, three workshops have taken place, with a fourth edition to be held in 2006; although discussion topics continue to touch upon demand and supply fundamentals and the mutual need for investment, they are likely to take on a broader scope in the future.

But it is not only the depth and breadth of the discussion topics that have evolved in the interaction process between the IEA and non-members of the OECD: it has generally become more inclusive, involving government and industry as well as smaller players. The IEA Secretariat has endeavoured to ensure the participation of consumer nations, mainly from the developing world, by increasing interaction and sharing values as well as common objectives. Thus, a series of measures which tackle region- or country-specific matters, including security of supply, stocks and stock management, data transparency and long-term demand–supply projections, are widely discussed in workshops and meetings. Outreach activities, which since the IEA's establishment have been part of its core business, are taking on an increasingly important dimension as emerging economies become the main drivers for demand. Increasing the co-operation between IEA and non-IEA member countries has proved to be a useful tool in ensuring market stabilisation, harmonisation of definitions and data exchange.

## ELECTRICITY

Electricity market reform has advanced at a slow but steady pace in many IEA member countries. IEA member countries are in various stages of reform. The first pioneer markets have now demonstrated their viability and positive contribution to efficiency through a relatively long track-record of robust performance. No markets are perfect, however, and they are continuously developing to improve and to meet new needs and challenges. During the past year, since the last Compendium, electricity market reform has taken important steps forward in some markets and countries. In general, market reform has continued to develop in a slow evolutionary process, drawing from experience and under increasing pressure from various stakeholders such as consumer groups. The IEA will publish a report drawing some important lessons from the first ten years of liberalised markets in some of the pioneer markets. The main conclusions are as follows:

- Liberalisation of electricity markets has delivered significant long-term benefits for consumers.
- Prices that reflect the inherent volatility of electricity are a key feature in liberalised electricity markets.
- Liberalisation is a lengthy and demanding process rather than an event.
- Liberalisation requires strong and committed involvement by government but the role of government has fundamentally changed.
- There are some limited but important aspects of generating, transporting and consuming electricity that markets will fail to address appropriately. These failures must be identified and carefully addressed through specific policies.

Energy policy to reform markets is still heavily influenced by skepticism in the wake of the Californian crisis and the collapse of Enron in 2000/01. Various aspects of security of supply considerations also continue to be an important driver for energy policy in the wake of the major blackouts in 2003. This is reinforced by the recent steep increase in oil and gas prices which have a spill-over effect on the price of electricity. A recent IEA report on transmission security in competitive electricity markets describes the blackouts and draws some lessons and conclusions (*Learning from the Blackouts – Transmission System Security in Competitive Electricity Markets*, 2005).

# IEA EUROPE

## Developments towards an Internal Electricity Market

Many of the most important parts of the EU Market Directive took effect from 1 July 2004, including market opening for all non-household consumers, legal unbundling of transmission system operation and the establishment of national regulators. In October the European Commission sent formal notices to 18 of the 25 member countries asking them to transpose the EU market directive – and to 17 countries regarding electricity. The deadline for full market opening for all consumers is 1 July 2007.

As a part of the process of implementing the 2003 EU market directive and regulation on cross-border trade, the European Commission issues annual benchmarking reports to assess progress. The evaluation is to end with an overall assessment by the end of 2005. A fourth benchmarking report was issued in January 2005. With it, the European Commission concluded that there had been progress in the transposition of EU rules but many obstacles to the development of an internal market still remained:

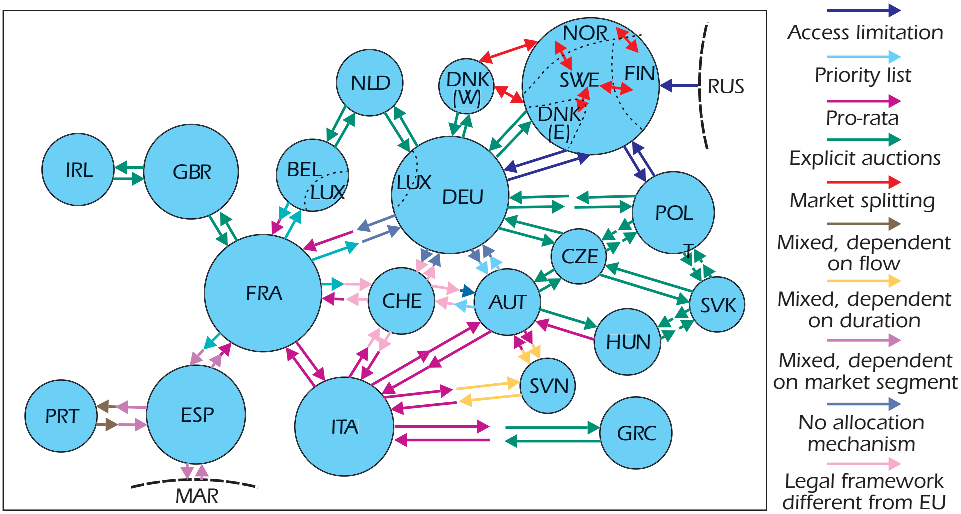
- National energy supply had failed to be integrated into a wider European market. This related both to the development of market rules that could improve the use of existing transmission capacity for cross-border trade and to investment in necessary new transmission capacity.
- The market structure in many member countries is highly concentrated, leaving competition to too few companies.
- Much progress had been made on the unbundling of network operators and the implementation of regulated third-party access but certain aspects still remained unsatisfactory. An independent regulator is crucial in advancing this process.
- Regulated end-user prices still existed in many countries. Although such control measures may be valuable in a transitional phase, there is a real risk that they will stifle competition and create other counter-productive incentives.

The European Commission reviewed progress again in July 2005 when it concluded that the situation had improved considerably in most member countries. It decided, however, to bring 5 EU member countries (4 related to electricity) to the third stage in the infringement procedure – which implied bringing these member countries before the European Court of Justice.

As regards improving the framework for effective cross-border trade over a wider European market, there has been little progress in practice. The association of European Transmission System Operators (ETSO) issued a review of the various forms of cross-border congestion management used between its member countries. As can be seen in Figure 39, many of these are not market-

Figure 39

**Methods for Congestion Management in Europe**




Source: ETSO.

based as required in the EU Market Directive, and many are not co-ordinated. ETSO and the association of European Power Exchanges (EuroPEX) have developed a model for cross-border trade based on the integrated trade of energy and transmission capacity (implicit auction of transmission capacity) which is used in the Nordic, Australian and various US markets. This model is called flow-based market coupling. It also takes the meshed character of the European transmission grid into account to a certain extent. The power exchanges in the Netherlands (APX) and France (Powernext) agreed with the Belgian system operator (ELIA) to establish a Belgian power exchange (Belpex) based on market coupling between the three exchanges. The two TSOs Statnett (Norway) and TenneT (the Netherlands) have started the construction of a submarine cable that is to connect the two systems by late 2007 or early 2008. Transmission capacity on the cable will be allocated using market coupling.

## European Commission Competition Directorate Opens Sector Inquiry into Electricity

Wholesale electricity prices have increased significantly in Europe during the past year. There are several fundamental factors that contribute to this development. The price of gas has risen markedly and the price of coal is still at a high level. At the same time, an extra marginal cost to use these fossil fuels has been introduced in Europe through the European $CO_2$ emission allocation and trading mechanism. In several European countries the balance between demand and supply is also tightening. New generating capacity is under construction particularly in Italy, Spain and Germany, but also in the Nordic countries and the United Kingdom. Beside the various fundamental drivers for higher prices, there is increasing concern that abuse of dominant position by large incumbent market players is also an important part of the explanation.

Referring to recent increases in prices, rigidities in cross-border trade and high market concentrations, the Competition Directorate of the European Commission has decided to open a sector inquiry into electricity market competition. The inquiry will focus on the functioning of wholesale markets and on how prices are formed, including levels of market integration and the functioning of cross-border trade. Barriers to entry into the electricity market will be examined by focusing on relations between network operators and their affiliates.

The inquiry will complement the assessment process connected with the transposition of the Market Directive. An interim report will be ready by the end of 2005 to feed into the overall assessment report of the development of the internal market. The main results will be published in 2006.

## European Union Initiatives on Security of Supply

In December 2003, the European Commission proposed a directive concerning measures to safeguard security of electricity supply and infrastructure investment. The directive is in the final process of approval but since 2003 a specific initiative on infrastructure investment has developed in parallel. The European Commission has identified seven packages of priority projects for adding new or extending existing electricity transmission interconnections to better serve the European energy market through enhanced competition, to integrate renewable energy into the European network and to reinforce security of supply. The project, Trans-European Energy Networks (TEN-E), supports feasibility studies of priority projects and it is possible to apply for additional funding for projects.

## Important Country Developments

The German parliament approved a new law on energy markets that came into force in July 2005. It sets the framework for regulated third-party access to electricity and gas networks. A new regulator, the Federal Network Agency (BundesNetzAgentur) has been established on the basis of the former Regulatory Authority for Telecom and Postal Services (RegTP), competent also for electricity, natural gas and railways. Preparatory work has made it possible to start operations in the energy field immediately.

The trading arrangements in England and Wales, based on unbundled system operation and regulated third-party access, were extended to include Scotland from 1 April 2005 in the new British Electricity Trading and Transmission Arrangements (BETTA).

Table 8

## Electricity Market Reform in IEA-EU Countries as of January 2005

| | *Declared market opening (% of total)* | *Large[1] eligible customers switch since market opening* | *Small eligible customers switch since market opening* | *Unbundling transmission* | *Unbundling distribution)* |
|---|---|---|---|---|---|
| Austria | 100 | 22[2] | 3 | Legal | Legal |
| Belgium | 90 | 35 | 19[3] | Legal | Legal |
| Czech Republic | 47 | n.k. | | Legal | Legal |
| Denmark | 100 | >50 | 5 | Legal | Legal |
| Finland | 100 | >50[4] | n.k. | Ownership | Accounting |
| France | 70 | 22 | | Legal | Management |
| Germany | 100 | 35[2] | 6 | Legal | Accounting |
| Greece | 62 | 0 | | Legal | None |
| Hungary | 67 | 24 | | Legal | Accounting |
| Ireland | 56 | >50 | 1 | Legal | Management |
| Italy | 79 | 15 | | Ownership | Legal |
| Luxembourg | 57 | 10 | | Management | Management |
| Netherlands | 100 | 30 | 35 | Ownership | Legal |
| Portugal | 100 | 9 | 1 | Ownership | Accounting |
| Spain | 100 | 18 | 0 | Ownership | Legal |
| Sweden | 100 | >50[4] | n.k. | Ownership | Legal |
| United Kingdom | 100 | >50 | >50 | Ownership | Legal |

n.k.: not known.

1. In general the split between, large and small customers is at the threshold of 1 GWh/year.
2. The remaining customers have renegotiated with their existing supplier.
3. Flanders region only.
4. Most large users in Finland and Sweden tender every year for a new supplier.

Source: *EU* Commission, Fourth Benchmarking Report.

# IEA NORTH AMERICA

## Development of Mandatory Reliability Standards

In the wake of the North American blackout on 14 August 2003, it became clear that current reliability standards and rules based on voluntary agreement were not adequate to meet the new challenges in liberalised markets. Liberalisation of electricity markets has changed the use of transmission systems fundamentally. Transmission assets are used better and more dynamically. This creates, on the other hand, a new framework and a new set of challenges for secure system operation.

The proposed new energy act in the United States includes legislation that makes reliability rules and standards mandatory. It is currently in the process of final approval.

An international working group was established on 30 June 2005 to consult on the establishment of an international framework for reliability and issues related to international aspects of mandatory reliability standards in North America. The working group was formed by the US Department of Energy (DoE) and the Federal Energy Regulatory Commission (FERC) on the one hand, and the federal Natural Resources of Canada and the Ontario Ministry of Energy on the other. The bilateral working group is committed to the following actions:

- Developing principles to guide the establishment of a reliability organisation that can function on an international basis.
- Co-ordinating on the electric reliability standards process.
- Consulting on policy and regulatory issues surrounding reliability.

## The United States: Development of Regional Transmission Organisations

Encouraged by the FERC, regional transmission organisations (RTOs) are developing and extending at a slow but steady pace. There are now six RTOs involving electricity supply in 30 US states. These are fully or partly approved by FERC to be in accordance with FERC minimum criteria, including the publication of market rules that create a level playing field. In June 2002, the FERC proposed a Standard Market Design to remedy remaining undue discrimination and establish a standardised transmission service and wholesale electricity market design, with the aim of providing a level playing field for all entities seeking to participate in wholesale electricity markets. In July 2005 this proposal was formally withdrawn and terminated as a result of extensive comments mainly relating to FERC versus state jurisdiction. The development of voluntary RTOs since 2002 has also contributed to fulfilling the purpose that was otherwise intended with the proposed Standard Market Design.

On 1 May 2005, the RTO across several Midwestern states, MISO, started operating a wholesale market based on locational marginal pricing. These are the same principles used in the Pennsylvania-New Jersey-Maryland interconnection (PJM), the New York Independent System Operator (NY-ISO) and the New England ISO. This means that some 75 million consumers across 26 US states are now served by a wholesale electricity market based on nodal locational marginal pricing. An additional 20 million consumers in Texas are served from a zonal-based wholesale market.

## Canada: Review of Electricity Market in Alberta

The enactment of the 1995 and 1998 Energy Utilities Acts established the framework for a competitive electricity market. A major refinement was made again in 2003 with the establishment of a merged independent system and market operator in the Alberta Electric System Operator (AESO). The framework includes regulated third-party access, trade in a balancing pool and full customer choice, but it also maintained a regulated rate option (RRO) for those residential consumers who do not wish to change supplier. The RRO was intended to be terminated by the end of 2005.

The framework has been a success. 3 500 MW of new capacity has been built since 1998, and there has been competition in the wholesale and retail markets between several market players. There has been more response from the largest industrial consumers compared to what is known about what has happened in other markets. Concerns in the wake of the 2003 blackout and concerns for continued success in bringing forward new investment in a timely and adequate manner made the Alberta government initiate a review of the market in early 2004. The review was conducted with the close involvement of stakeholders. Following the review, a report was published in June 2005 drawing the following main conclusions:

- Regulated rate option should continue in a revised form after 2005 based on hedging contracts.
- The ISO does not currently have adequate information to ensure balanced supply and demand in the day-to-day system operation. A list of refinements was proposed.
- On long-term adequacy of generating capacity, a special capacity measure was considered. However, based on assurances from market participants that they would continue to develop new projects within the current market framework without a capacity market, this option was discarded. Instead, a robust monitoring system will be developed to provide the market place with transparent information about reserve margins.

Immediately following the publication of the review, the Alberta government decided to extend a revised version of the regulated rate option.

# IEA ASIA-PACIFIC

## Australia: Electricity Market Reform

The Australian government published a white paper on Australia's energy policy in June 2004. Related to energy market reform, it emphasised the urgency and importance of continued energy market reform. The white paper refers to the ongoing reform process undertaken by a joint effort between federal and state governments as a response to the 2002 electricity reform review. A vision for the future to accelerate the drive for an open, efficient and fully competitive national energy market includes the following points:

- Stimulate the long-term investments required to meet future energy demand.
- Provide for competitive neutrality between public and private sector investment.
- Support active demand-side involvement in the integrated energy market.
- Ensure there is competitive trade, within and across state borders, in energy services and supplies.
- Pursue strengthened financial markets to underpin liquidity and help manage risk.
- Pursue national emergency response protocols, involving governments, industry and users, to better co-ordinate responses to national energy supply emergencies and to minimise their economic impact.

In July 2005, the new National Energy Regulator commenced operations. This is one of the outcomes of the 2002 review of the energy market reform made by the Council of Australian Governments. The new regulator will replace 13 federal and state regulators in gas and electricity.

## Japan: Implementation of the 2003 Electricity Utility Industry Law

A new Electricity Utility Industry Law was amended in 2003. It sets the framework for the next steps of electricity market reform in Japan towards 2007. On April 2005, the group of consumers with free choice of supplier was extended to include small factories and other medium-sized and small businesses. This means that consumers representing 63% of consumption are free to choose their supplier. The remaining small business and residential consumers will get access to the market in April 2007.

As decided in the amendment of the 2003 law, an independent National System Organisation has been established. Its main responsibility is:

- Rule-making regarding issues such as construction of facilities, network access, system operation and information disclosure.

- Arbitration and dispute settlements between network users and the transmission and distribution divisions of General Power Utilities.
- Providing a central dispatching liaison office.
- Providing a forum for the industry to discuss inter-regional interconnection line improvements.
- Evaluating system reliability and publishing summer/winter outlooks.
- Preparing and disseminating statistical data.
- Carrying out research on power systems.

## GAS

Increasing dependence on imports of natural gas in Europe, North America and other regions has heightened concerns over gas supply security. IEA member countries' gas import dependence is expected to rise from its current level of 20% to over 40% in 2030. Europe, in particular, where market reform is proceeding apace, is highly import-dependent on two main sources, Russia and Algeria, where there is no clear gas upstream nor transport regulation and their gas production and exports are managed by companies executing sovereign rights of States. The recent disruption in liquefied natural gas supplies from Indonesia demonstrated the risks of relying on imports of gas from politically sensitive regions.

On the other hand, the expected expansion of international LNG trade could alleviate some of the risks of long-distance supply chains if it leads to more diversified supplies, for example the recent emergence of Qatar as a major additional source of LNG. Increased short-term trading will also make LNG supplies more flexible and dampen the level of volatility in import markets.

The gas industry has seen the development and strengthening of several market trends across OECD regions in 2004-2005. These inlcude the continued building of gas-fired power stations and the emergence of a nascent Atlantic market in liquefied natural gas (LNG), against the backdrop of consistently high gas prices in all regions. These challenges are being met by developments in IEA countries' gas policies.

### PRICES

Gas prices in most IEA countries are linked directly to oil products, and with the price of crude reaching more than USD 60/bbl, gas prices have automatically followed. The US and the UK have the only markets in which the price of gas is substantially determined by the interplay between the supply and demand of gas, but both of these markets are becoming very tight, with domestic supply dropping and demand increasing, with a gap before new supply is set to come on line. In the case of the UK, the incremental (price setting) supply flows from the Continent through the sub-sea interconnector – this gas source is still priced with reference to oil. In the US, the rising price of gas has been limited by the possibility of demand-side switching to alternative fuels, but these fuels are inevitably oil-based, which means that the gas price has been capped by oil products. Thus, the current gas price in all IEA countries is high because of the world oil price. The difference between the US/UK markets and those whose gas price is still mathematically linked to oil is that as supply to the liberalised markets increases (*e.g.* new LNG imports), price pressures may ease. In IEA countries whose gas markets are not liberalised, increasing the supply of gas will not cause the price to fall even if it outpaces demand.

## ATLANTIC LNG MARKET

The current emergence of an Atlantic gas market has been driven by the supply gap in the USA and its correspondingly high prices. The prices available for LNG cargoes in US East-Coast ports have on average been over USD 1/MBtu higher than corresponding prices in European markets, notably Spain, meaning that several cargoes have been diverted to the US. In response, Spanish players have been forced to outbid the US price for several cargoes in early 2005. With the first of the UK's three planned LNG receiving terminals entering operation, Zeebrugge being upgraded, and many new Spanish, French and US East-Coast terminals being built, the development of an Atlantic LNG market is fast becoming a reality. This process is likely to repeat itself in the Pacific, although further into the future owing to the slow development of US West-Coast terminals.

## GAS-FIRED POWER GENERATION

As OECD energy markets become more efficient and concerns about environmental impact of fossil fuels grow, gas-fired generation is proving to be the most flexible, least risky and cleanest "conventional" source of power. The majority of the cost of operating a gas-fired power plant is the cost of the fuel, which, despite the current high prices, is reduced by continued improvements in the efficiency of gas turbines. The overall cost to install new gas-fired plant is relatively low and relatively well defined per unit capacity, and, in addition, the time to install new capacity is short when compared with coal or nuclear plant. These factors all dramatically reduce the risk for investors. Alongside the quick start-up and shut-down times, the financial flexibility of having a plant with low fixed costs relative to marginal costs also suits the increasingly variable demand profile of power consumption in a number of IEA markets, and makes it the best choice for the backup of intermittent renewable energy sources. The attraction of gas plant is further augmented by its relatively low impact on the environment compared with other forms of conventional power generation, meaning that gas will continue to be the "fuel of choice" while these advantages persist.

# IEA NORTH AMERICA

## United States

The USA is the world's largest market for natural gas, as well as being its second-largest natural gas producer after Russia. Historically, US domestic gas supply has been augmented by exports from Canada and Mexico, but the latter supplies have now decreased to the point where the USA exports gas to Mexico. US production of natural gas has started to plateau, from 541 bcm in 2003 to 532 bcm in 2004. This decline in domestic production, coupled with an increase in domestic demand, particularly for power production, has meant that prices at the benchmark Henry Hub in 2004 were 76% above the level of 2002. At these pricing levels, and with robust demand forecast, observers have expected more supply to be forthcoming, and the industry has indeed responded by increasing drilling for gas in the US. The problem has been, however, that discoveries made so far have not been sufficient to offset the decline in mature gas fields.

The resulting tightness in the US market has meant that the US has started to look in earnest at importing liquefied natural gas in order to fill the supply gap. The US had only limited LNG import capacity in 2003, but with prices as high as they are at the moment, gas importers are keen to expand this as quickly as possible. This expansion has presented an increasing problem, with regasification terminal siting becoming a key issue of contention between the states and federal government over who has the authority to approve the siting of LNG terminals. There has been a very vigorous campaign at the local level against LNG import terminals to try to prevent their location near to centres of population, because of concerns about security and the impact on the local economy. However, the federal response has been to facilitate the development of those LNG projects that satisfy environmental and safety requirements and are in the public interest. In addition, FERC has streamlined the approval process down to one year, by performing comprehensive reviews in conjunction with other agencies.

### Restructuring at the retail level

In recent years, the US retail market has opened more to competition as various states have initiated retail unbundling programmes to allow residential natural gas users to select their gas supplier. The nature of these customer choice programmes varies widely from state to state. Table 9 provides an overview of the status of the natural gas industry restructuring in each state, focusing on the residential customer class. Overall, however, continuously high prices for natural gas in 2004 and increased price volatility seem to have dampened domestic consumers' interest in industry restructuring. Between 2003 and 2004, there were almost no changes in natural gas industry restructuring status except that South Carolina and Texas moved from "no unbundling – considering action" to "no unbundling". In addition, between 2003 and 2004, there was an almost 5% decrease in the number of residential consumers participating in customer choice programmes.

## LNG terminal siting issues

With the price of Henry Hub hovering above USD 6/MBtu, the gas industry has become increasingly interested in importing LNG to the US. Nearly 30 applications to build new LNG importing terminals in the US have been filed with the FERC or Coast Guard. A few more LNG importing terminals have been proposed for Canada and Mexico with a view to increasing supplies for all of North America. The most likely sites for new LNG terminals are in the Gulf of Mexico, long accustomed to gas infrastructure, whereas the US west coast is proving to be more challenging despite the obvious demand. Local opinion in many states is often firmly against siting these LNG terminals for many reasons. They are frequently seen as a security threat in people's

Table 9

**Status of US Natural Gas Industry Restructuring at the Retail Level by State, as of December 2004**

| *Residential natural gas restructuring status* | *States* |
|---|---|
| Statewide unbundling – 100% eligibility | DC, NJ, NM, NY, PA, WV |
| Statewide unbundling - implementation phase | CA, CO, GA, MD, MA, MI, OH, VA |
| Pilot programmes/partial unbundling | FL, IL, IN, KY, MT, NE, SD, WY |
| No unbundling - considering action | IA, KS, ME, MN, NV, NH, OK, VT |
| No unbundling | AK, AL, AR, AZ, CT, HI, ID, LA, MS, MO, NC, ND, OR, RI, SC, TN, TX, UT, WA |
| Pilot programme discontinued | DE, WI |

Source: EIA website: *www.eia.doe.gov/oil_gas/natural_gas/restructure/restructure.ht* backyard. The federal government is aware of the need for these import facilities to be built as soon as possible, but terminal siting involves many different authorities, such as the US Coast Guard, local government and Army Corps of Engineers in addition to the FERC. The Energy Policy Act of 2005, which passed in the summer of 2005, affirmed FERC's clear jurisdiction over terminal siting. However, states still have the ability to effectively veto any LNG facility by denying permits associated with the Clean Water Act, the Coastal Zone Management Act, and the Clean Air Act.

### Arctic National Wildlife Refuge

Drilling in the Arctic National Wildlife Refuge (ANWR) in Alaska is seen by many in the US as the solution to gas supply problems as the nature reserve sits atop large resources of hydrocarbons. Although the exact amount of deposits in ANWR is not known, present estimates are that the development could contain as much as 500 bcm of gas, in addition to large quantities of oil. The ANWR was almost opened up to drilling in 1995, but this was prevented by President Clinton who vetoed the Balanced Budget Act containing the provision. More recently, the House and Senate approved the 2006 budget bill which includes a proposal to open the area, but specific legislation referring to ANWR in the Energy Bill is likely to be hotly debated between the House and the Senate.

## Canada

With the world's largest consumer of raw materials just south of the border, the Canadian gas market is driven to some extent by that of the US. Further pressure on gas prices has come from the ratification of the Kyoto Protocol, which seems likely to force electricity generators to switch from coal- to natural gas-fired plant. 2004/05 has seen unprecedented interest from the hydrocarbon industry in gaining access to unconventional oil and gas reserves in Canada. This has resulted in government efforts to encourage the building of pipelines to link stranded reserves with markets, and to encourage investment in the oil-sands projects, which contain huge reserves of unconventional oil.

### Oil-sands

Oil producers have been attracted to Alberta's oil-sands as an economic source of heavy crude, particularly because of cost savings in the mining process in recent years coupled with continuing high crude prices. The mining of oil-sands is an important and rapidly growing market for gas in Canada, with the cost of gas making up approximately half of the total process cost for deep mines. Although strip mining of oil-sands is economic at up to 75 metres depth, so-called "in-situ" methods of production have to be employed at greater depths, and these methods all use significant quantities of natural gas. As fewer shallow deposits remain, so the demand for gas increases, and it is estimated that consumption of gas by the oil-sands industry is expected to reach 5% of production within the next few years. The government has therefore started to look at new sources of gas by encouraging drilling offshore and by facilitating the building of a pipeline from proven reserves in the north-west to the market.

### Mackenzie pipeline

The proposed Mackenzie pipeline will carry gas from the Mackenzie delta through to the Alberta gas system for use in domestic supply, particularly the oil-sands projects, and also for export to the USA and/or Asia. The pipeline will be routed along the Mackenzie valley through many native lands, and has come up against considerable obstacles to development since its inception. The size of the project has meant that Canadian government involvement has been necessary to get all parties talking, in addition to it own role in revisiting its policies regarding social provision for aboriginal groups. Although recent developments have seen progress made by the government in settling remaining lawsuits brought by several groups as well as progress on social policy issues, the pipeline is well behind schedule and unlikely to be operational by 2010.

## IEA ASIA-PACIFIC

IEA Pacific countries have started to see the effects of the globalisation of the LNG industry on their domestic gas markets, with spot cargoes now making up a small but significant percentage of gas supply into the region. The largest market-based development in the region is the future development of Sakhalin Island LNG in Russia, and RasGas in Qatar, both of which are planned to supply the US West Coast market. The singular difference about these new LNG projects is that the US gas will be priced on the Henry Hub index, whereas previous cargoes in the region have all been priced on either the JCC or some other oil index. As a result of this, spot gas importers will have to bid for cargoes which are alternatively destined for the US, and will have to match the prices offered in the US.

### Japan

After the Gas Utility Industry Law was amended in June 2003, owners of LNG import facilities have been required to publish the amount of surplus capacity at their terminals. Furthermore, if these importers deny access to a third party when they have available space, they are required to explain why this was the case. It is envisaged that this amended law will be extended from LNG terminals to other forms of natural gas infrastructure and down to all levels of customers, leading to TPA gas pipelines and import terminals.

### Korea

The Korean government signalled in 1999 that it is keen for competition to develop in the gas sector, and has proposed that Kogas provide TPA to all gas infrastructure as of 2003. Since this proposal was adopted, world energy prices have risen dramatically, which may have provided more impetus for reform, but a study in 2004 by MOCIE (the Ministry of Commerce, Industry and Energy) showed that market liberalisation might lead to unstable supplies, and even higher prices. This has led to a lack of popular support for the proposals, but it is envisaged that further studies will follow, and that the government will try to regain the initiative over the coming year.

### Australia

Key government policy decisions have focused around two issues in the past year: further reform of Australian energy regulation and ongoing territorial issues with East Timor.

#### Regulation

As part of the comprehensive liberalisation undertaken by Australia in the past decade, the federal government in concert with the states has recently established a single national energy regulator, covering both electricity and gas, and replacing at least 13 bodies regulating these issues.

#### Timor Sea

The Timor Sea holds substantial proven reserves of natural gas which could be monetised via liquefaction and transportation to Asia or the USA. The Bayu-Undan project, which draws gas from the Timor Sea, is scheduled to come on line in early 2006 producing 3 Mt/year of LNG and will augment the 8 Mt/year export facility currently in operation on the North-West Shelf. Negotiations between Australia and East Timor are under way to develop a framework enabling the Greater Sunrise gas project to proceed.

## IEA EUROPE

Europe is in the middle of a long process of reform which began in the Nordic countries and the UK in the 1980s. In the US, this reform started earlier, has taken approximately 20 years, and is still ongoing – although it has already resulted in substantial benefits to the US economy. Further developments in European gas include the appointment of national regulators and the continued emergence of gas hubs as places to trade gas volumes, most notably in North-West Europe. The UK, Europe’s second-largest producer of natural gas, became a net importer in 2004 owing to the decline of its production in the North Sea and continuing growth in demand. The resulting massive investment by private companies in import infrastructure has been seen as a vindication of the government's policy to fully liberalise the gas market ahead of the EU directives.

## European Commission Gas Directive

The most recent European Commission Gas Directive 2003/55 was published in 2003, with an implementation date of July 2004 set for all EU member States. This directive, once transcribed into national law, obliges member States to set up national regulators and open up third-party access to their gas infrastructure, as well as stipulating dates for market opening in the EU.

Gas Directive 2003/55:

- Full market opening for all non-household customers by 1 July 2004 and for all customers by 1 July 2007.
- Legal unbundling of transmission and large and medium-sized distribution companies.
- Third-party access to transmission and distribution networks on the basis of regulated tariffs.
- Access to gas storage facilities either on a negotiated or regulated basis.
- Strengthening of public service obligations, especially for vulnerable customers.
- Monitoring of security of supply.
- The establishment of a regulatory authority in each member State with a common minimum set of responsibilities.

As ten countries (Belgium, Estonia, Germany, Greece, Ireland, Latvia, Lithuania, Luxembourg, Spain and Sweden) had failed to implement the directive by July 2004, the Directorate-General for Transport and Energy sent them final warning letters in May 2005, which met with some success. The most important result was that Europe's largest gas and power market, Germany, passed a new energy act in July 2005 adopting the directive. In July 2005, the EC followed up the five remaining countries which had still not undergone this process, namely Estonia, Greece, Ireland, Luxembourg and Spain, with threats of litigation before the European Court of Justice.

In addition to the Directorate-General for Transport and Energy, the Directorate-General for Competition has also shown interest in the gas sector. The EC has launched an investigation into competition in the gas and power markets, specifically into wholesale competition and price formation. An interim report is due by December 2005, with final results to be published in 2006.

## Regulation

The European Regulators Group for Electricity and Gas (ERGEG) was set up by the EC in November 2003 to advise and assist the commission in establishing

Table 10

**Gas Market Reform Progress in EU Countries – March 2004**

| | *Declared market opening* | *Large eligible industrial users switch (% 2002)* | *Unbundling transmission* | *Network access* |
|---|---|---|---|---|
| Austria | 100% | 9% | Legal | Legal |
| Belgium[1] | 90% | n.a. | Legal | Legal |
| Denmark | 100% | 3% | Ownership | Legal |
| Finland | - | - | - | - |
| France | 70% | 5% | Legal | Accounting |
| Germany | 100% | not known | Accounting[2] | Accounting |
| Greece | - | - | - | - |
| Ireland | 86% | 1% (all self-ship) | Management | Management |
| Italy | 100% | not known | Legal | |
| Luxembourg | 72% | not known | Management | Management |
| Netherlands | 100% | not known | Legal | Legal |
| Portugal | - | - | - | - |
| Spain | 100% | 22% | Legal | Legal |
| Sweden | 50%[3] | not known | Accounting | Accounting |
| UK | 100% | 19% | Ownership | Ownership |
| Norway | - | - | - | |
| Estonia | 95% | 0% | Accounting | Accounting |
| Latvia | 0% | 0% | Accounting | Accounting |
| Lithuania | 70% | 0% | Accounting | Accounting |
| Poland | 34% | 0% | Legal | Accounting |
| Czech Rep. | 0% | 0% | None | None |
| Slovakia | 34% | 0% | Management | Management |
| Hungary | 69% | 5% | Legal | Accounting |
| Slovenia | 91% | 0% | Legal | Accounting |
| Cyprus | - | - | - | - |
| Malta | - | - | - | - |

1. Full market opening in the Flanders region, non-households in other regions.
2. Some legal unbundling on a volontary basis.
3. 95% from 1 January 2005, all non-households.
Source: European Commission, Fourth Benchmarking Report.

and monitoring the internal market in gas and electricity. It is the only body formally appointed to look at regulation on a European level, though it has no powers, save through the commission. Over the past year the ERGEG has been concerned with recommending Guidelines for Good TPA Practice for Storage Operators (GGPSSO), which were debated at the Madrid forum in March 2005 and subsequently implemented from 1 April 2005.

## Structural Issues – North Sea

The UK became a net importer of gas in 2004 after 20 years of gas exports sourced on the UK North Sea Continental Shelf (NSCS). In response, an unparalleled level of import investment is taking place as multinational companies stake their faith in the liquidity and transparency of the NBP, the UK's gas hub. Despite this activity, the UK is set for a very tight winter in 2005/06 as the majority of import facilities will come on line after this time. This has led the UK government to adopt policies in 2004/05 encouraging the exploration of new blocks in the North Sea, whilst forcing inactive blocks onto the market. This initiative has also been coupled with new classes of licence that help to decrease the risks of exploring new regions, as well as incentives to further develop brownfield sites.

Norway has also taken steps to increase production in its waters given recent signs that the Norwegian NCS is also reaching maturity. In response, the most recent licensing round offered an increased number of blocks, some of which were located in the Barents Sea – a site of huge untapped wealth in hydrocarbon deposits, but which faces operational challenges, including environmental concerns.

## Spain

Spanish gas demand in 2003 increased by 14% compared with 2002 and continued to grow at this rate in 2004. This is putting exceptional strain on its distribution infrastructure, and particularly on import facilities, as Spain imports 99% of gas demand. The Spanish gas market has a regulated price for default customers, and a market price for customers who have the power and inclination to choose.

The policy was designed to make it more attractive for consumers to switch providers, and therefore promote the liberalisation process. However, the fixed regulated price was capped by ministerial order at a level approximately USD 1.60 below the Henry Hub price with which Spain must compete to secure spot LNG cargoes. This means that gas suppliers in Spain are making significant losses supplying the regulated market, along with the usual problems of shielding the consumer from pricing signals such as a lack of demand response. The Spanish government has recognised the problem, and has commissioned a review into energy policy which should be ready by the third quarter of 2006.

# CLIMATE CHANGE POLICIES

## INTRODUCTION

2004 marked Russia's ratification of the Kyoto Protocol, and hence its entry into force on 16 February 2005. The Protocol sets binding targets for developed countries to reduce greenhouse gas emissions by an average 5.2% below 1990 levels. With its entry into force, Kyoto's emission targets become binding legal commitments for those industrialised countries that have ratified it. The Kyoto Protocol was designed as a first step. The challenge now is to forge an international framework that engages all major emitting countries in an effective long-term effort. At their tenth annual conference in December 2004 (COP 10) in Buenos Aires, parties to the UN Framework Convention on Climate Change prepared for the imminent entry into force of the Kyoto Protocol, and agreed to convene a "Seminar of Government Experts" in May 2005 that provides an opening to discuss possible future efforts but explicitly "does not open any negotiations leading to new commitments."

In parallel, over 2004, other main climate change policy developments included the launch of the European Emissions Trading Scheme, the announcement of climate plans (*e.g.* France, the Czech Republic, Portugal, etc.), and the launching of carbon funds (*e.g.* Japan and Denmark).

In July 2005, at the Gleneagles Summit, the G8 countries pledged to introduce innovative measures to achieve substantial reductions in greenhouse gas emissions and promotion of low-emitting energy systems. This pledge was supported by five major non-G8 countries: Brazil, China, India, Mexico and South Africa. To this end, the G8 declared that they will take further action under the Gleneagles Plan of Action. The action plan outlines six objectives: transforming the way we use energy; powering a cleaner future; promoting research and development; financing the transition to cleaner energy; managing the impact of climate change; and tackling illegal logging (see Chapter 2: 2005 IEA Ministerial and G8 Gleneagles Summit).

In July 2005, the United States, China, India, Japan, Korea and Australia announced the Asia-Pacific Partnership on Clean Development to promote the development and deployment of existing cleaner, more efficient technologies and practices in areas such as energy efficiency, methane capture and use, rural/village energy systems, clean coal, civilian nuclear power, advanced transportation, LNG, geothermal, building and home construction/operation, bioenergy, agriculture/forestry and hydropower/wind/solar power. The partnership will be consistent with and contribute to the efforts under the UNFCCC and will complement, but not replace, the Kyoto Protocol.

# MAJOR DEVELOPMENTS OF CLIMATE CHANGE POLICIES IN IEA MEMBER COUNTRIES

To fight against climate change, all IEA member countries have adopted a portfolio of policies and measures (PAMs) involving all energy-intensive sectors. No particular sector in any IEA member country has been an exclusive target over the past years, reflecting the multi-sectoral nature of the climate mitigation problem. In this chapter, the environmental policy instruments are defined as follows.

**Fiscal measures** are an important component of the policy mix developed by IEA member countries to reduce greenhouse gas emissions (56 in 2004). Fiscal measures have been set up to support the development of emerging low-carbon technologies or to impose a direct cost on fossil fuel sources. The former include fiscal measures such as tax reductions, incentives or subsidies. Moreover, the form in which subsidies are administered can be classified in different ways. Some have a direct effect on price, like grants and tax exemptions, while others act indirectly, such as regulations that skew the market in favour of a particular fuel or government-sponsored technology research and development. It is also important to remove or adjust environmentally harmful fiscal provisions, such as tax exemptions or subsidies that have detrimental effects on the environment, while keeping in mind the non-environmental objectives the provisions were meant to serve.

**Regulatory policies** are another important policy tool to reduce greenhouse gas emissions and have been increasingly used by IEA member countries over the past couple of years (65 in 2004). Regulatory instruments modify a legal framework. Although often considered as inflexible, regulatory measures offer a high level of certainty on the achievement of emissions reductions. As in previous years, these instruments have been most commonly used to promote energy efficiency, as with the mandatory use of energy labels on cars, or renewable energy sources, such as the introduction of portfolio standards.

**Policy process and outreach** are an intrinsic part of policies that reflect a phase of information gathering and organisation, or of information dissemination. A clear distinction can be made within policy processes between "planning" policies (consultation, strategic planning, and institutional development) and "outreach" policies (information dissemination, and advisory efforts). In any case, they are often the precursor of, or complementary to, more concrete measures. Not surprisingly, since countries have been promoting or are seeking to promote new policy initiatives, a substantial investment is being made in informing people of policy efforts, and in seeking input in the design of new policies (51 in 2004).

Funding for energy **research and technology development** is another traditional area of government intervention (16 measures in 2004). In 2004, these policies mainly focused on energy production. Although many analytic studies suggest that the private sector is best suited to pursue commercial development of technologies, these investments only occur under a specific (and limited) set of market conditions. At an early stage of technological development, risks are high, the payback period of RD&D investments is indeterminate, and R&D findings are often difficult to protect. In the case of RD&D for low-carbon technology, the current uncertainties regarding the second and subsequent commitment period obligations of the Kyoto Protocol also tend to reduce private-sector involvement. In such cases government intervention plays an essential role in filling the RD&D investment gaps.

**Voluntary agreements** are commonly introduced as a less rigid way of reducing greenhouse gas emissions than regulatory measures. They rely on co-operation between governments and actors from the various energy-intensive sectors to reduce GHG emissions. The use of such voluntary approaches usually represents a small share of national strategies (6 in 2004), but plays an important role in offering a flexible and integrated (public-private) approach compared to traditional policy instruments.

**Tradable permits,** whether created through emissions trading, green (renewable) or white (energy efficiency) certificates, or flexible mechanisms under the Kyoto Protocol, have been a central theme of international and national debates on strategies to mitigate climate change (31 in 2004). Such measures are increasingly being developed by IEA member countries, and 2004 marked the confirmation that such market instruments will play a key role in climate mitigation strategies, both nationally and internationally. Although over the past four years most tradable permit measures were developed in the EU region, the adoption of the European "linking" directive and the ratification of the Kyoto Protocol mark the future international dimension of emissions trading. Likewise, the creation of new carbon funds illustrates governments' inclination to use such instruments to mitigate climate change and lower the overall cost of the latter.

## SECTORAL POLICY DEVELOPMENTS IN 2004

The following section highlights policies and measures which were taken during 2004[1] according to the IEA "Dealing with Climate Change" policies and measures database. These are broken down into which sectors they are designed for (energy production, transport, industry and residential). Moreover, policies that cover all sectors or a country's general climate strategy are considered as cross-cutting and are categorised under their own section (*e.g.* tradable permits, carbon funds, and mandatory emissions reporting).

1. Since 1999, the IEA has reviewed and collected information on IEA member countries' policies and measures taken or planned to reduce GHG emissions from the energy sector. The IEA "Dealing with Climate Change" policies and measures database is accessible on http://www.iea.org/dbtw-wpd/textbase/envissu/pamsdb/index.html

# ENERGY PRODUCTION

## Developing Non-carbon Energy Sources: Renewable Energy Production

It is hardly surprising that a wide range of policies is currently being used to promote the development of renewable energy in IEA countries (ranging from capital grants to market-based green certificate systems). The diverse characteristics and benefits of renewable energy make it difficult to envisage a single instrument to foster its market development. Government instruments to enhance emerging technologies generally evolve to follow advances in technology and drive market developments. Variations in the balance of policies in each group give an indication of how the focus of incentive systems is changing. The IEA policy database reveals that a combination of instruments is being used to address different aspects of the challenge of bringing policies into mainstream use.

Renewable energy sources (RES) benefit from **tax exemptions, tax reductions, or tax credits** but are not applied equally among IEA countries. Some have already exempted RES energy production from all taxes, such as solar heat and power for domestic use in Germany. Likewise, in 2004, the Flemish government passed legislation to exempt all Belgian green power from distribution tariffs. Tax credits were also announced in Korea, where the government plans to give tax incentives to encourage alternative energy use. Interest payments for companies operating in the alternative energy sector could be lowered from 5.25% to 3%. Other IEA countries, however, have not yet introduced this type of subsidy.

IEA countries also use subsidies to encourage the development and deployment of renewable energy sources in the form of preferential loans, feed-in tariffs and the allocation of grants. In 2004, **preferential loans** were introduced in Korea for companies using alternative energy sources such as solar and wind energy. Straight **feed-in tariffs**[2] set a predetermined buy-back rate for all electricity produced under certain conditions. Such measures were expanded in Austria and set up in Spain, with the aim of increasing the share of RES in the production mix. In the case of Spain, the new decree defines a system that gives the owner of the renewable installation the choice of selling the production or surplus of electrical energy either to the distributor or directly on the market. If the owner of the installation decides to sell his production or surplus directly on the market, he will receive the negotiated market price, plus an incentive for participating, and a premium if the installation is entitled to receive one. By rewarding energy production instead of investments, feed-in tariffs encourage market deployment while promoting

2. **Feed-in tariffs** are based on actual energy production, providing an incentive to maximise capital use and reduce the costs of energy production. In doing so, they reduce costs to consumers; they thus may be contrasted with capital incentives, which reduce the initial costs of obtaining capital for plant construction.

increases in production efficiency. Advanced "feed-in" tariffs – where incentives are reduced over time to reflect reductions in the cost of technologies[3] – were also implemented in Germany. Under the new Renewable Energy Sources Act, generation from biomass plant will be paid for 20 years, and the rate fixed for new plants will drop by 1.5% each year.

**Capital grants** for market development remain a major element of renewable energy policies in IEA countries. In 2004, there were 8 entries in the climate change energy policies database that relate to government grants for the development of renewable energy. In most cases, though, this type of instrument is now limited either to very small-scale technologies (*e.g.* wave energy) which cannot directly compete on mainstream markets under current conditions, or to technologies which are handicapped by high costs of market entry (*e.g.* photovoltaic).

In 2004, **regulatory reforms** were proposed and/or developed in several IEA countries to support the development of alternative energy sources in more competitive electricity markets. Such schemes were approved in Spain and the UK. **Minimum mandatory quotas** of electricity to be produced from renewable sources were established in Norway and in the Czech Republic, and were planned in Switzerland. These measures are part of a broader international effort developed over the past few years to support renewable energy sources. Similar renewable energy quotas have already been set in Australia and at the EU level over the past few years. Guarantees of origin were made mandatory in the Netherlands, implementing the 2001 European Renewable Directive, in the form of production certificates to enable a distinction to be made between electricity produced from renewable energy sources and "standard" electricity.

Government support to **RD&D**, as with fiscal measures and regulatory instruments, aims to stimulate the creation of new markets for climate-friendly technologies. The goal is to curb GHG emissions through competitive technological development rather than the early introduction of more rigid measures such as regulatory or fiscal instruments. Governments have traditionally played a decisive role in both framing and funding R&D policies at the national level and in international collaborations. Currently, these measures focus on emerging technologies such as wind power, new biomass technologies, solar photovoltaic and concentrating solar power.

In 2004, the Australian, Belgian and German governments pushed for **technological development** in wind or solar sources. Moreover, a co-operative Danish-German research project on the deployment of wind energy in the North and Baltic Seas is planned. Technological development and market are strongly linked and can function as a virtuous circle[4]. This virtuous circle takes

3. Advanced "feed-in" tariffs can also be banded (differentiation of tariffs) to reflect differences in available technologies, resources and other variables.
4. IEA (2004): *Renewable Energy Market & Policy Trends in IEA Countries,* IEA/OECD, Paris.

into account the relationship between technology R&D, improvements in manufacturing and learning from market experience that is enhanced by a supportive policy framework. Similarly, **demonstration projects** were introduced in Australia for solar technology and in the Canadian province of Saskatchewan for wind-powered turbines.

**Institutional development** was also carried out in one IEA country in 2004. The creation of a dedicated RES institution often provides a country with a framework for deployment, and is a precursor of more concrete measures. In Italy, a Biomass Research Centre was created with the objective of studying and stimulating the use of clean and renewable energy. The opening of the centre is part of a broader strategy to encourage the use of renewable fuel sources.

## Increasing the Use of Less Carbon-intensive Fossil Fuels

Increasing the use of less carbon-intensive fossil fuels consists mainly of switching from coal to gas in the power production sector, or from oil to gas, although oil is not as commonly used as coal for power generation[5]. Government intervention to promote such an approach is more ambiguous than for other polices due to the well-established markets for all fossil fuels. Yet fiscal measures, including **carbon-based taxes,** can be used to support less carbon-intensive fossil fuels. $CO_2$ and other environmental taxes used in many countries result in competitive gains for renewable energy projects compared with fossil fuel projects. In 2004, only Hungary implemented new taxes to reflect environmental costs based on the $CO_2$ content of energy sources.

Energy efficiency improvements and fuel switching in the energy sector were also supported through government subsidies. **Preferential funds** were set up in Australia through the Low Emissions Technology Demonstration Fund. This fund was created to support industry-led projects which demonstrate low-emission technologies. It is designed to facilitate private-sector investment of at least USD 1 billion, and provides a path by which industry can invest in a low-emissions future. It is aimed at supporting technologies at the commercial and demonstration stage, when required investments are large and risks remain high.

**Subsidies** for gas-related products were also allocated in Portugal. The government intention is to support projects with a minimum eligible investment, designed for the production of electric and thermal power from renewable sources, rational use of energy, and conversion of consumption to natural gas.

**Strategic planning** was also introduced for the development of clean coal technologies in Australia and in the Canadian province of Alberta. The Australian COAL21 Action Plan's key objectives are mainly to create a national plan to

5. In 2000, coal represented 44% of the world power generation fuel mix, while oil accounted for only 8% *(WEO-2004)*.

scope, develop, demonstrate and implement near-zero emission coal-based electricity generation; and to facilitate the demonstration, commercialisation and early uptake of technologies identified in the plan. Likewise, research agreements were signed between the UK and the US for the development of clean energy.

### Increasing Energy Efficiency

Energy efficiency refers to the ratio between energy output (services such as light, heat and mobility) and input (primary energy). Improving energy efficiency both by reducing quantities of energy consumed and by changing processes, offers a powerful tool for achieving reduced greenhouse gas emissions.

**Mandates and standards** were introduced in 2004 to reduce the quantity of energy consumed. In the Belgian region of Flanders, electricity grid managers are now obliged to carry out an energy audit of public lighting every five years. Likewise, in Italy, electricity and gas suppliers are required to help their customers save energy.

In 2004, the European Commission adopted a much-awaited proposed directive on combined heat and power, to increase support to energy efficiency measures. The Directive for the Promotion of Combined Heat and Power (CHP) sets up a regulatory framework for the promotion and development of CHP technology. It urges member States to facilitate the access of co-generation to the network, in particular proposing preferential tariffs which take account of the advantages of this technology in terms of energy efficiency and $CO_2$ emissions.

Policy process and outreach measures in the form of **strategic planning** were introduced in the UK, under the Combined Heat and Power to 2010 Strategy. The strategy incorporates the full range of measures to support the growth of CHP capacity needed to meet the CHP target, and lays the foundation for long-term growth in CHP.

## TRANSPORT

The policy listings in the Dealing with Climate Change Policies and Measures database[6] make clear that the national focus to date has been on improving fuel economy through technical changes to vehicles, and by increasing consumer awareness on the environmental performance of vehicles. The majority of these measures involve either assisting the development of lower carbon-intensive fuels, or including mandatory labelling of fuel consumption and emissions of new passenger cars.

6. http://www.iea.org/dbtw-wpd/textbase/envissu/pamsdb/index.html

## Increasing the Use of Less Carbon-intensive Fossil Fuels

The measures used to promote advanced vehicle technologies are more diverse than policies aimed at increasing the production capacity of less carbon-intensive fuels. Measures intended to promote technological development include fiscal measures, regulatory policies, funding of R&D, and information dissemination programmes. Over the past five years, multiple technologies have benefited from such policies, including ethanol-blended fuels, hydrogen fuel cells, and vehicles using liquid natural gas (LNG).

**Grants and subsidies** play a crucial role in the promotion of these costly technologies in IEA countries. More than ten IEA countries have fiscal measures which either attribute grants for the purchase of low-emitting vehicles, or allow tax reductions for low-emitting fuels. In 2004, in Italy for example, the Ministry of Environment set up a programme that will reimburse Italian city governments up to 65% of the cost of adding environment-friendly vehicles to each city's fleet.

Some governments have also taken important steps to provide customers with financial incentives to purchase hybrids, reducing some, though not all, of the average current price premium. **Grants** based on the level of the car's carbon dioxide emissions are an instrument that has been implemented in several IEA countries. Similarly, grants which increase the availability of biofuels for the domestic transport market have been introduced in 2004 in Australia through the Biofuels Capital Grants Programme. The Australian government intends to provide a capped amount of AUD 37.6 million to fund capital grants for projects that provide new or expanded biofuels production capacity.

**Tax credits or exemptions** are also used to encourage consumers to purchase less carbon-intensive fuels. Since 2004, the Belgian government has implemented fiscal deductibility for the purchase of clean vehicles: up to 15% of the vehicle price (maximum EUR 4 000) for cars with $CO_2$ emissions lower than 105 g/km; up to 3% of the vehicle price (maximum EUR 750) for cars with $CO_2$ emissions between 105 and 115 g/km. Likewise, in its 2005 draft budget, the Portuguese government has introduced a tax exemption for biodiesel fuels. This is expected to create a tax incentive for consumers to buy products that use this renewable fuel.

In addition, subsidies in the form of **differential taxation** can be used to encourage or discourage the use of certain fuels or to lower the effective cost of heating fuels to end-users. Differential fuel taxation contributes to the penetration of low-carbon fuels for transportation. Several OECD countries are already in the process, or are thinking of restructuring their energy taxes to penalise the most carbon-intensive fuels, in some cases through a carbon tax. For example, the Italian government is considering a proposal to tax cars depending on their pollution levels, with reference to their engine size, registration year and type of fuel they use.

**Regulatory** measures have also been introduced to influence the penetration of low-emitting fossil fuels. For example, in 2004, in Canada, provincial regulations for increased ethanol content in fuel came into effect. The regulations specify that automotive gasoline must have a minimum average ethanol content of 2%, rising to 7.5% on 1 November 2005. Likewise, in Europe, some countries (*e.g.* Austria) have pursued the transposition of the Directive on the Promotion of the Use of Biofuels which ensures that a minimum proportion of biofuels and other renewable fuels is placed on their markets.

**R&D funding** to develop sustainable cars is another policy introduced by some IEA governments to help research programmes to develop key technologies such as vehicle on-board hydrogen and electricity storage. In 2004, the US Department of Energy released the "Hydrogen Posture Plan", a document which outlines the priority activities and deliverables to support a shift to a hydrogen-based transportation energy system. The plan integrates research, development and demonstration activities over the next decade, leading up to a commercialisation decision by industry in 2015.

Governments also actively use information dissemination programmes to highlight "green" vehicle choices and encourage their purchase. For example, in Australia, the Green Vehicle Guide (GVG) was released in 2004, providing information on the environmental performance of all new vehicles sold in Australia weighing 3.5 tonnes gross vehicle mass or less. The GVG provides fuel consumption data as well as an overall environmental star rating on each vehicle model and variant.

## Reducing Vehicle Travel

A number of different policy instruments have been applied to reduce travel by vehicle. One of the most widely used in IEA countries is taxes. Pricing mechanisms have also been used to reduce travel by vehicle. However, in 2004 only one IEA country introduced a measure with this aim, and it was in the form of a **grant**. In Belgium, a grant has been made available for freight transport by rail on distances longer than 50 km (EUR 22 per unit + EUR 0.40 per kilometre).

Urban planning and the improvement of public transport can also contribute to reducing the energy intensity of the transport sector. Improving transit systems and encouraging modal switching (for example from road to rail) has been a priority in European countries. In 2004, the European Commission adopted a regulatory measure in the form of **strategic planning** – "Towards a Thematic Strategy on the Urban Environment". It sets out the problems and challenges facing Europe's urban areas, focusing on four priority themes: urban environmental management, urban transport, sustainable construction and urban design.

# INDUSTRY

## Reduce Energy Intensity and Increase Energy Efficiency

In industry, improving the efficiency of industrial processes through more integrated approaches (*e.g.* by increasing the use of waste heat) and the introduction of new technologies can contribute to reducing energy intensity.

Fiscal measures designed to improve the industry sector's energy intensity are mainly in the form of incentives and preferential tax rates for investments made in energy efficiency technologies. In 2004, **tax exemptions** were introduced in Sweden for companies which make electricity-related energy efficiency improvements. In return, companies undertake to introduce an energy management system and to perform ongoing energy audits in order to determine their potential for improving the efficiency of their energy use. The underlying intention is that companies should improve the efficiency of their electricity use without being subjected to the pressure of taxation that could have an adverse effect on their international competitiveness. **Tax reductions** for investments in energy efficiency were also introduced in the Netherlands, under the Energy Investment Allowance.

**Regulatory instruments** for manufactured products are also used to guarantee minimum energy efficiency of products or equipment for market users. In 2004, minimum energy efficiency standards were proposed in Canada for water heaters that would harmonise Canadian requirements with those in the United States. Similarly, in Australia, initiatives were launched to introduce minimum energy performance standards for major domestic appliances, and industrial and commercial equipment. Mandates such as labelling for household equipment (such as in France) or an energy plan with energy-saving measures (the Netherlands) were also implemented in 2004.

IEA countries have implemented programmes to promote "best practices", in some cases involving benchmarking against comparable industries worldwide. In Australia, for example, the Top Energy Saving Award Winner was introduced in 2004 to reward the most efficient star-rated products on the market, applying to both electric and gas products that carry a star-rating energy label. This award system helps consumers identify the most efficient products on the market.

## Development of Renewables

In 2004, two governments of IEA countries enforced fiscal measures aimed at promoting the use of renewable energy sources in the industry sector. Tax exemptions for biodiesel fuels were introduced in Portugal. This is expected to create a tax incentive for consumers to buy products that use this renewable fuel. Grants were also offered in the United States to small businesses that are developing new renewable energy technologies.

# RESIDENTIAL

## Improving Energy Efficiency

In buildings, energy efficiency means using less energy for heating, cooling, and lighting. It also means buying energy-saving appliances and equipment for use in buildings. Fiscal incentives were initiated in 2004 both for residential and non-residential buildings. Options to increase the efficiency of in-house appliances and equipment were introduced in France and Sweden in the form of **tax credits** or **reductions**. Such policies dedicated to retrofit measures and home improvements can help dismantle financial barriers. **Grants** for public or commercial buildings to help offset the cost or improve energy efficiency by designing energy-efficient buildings were established in countries such as Sweden, Belgium and the Netherlands. In Belgium, for example, in the spring of 2004, a proposal for a limited time subsidy for certain energy efficiency and renewable energy investments in public buildings was put forward in the form of a tax credit corresponding to 30% of the total cost of approved projects, rising to 70% to support the cost of installing solar cells.

In 2004, **mandates and standards** were also extensively used in the buildings sector. Minimum energy performance and internal climate requirements and energy certificates for buildings were implemented in the Belgian region of Flanders. Likewise, the United Kingdom approved a Code for Sustainable Development, establishing higher standards for energy and water efficiency. For retail goods, such as electric appliances, governments extended **minimum energy efficiency standards** to additional products in countries such as the United States and Australia. For example, the US proposed new standards for residential furnaces and boilers, commercial air-conditioners and heat pumps.

**Information dissemination campaigns** were also used as a means to encourage energy efficiency improvements in the residential sector. In 2004, the largest number of measures were introduced by the United States. The Department of Energy launched the Energy Star Program, a multi-year campaign to encourage people to save energy in their homes. Likewise, a year-long public education and awareness campaign called "Powerful $avings" provided consumers with the information and tools necessary to make smart energy choices a part of their daily lives.

## Development of Renewables

In 2004, the development of renewables in the building sector was mainly encouraged through **mandate**s. For example, in Spain, in November 2004 the Ministry of Industry announced that from 1 January 2005, anyone who intends to build a home will be obliged to include solar panels in their plans.

# CROSS-CUTTING ISSUES

## Reporting Emissions

To allow emissions reduction efforts to be measured, several IEA countries introduced reporting of greenhouse gas emissions in 2004. For example, Canada's major emitters have mandatory reporting obligations since March 2004. Likewise, a joint initiative between the Australian government and industry, called Greenhouse Challenge Plus, provides a framework for undertaking and reporting on actions to reduce greenhouse emissions. It also provides a vehicle for voluntary recording of verified early abatement actions.

## Carbon Taxes

Economists and international organisations have long advocated **carbon taxes**, because they can achieve the same emissions reduction target at lower costs as conventional command-and-control regulations. Carbon taxes act as a continuous incentive to search for cleaner technologies, whereas for command-and-control regulations, there is no incentive for the polluters to go beyond the standards, unless the standards are continually revised and set slightly above the best available technologies.

If the goal is to reduce $CO_2$ emissions, an energy tax can act as a $CO_2$ tax in the sense that it will encourage less energy consumption and therefore reduce emissions. Several IEA countries, including Sweden, implemented **increases of energy taxes**. In December 2004, the Swedish parliament decided on further tax modifications within the overall "greening" of the tax system. From 1 January 2005, the tax on petrol will be increased by SEK 0.15 per litre, and the tax on diesel fuel by SEK 0.3 per litre. The taxes on vehicles have also been increased. The tax on electricity, industry excluded, is increased by SEK 0.012 per kWh. The increased taxation is offset by income tax relief estimated to total SEK 3 700 million.

## Tradable Permits

The appropriate use of market instruments has been a central theme in international and national debates on strategies to mitigate climate change. 2004 was a particularly significant year for EU emissions trading. After voting in favour of the directive establishing a framework for greenhouse gas emission allowance trading, 2004 marked the year where member countries were actively developing national allocation plans (NAPs) specifying the total amount of allowances that they intend to allocate and how they are to be allocated (see Table 13).

In 2004, amendments – the so-called EU Linking Directive – were also made to the directive allowing companies in the EU trading scheme to use the credits from Clean Development Mechanism (CDM) and Joint Implementation (JI) projects, once they are issued, up to a percentage of their allowed emissions[7].

### Carbon Funds

In 2004, three IEA countries created carbon fund projects to acquire project-based emission credits under tradable permit schemes (*i.e.* Japan, Spain and the Netherlands). Carbon funds provide a way to acquire tonnes that can be traced to individual projects, a possibility that does not exist in international Assigned Amount Unit (AAU) transactions. According to government announcements, an increasing number of Annex I Parties under the Kyoto Protocol plan to purchase carbon credits from CDM projects directly, and volumes bought by governments are likely to increase in the near future with the commencement of the Kyoto Protocol's first commitment period (2008-2012). Countries have also launched a number of funds with the private sector for JI and CDM projects, summarised in Tables 11 and 12 below. Investors in carbon funds range from government agencies of countries with Kyoto commitments to private companies with an interest in acquiring project-based emission credits.

## DEVELOPMENTS IN EMISSIONS TRADING

Trading is just one of the many policy instruments that countries have put in place to control their greenhouse gas emissions. While history and practicability explain why emissions trading (ET) is not necessarily the instrument of choice, there are other reasons why emissions trading may need to be supplemented by other measures, *e.g.* to correct for market failures, to reduce overall costs of reducing GHG emissions, and to help technology development to ensure the availability of longer-term supply sources. This question can be approached in theory, but warrants a detailed look at actual implementation of ET systems, as they sometimes differ from the theoretical ideal. Furthermore, some sectors may not be conducive to effective implementation of emissions trading.

Power generation and heavy energy-consuming industries have been the usual targets of ET systems to date, a natural bias given their relatively large contribution to the environmental problem at stake, the manageable number of installations that can be included in the regime without entailing excessive administrative costs, the variety of technological options available among various industries to reduce emissions, and the economic motivation of these actors, more prone to engage into least-cost energy choices than householders and smaller businesses with more limited, less visible, energy expenditures.

7. Note that JI units or emission reduction units (ERUs) cannot be used before 2008 in the EU trading scheme while CDM units or certified emission reductions (CERs) can be used for compliance with commitments during 2005-2007 and 2008-2012.

Table 11

## Overview of Multilateral Carbon Funds

| Type | | Name | Investors | Launch | Investment goal |
|---|---|---|---|---|---|
| Multilateral funds | Private funds | World Bank BioCarbon Fund | Public and private entities | May 2004 | USD 100 million |
| | | World Bank Community Development Fund | Public and private entities | July 2003 | USD 128 million |
| | | World Bank Pan-European Carbon Fund | European Investment Bank | June 2005 | USD 100 million |
| | | World Bank Prototype Carbon Fund | Public and private entities | July 1999 | USD 180 million |
| | | Andean Development Corporation's Latin American Carbon Program | Private and public entities, including the Dutch government | 1999 | USD 45 million |
| | | Asian Development Bank's CDM Facility | Public and private entities | August 2003 | USD 70 million current budget |
| | | Baltic Sea Region Energy Cooperation (BASREC) Testing Ground Facility (TGF) | Governments of Denmark, Finland, Iceland, Norway, Sweden. Germany intends to contribute | December 2003 | EUR 30 million |
| | | European Bank for Reconstruction and Development's Multilateral Carbon Credit Fund | Public entities, including 9 EU governments | July 2005 | EUR 50-EUR 150 million |
| | | KfW | Private and public entities, including the German Carbon Fund | June 2004 | EUR 50 million |
| | | Singapore-ASEAN Carbon Facility | Public and private entities | 2003 | USD 120 million |
| | Public-private partnerships | Asia Carbon Fund | Public and private entities | March 2005 | EUR 200 million |
| | | EcoSecurities – Standard Bank Carbon Facility | Private and public entities, including the Denmark Carbon Facility | May 2003 | DKK 59 million |
| | | European Carbon Fund | CDC – Ixis, Fortis Bank | January 2005 | EUR 105 million |
| | | Japan GHG Reduction Fund JBIC-JGRF-JCF | Japan Carbon Fund | December 2004 | USD 141.5 million |
| | | Natsource's Greenhouse Gas Credit Aggregation Pool | Public and private entities | February 2005 | USD 130 million |

**Approximate funding total: USD 1.67 billion**

Table 12

## Overview of Government Carbon Funds

| Type | | Name | Investors | Launch | Investment goal |
|---|---|---|---|---|---|
| Single government funds | Own tender | Austria JI/CDM Program | Austria | 2003 | EUR 72 million |
| | | Belgium JI/CDM Tender | Federal government of Belgium | May 2005 | EUR 10 million |
| | | Climate Fund | Canada | April 2005 | CAD 1 billion |
| | | Denmark JI/CDM Program | Denmark | 2004 | EUR 100 million |
| | | Finland JI/CDM Pilot Program | Finland | May 2003 | EUR 20 million |
| | | French Carbon Fund | France | February 2005 | EUR 50 million |
| | | CERUPT | The Netherlands | 2001 | EUR 32 million |
| | | ERUPT | The Netherlands | 2000 | EUR 50 million |
| | | Sweden International Climate Investment Program | Sweden | 2000 | SEK 350 million |
| | | Government of Japan | Japan | March 2005 | JPY 5.7 – 8 billion USD 53 - 74 million |
| | | Swiss Climate Penny | Switzerland | June 2005 | EUR 65 million |
| | Through multilateral institutions | World Bank Netherlands Clean Development Facility | Government of the Netherlands | May 2002 | EUR 136 million |
| | | World Bank Danish Carbon Fund | Danish investors only: public and private | November 2004 | USD 30 million |
| | | World Bank Italian Carbon Fund | Italian investors only: public and private | January 2004 | USD 80 million |
| | | World Bank Spanish Carbon Fund | Spanish investors only: public and private | November 2004 | EUR 170 million |
| | | IFC | Netherlands Carbon Facility | Jan. 2002 | USD 44 million |
| | | IFC-IBRD | Netherlands European Carbon Facility | 2002 | USD 70 million |
| | | Rabobank Carbon Procurement Department | Netherlands | Summer 2003 | EUR 45 million |
| **Approximate funding total: USD 2.06 billion** | | | | | |

Sources: CDC, various (available on demand), IEA.

Current emission trends (IEA statistics) show that emissions from other sectors are also a cause for concern if countries are to stabilise or reduce their GHG emissions in the long run. While a range of policy tools are available to address these emissions, there is a literature looking into the possibility of broadening the application of ET to non-industrial activities (road transport and aviation, in particular).

## IMPLICATIONS OF EU-ETS ON COMPETITIVENESS OF ENERGY-INTENSIVE INDUSTRIES

Under the Kyoto Protocol, the European Union committed to reducing its emissions of greenhouse gases by 8% from 1990 levels during the 2008-2012 period. Under Article 4 of the Kyoto Protocol, the EU-15 negotiated a burden-sharing agreement to account for member States' emission levels at the time, varying levels of economic development, and specific national circumstances (*e.g.* a high share of non-fossil energy in power generation). Subsequently, individual States' targets range from +27% for Portugal to -28% for Luxembourg. Like other Kyoto Parties, they can rely on the mechanisms to offset emissions above these agreed objectives.

In October 2003, the European Parliament and the Council of the European Union adopted Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community (referred to as the EU Emissions Trading Scheme – EU-ETS). It was amended in October 2004, primarily to introduce the possibility for entities covered by the EU-ETS to rely on the Kyoto project-based mechanisms to comply with their emission objectives[8]. Both decisions were voted while uncertainty remained on the fate of the Kyoto Protocol, but were motivated by countries' commitment under it. In addition, the scheme is fully compatible with the Protocol's flexible mechanisms, as it rests primarily on the possibility for parties to trade emission quotas under its Article 17.

Starting in January 2005, approximately 12 000 plants across the EU-25 should be able to buy and sell $CO_2$ emission allowances, covering about 45% of the EU's total $CO_2$ emissions. The emerging price provides all sources with a clear market incentive to control their emissions, either to buy allowances when reduction costs exceed the market price, or to sell them if allowances can be sold at a profit.

In parallel with the development of the European carbon market, electricity markets are increasingly opening to competition. The introduction of competition in the generation and supply of electricity has been introduced to improve this industry's economic efficiency with the aim of delivering electricity at lower prices. A direct implication of the EU-ETS is that electricity

8. Directive 2004/101/EC of the European Parliament and of the Council, generally known as the Linking Directive since it establishes links with other mechanisms under Kyoto.

markets should, in theory, reflect the cost of meeting the emissions cap. Under perfectly competitive conditions, the value of $CO_2$ allowances should be reflected in the short-run generating costs of fossil-fired plants and thus in wholesale electricity market prices: since any emission above target would imply the purchase of allowances – and in return, every unused allowance can be sold at market value (the so-called opportunity cost)[9]. In spite of such phenomenon being well known to economists, and well documented by IEA after its early market experiments with the electricity industry, the impact of rising electricity prices on industry has taken the forefront of EU discussions on the competitiveness effects of the EU-ETS.

In the face of early uncertainty on levels of allocation and the resulting economic burden for industrial activities, and on the sudden realisation that $CO_2$ prices could drastically augment electricity prices, European industry has raised concerns about the negative competitiveness impacts of the scheme.

The EU-ETS is embedded in the broader regime created by the Kyoto Protocol, but applies only to a subset of countries and industrial activities whose products, in some cases, face competition from countries without emission constraints. Earlier IEA work has shed light on the possible consequences of emissions trading for several industries – considering both the direct and indirect costs associated with emissions trading, based on the assumption of an average allowance price of EUR 10 per $tCO_2$[10].

Industry's ability to pass on the extra carbon cost to consumers is critical to maintain profitability. At present, it seems that electricity is the only sector likely to reflect part or all of the opportunity cost of holding $CO_2$ allowances. Other sectors may not be in a position to act similarly as they compete with producers outside the EU. How power markets will react to the carbon constraint and the corresponding price of $CO_2$ could have strong repercussions on the profitability of sectors like aluminium. The longer-term dynamics in power generation and the competitive nature of the markets will also influence this picture.

When considered from the standpoint of an average, typical plant, the implementation of the EU scheme would only have modest impacts on the cost structure of most of energy-intensive industries and power generators covered in the scheme – non-cost aspects of competitiveness are more difficult to assess. Local circumstances, especially power prices, and higher exposure to foreign competitors could of course alter these conclusions. While aluminium-smelting is not included in the scheme, it would be affected significantly through increasing electricity prices.

9. Reinaud J. (2003), *Emissions Trading and its Possible Impacts on Investment Decisions in the Power Sector,* IEA Information Paper, March.
10. Reinaud, J. (2004), *Industrial Competitiveness under the European Union Emissions Trading Scheme,* IEA Information Paper, March.

Foreign imports could increase their competitiveness in European markets for some steel products and aluminium, in spite of freight costs and border tariffs. It is not clear from the analysis to date to which extent the competitiveness of European products would be affected in foreign markets.

The relatively low-cost impacts derived from our analysis stem first from the grandfathered nature of allowances under the EU-ETS, a much more favourable allocation mode than auctioning from the standpoint of an industry's cost[11]. In theory, whether allocated for free or not, incentives to reduce emissions should be identical and it is sometimes argued that the full opportunity cost of allowances should be the guiding force for production and investment choices. The coming years will be critical as they will provide evidence on the impacts of the EU trading scheme on industry's competitiveness.

In any event, grandfathering is generally considered by economists as a transitory measure, introduced to minimise the negative effect of a new constraint on productive equipment that was invested at a time where no such constraint existed. For the price signal to operate in full, newcomers should acquire allowances from the market to completely offset their emissions. The reality of the EU-ETS suggests otherwise, with most NAPs introducing reserves for new entrants.

Secondly, freight costs and border tariffs are two other important elements in the broad competitiveness picture. A comparison between international transportation costs and $CO_2$ cost provides an indication of the level at which products from non-carbon-constrained countries – including freight costs and cost differentiation – would become cost-competitive. Freight prices have risen significantly since 2003, following sharp increases in traded volumes (in steel and coal, mostly going to China), yet this may only be temporary. At current levels, freight costs would protect most European heavy industry from non-EU imports. However, foreign imports could compete in European markets for some steel products and aluminium. These commodities would face increased electricity costs higher than freight costs for imported aluminium – provided that electricity prices reflect the full opportunity cost of $CO_2$ allowances. The study[12], however, did not consider competition from regions with low freight costs such as the Southern Mediterranean. Neither does the study cover the impacts on EU's competitiveness in foreign markets.

A careful balance would have to be found to maintain low impacts on international competitiveness, introduce incentives to reduce $CO_2$ emissions, invest in innovative and more energy-efficient processes, and maintain international market openness. Negative competitiveness implications and associated leakage of $CO_2$ emissions to other regions may otherwise undermine the sustainability of industry's efforts to curb emissions under the EU-ETS.

11. A study focused on the effects of the EU-ETS on the UK industry arrives at similar conclusions (Carbon Trust, 2004).
12. Reinaud, J. (2004), *op. cit.*

## CARBON PRICES

In spite of all 25 NAPs not being final in early 2005, EU allowances (EUAs) have been trading quite actively, mostly through forward transactions, as market players are waiting for registries to be completed before they can conclude spot transactions. In spite of some incomplete NAPs and registries, the first six months of 2005 recorded EUA transactions[13] totalling more than 70 $MtCO_2$, compared to 107 $MtCO_2$ traded globally in 2004[14].

At this early stage of the emissions market and in spite of rather active EUA trading, it is still the preserve of relatively few companies, and the feeling among participants is that once the remaining national allocation plans have been approved and national registries launched, a spot market may develop that will encourage much broader participation, and therefore fewer distortions. Fundamentally, the level of participation should depend on the stringency of the overall environmental constraint.

According to market players, there is an ongoing problem with credit or legal clearance between counterparties. Sources continue to report being unable to trade with particular counterparties due to a preference for a different contract, while for some, credit clearance is still an issue. Lack of clearance can mean that on occasion, the best offer or bid may not be from cleared counterparties, forcing the buyer or seller to seek the next best bid or offer and thus distorting the true market level. This problem may be of a transitional nature, however.

A number of factors could influence the price of carbon under the EU-ETS:

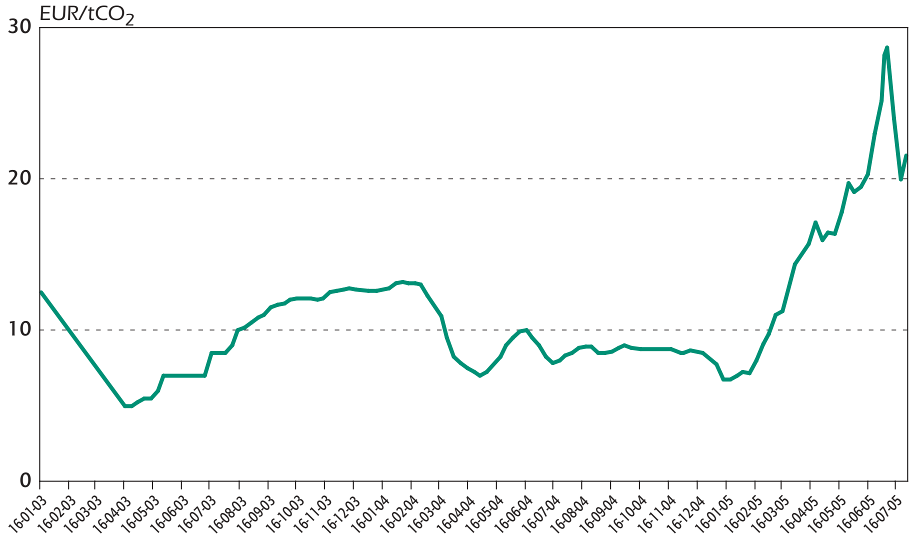
- *The overall stringency of caps imposed on installations.* This is a function of the initial allocation – it is assumed that allowances are some 3% lower than business-as-usual emission projections – and of the economic environment of the underlying activities. For instance, a sustained steel demand from China would obviously increase emissions in the near term and drive up demand for allowances. Similarly, demand for electricity-intensive products would also put pressure on the power sector to reduce emissions.

- *External supply of project-based mechanisms.* An abundant supply of Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) could have a dampening effect on the price, as project-based reductions are generally expected to cost less than EUAs. This is confirmed by current observations: project-based units being priced mostly at EUR 5-7 per $tCO_2$ against EUR 20-25 for EUAs. As mentioned above, it is not clear that CDM and JI can deliver large enough volumes of credits to meet a significant

13. "Forward" agreements for $CO_2$ allowances are deals to deliver and pay for allowances in the future at a previously agreed price.
14. World Bank (2005), *State and Trends of the Carbon Market,* Washington.

Figure 40

**The European Union Emissions Trading Scheme Carbon Prices for Calendar Year 2005 Allowances**




Source: Point Carbon, IEA, Argus.

portion of Kyoto Parties' demand. On the other hand, a limited demand for EUAs caused by relatively mild emission caps could increase the relative importance of project-based units.

- *Relative fuel prices.* For some industries, especially power generation, the price of gas relative to the price of coal affects operating choices. A relatively high gas price encourages more use of coal, which should drive up demand for $CO_2$ allowances, all other things being equal. If such a phenomenon is sustained and EUA supply becomes tighter, $CO_2$ prices may reach a level that allows gas, a cleaner fuel, to be more competitive again.
- *Weather: temperature, rainfall, cloudiness.* Because power generation represents the bulk of total EUA allocations, factors that affect power generation are bound to affect the supply and demand of EUAs. A dry year in Scandinavia is likely to trigger more demand from fossil-based generators and to increase emissions – a situation that has frequently caused Denmark's emissions to rise significantly, as its coal-based generating capacity was supplying the defaulting hydro-based generating from Norway and Sweden. "A warm, wet and windy winter would lower actual emissions, power consumption, $CO_2$ prices and UK gas prices... improve the hydro situation and increase wind production. It would lower the utilities' income

substantially but bring them closer to compliance."[15] While this illustrates an impact on emissions, even measured against an annual total, it is less clear how day-to-day temperature variations should impact $CO_2$ prices – even if this has been reported as a factor by financial information services.

- *Regulatory features.* National allocation plans[16] specify, in some instances, that EUAs that are yet to be allocated will be lost upon closure of a plant – *e.g.* for year 2006 if closure took place in 2005. The possibility of selling unused allowances is therefore minimal. Consequently, installations are less likely to resort to such measure as a means of reducing emissions. This should, in a tight market, put upward pressure on prices.

At least at this early stage where most allowances registries are not operational, it is likely that trading is motivated by speculative purposes, as opposed to compliance purposes. It is only when a significant demand for allowances is driven by compliance needs that the price will reflect the actual marginal cost of an avoided tonne of $CO_2$ in the market.

While marginal $CO_2$ abatement cost might in the long run direct investments towards abatement projects, fuel switching from coal to gas for power and heat production is probably the single most important measure in the short term. This is first because the power sector is the largest in terms of emissions for most of the member States. Secondly, coal emits about twice as much as natural gas per consumed unit. Point Carbon estimates that there is considerable scope for switching from coal to natural gas and other liquefied fuels in Europe. Thus, it is also important to monitor developments in fuel prices and assess their potential impact on fuel switching.

15. Carbon Market Europe, 1 July 2005.
16. For instance: Austria, Denmark, Finland, France, Sweden, and the United Kingdom. Others, like Germany, Hungary, Portugal or Slovenia, make it possible to transfer to firms that are opening plants.

## Table 13

## Overview of National Allocation Plans

| Country | Allocated allowances over the first period EU-ETS coverage | Allowances to energy sector | Allowances in relation to base year | Relation to base year, energy sector | Relation to projections |
|---|---|---|---|---|---|
| **Austria** | 98.58 $MtCO_2$. New entrant reserve (NER) included: 0.9 $MtCO_2$. ETS covers 81% of industrial emissions and 88% of energy production emissions | Electricity: 12.40 $MtCO_2$<br>District heating: 1.25 $MtCO_2$<br>Mineral oil refining: 8.30 $MtCO_2$ | KP compliance caps emissions at 13% below 1990 level: approximately 10 $MtCO_2$ equiv. | Energy sector: allocation represents an 8.3% reduction in 1990 emissions of 13.53 Mt GHG | Over 2005-2007, allowances cover 95% of projected emissions for ETS installations. Energy sector allocations cover 91.4% of projected emissions. 2010 projected emissions 11.5% above base year |
| **Belgium** | 161.72 $MtCO_2$ composite federal allocation<br>Flanders: 83.82 $MtCO_2$.<br>NER: 0.739 $MtCO_2$<br>Walloon region: 77.61 $MtCO_2$<br>NER: 1.5 $MtCO_2$<br>Brussels capital region: 0.29 $MtCO_2$<br>NER: 0.00737 $MtCO_2$/year | Composite electricity production: 55.16 $MtCO_2$<br>Flanders: 15.74 $MtCO_2$<br>Walloon region: 21.84 $MtCO_2$<br>Brussels capital region: 0.18 $MtCO_2$ | Belgium composite goal: 3.7% above 1990 emissions by 2005<br>Flanders: KP compliance caps emissions at 83.82 $MtCO_2$: -5.2% below 1990 emissions of 88.42 $MtCO_2$<br>Walloon region: KP compliance caps emissions at 7.5% below 1990 level.<br>Brussels capital region: KP compliance caps emissions at 3.48% above 1990 level | Electricity allocations in relation to emissions baseline:<br>Flanders: 28.9% below 2005 BAU<br>Walloon region: 2.0% above 2000<br>Brussels capital region: 787.9% above 2000 | Belgium composite: 2010 projected emissions 15.4% above baseline year.<br>KP target represents a 13.4% reduction in projected 2010 emissions.<br>Flanders:<br>2005 allocation covers 90.72% of projected emissions.<br>2010 allocation covers 79.04% of projected emissions.<br>Walloon region and Brussels capital region projections not specified |
| **Cyprus** | 17.1 $MtCO_2$. Including a reserve of 0.12 $MtCO_2$. Allocation covers 60% total emissions | 11.7 $MtCO_2$, increasing by year | NAP does not identify base year. As a non-annex 1 nation, Cyprus does not plan reductions relative to historic emissions | For power sector, average allocation 66% above average base period (1990-2003) emissions | +/-0% BAU until 2012 |

KP: Kyoto Protocol.

Table 13 (continued)

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Czech Republic** | 292.8 $MtCO_2$. NER: 1.5 $MtCO_2$. 3% early action reserve; 1.5% CHP reserve. Allocation covers 65% of total GHG emissions anticipated in 2010 | 63.69 $MtCO_2$ | Average annual allocation is 51.37% of total 1990 emissions. Baseline calculated on the two years of highest emission in 1999-2001. National Kyoto commitment: 174.9 $MtCO_2$, -8% of 1990 emissions | Energy sector allocation covers 96.83% of 2000 emissions of 65.78 $MtCO_2$ | Allocations follow projected emissions for all sectors |
| **Denmark** | 100.5 $MtCO_2$, 40% allocated in 2005, 30% allocated in 2006 and 2007. NER: 3 $MtCO_2$. ETS covers 45% of emissions | 21.7 $MtCO_2$ for electricity and heat production | 2006 $CO_2$ emissions 21% above those in 1990. Comparison made in light of aberrations in Denmark's normal electricity production accounting for emissions of -6.3 $MtCO_2$ in 1990 and +10.8 $MtCO_2$ in 2006 | Average annual allocation for electricity and heat production is 87.4% of observed 1990 emissions and 67.5% of adjusted 1990 emissions | -14.8% for all sectors covered by ETS. -26.2% for electricity and heat production |
| **Estonia** | 56.85 $MtCO_2$: 18 $MtCO_2$ in 2005, 20.9 $MtCO_2$ in 2006, 22.0 $MtCO_2$ in 2007. NER 1.94. ETS covers 69% of 2002 total emissions | Oil-shale power stations: 48.89 $MtCO_2$ | Average annual allocation accounts for 55% of 1990 emissions of 37.5 $MtCO_2$ | Electricity sector allocations cover approximately 58% of 1990 emissions | Allocation follows projected emissions to 2010 |

**Table 13 (continued)**

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Finland** | 136.5 $MtCO_2$: 44.4 in 2005, 45.9 in 2006, 46.2 in 2007. NER: 2.5 $MtCO_2$, 2% of total. ETS covers 59% of 2002 total $CO_2$ emissions | Heat and steam production and co-generation, on-site: 25.86 $MtCO_2$ Heat and steam production and co-generation, for distribution: 42.66 $MtCO_2$ Condensate, power production on-site steam turbines: 28.38 $MtCO_2$ | Peak-load power production: 0.12 $MtCO_2$ Average first period allocation represents 80.82% of 1990 $CO_2$ emissions of 56.3 $MtCO_2$ | Energy production emissions comprised 42% of total 2003 emissions. Average annual allocation to installations producing power for distribution and for on-site use represents approximately 98.3% of 1990 emissions | -3% relative to BAU over the first period. ETS caps emissions from district heating and power, oil refining and condensing power at approximately 1.5 $MtCO_2$ below projected 2006 emissions. KP compliance caps these same energy sector emissions at approximately 4.3 $MtCO_2$ below projected 2010 emissions |
| France | 377.28 $MtCO_2$. NER: 28.26 $MtCO_2$. ETS covers 20% of total GHG emissions and 29% of $CO_2$ emissions | Energy sector total: 180.75 $MtCO_2$ Energy production: 99.21 $MtCO_2$. NER: 0.21 $MtCO_2$ Urban heating: 19.53 $MtCO_2$. NER: 0.12 $MtCO_2$ Externalised combustion installations: 3.93 $MtCO_2$ Refining: 57.57 $MtCO_2$. NER: 12.385 Gas transport: 2.31 $MtCO_2$ Coke: 0.96 $MtCO_2$ | Average annual allocation represents 111.53% of 1990 $CO_2$ emissions | Allocation calculations follow various baselines. Centralised electricity production: average of 1996-2002 emissions Refining: average of 3 years of highest emissions in 1997-2001 Urban heating: 2002 emissions Externalised combustion: 2002 emissions Gas transport: 2002 emissions | NAP lists projections on terms of annual increase percentages. Over the first period, annual yearly emissions expected to rise by: 8.15% for electricity, 1.06% for refining, 4.66% for urban heating, and 4% increase per year for gas transport |

**Table 13 (continued)**

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Germany** | 1497 $MtCO_2$. NER 9 $MtCO_2$. 1.5 $MtCO_2$ reserve provided for the closure of nuclear power plants. ETS covers 50% of GHG emissions and 58% of CO | Energy and industry: 1509 $MtCO_2$, including voluntary industrial reductions. NAP includes no differentiation beyond 2002 for industry and energy despite setting forth a 4.5 $MtCO_2$ reserve for CHP | 2005-2007 allocations represent 84.68% of 1990 $CO_2$ emissions. 2008-2012 allocations represent 83.39% of 1990 emissions. Allocations indicate a 2.35% reduction over 2000-2002 emissions | Energy production 1990 emissions: 439 $MtCO_2$ Changes 1990 to 2002 is -16.3% for energy production | not communicated in NAP |
| **Greece** | 223.27 $MtCO_2$. NER: 9.48 $MtCO_2$. ETS covers 52.5% of total GHG emissions | Electricity production: 156.20 $MtCO_2$<br><br>Other combustion plants: 3.49 $MtCO_2$<br><br>Refining: 10.30 $MtCO_2$ | Average annual allocation covers 70.11% of 1990 baseline GHG emissions.<br><br>KP compliance caps 2008-2012 emissions at 25% above base year emissions: 1990 for $CO_2$, $CH_4$ and $N_2O$ and1995 for PFCs, HFCs and $SF_6$. Base year emissions thus estimated at 110.21 $MtCO_2$. | Energy sector allocation covers 70.14% of 1990 baseline GHG emissions. Electricity production allocation: 94.4% of 2001-2003 baseline emissions. Refining allocation: 94.8% of 2001-2003 baseline. Other combustion plant allocation: 99.1% of 2001-2003 baseline | Total first-period allocation covers 97.89% of projected BAU emissions. Electricity production allocation: 97.5% of BAU. Refining allocation: 94.8% of BAU. 2005 BAU projections represent 126.8% of total 1990 baseline GHG emissions and 133.4% of energy sector GHG emissions. 2010 projections represent 135.8% of total 1990 emissions and 144.69% of baseline energy sector emissions |

## Table 13 (continued)

### Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first periodeu ets coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Hungary** | 89.71 $MtCO_2$. NER: 1.79 $MtCO_2$, 2% of total allocation. 2.24 to be auctioned. Early action reserve of 0.5 | Power production and district heating: 53.34 $MtCO_2$. Installations generating heat for their own purposes (excluding the sugar industry): 6.55. Coke production, metal ore roasting and sintering: 8.16 $MtCO_2$. Mineral oil refining: 4.26 $MtCO_2$ | 2008-2012 emissions set at 6% below 1985-1987 average emissions. Average annual allocation over 2005-2007 represents 97.98% of 2001 emissions | Relation between average annual allocation and 2001 emissions: Power production and district heating: 85.4% of 2001. Industrial and other combustion installations: 125.65% of 2001. Mineral oil refining: 133.30% of 2001 | Allocations follow BAU projections without restriction. 2010 emissions projected at 128.18% of 2001 emissions. Still the 101.9 $MtCO_2$ projected for 2010 undercuts Hungary's KP compliance figure by 3.1 $MtCO_2$ |
| **Ireland** | 66.96 $MtCO_2$. NER: 1.5% of annual total. CHP reserve: 0.45 mt. 0.5 to be auctioned. ETS covers 34.5% of GHG emissions and 52% of $CO_2$ | Power generation: 43.11 $MtCO_2$<br>Mineral oil refining: 1.20 $MtCO_2$<br>Other combustion: 8.76 $MtCO_2$<br>CHP reserve: 0.45 $MtCO_2$ | For the period 2008-2012, emissions capped at 13% above 1990 levels for $CO_2$, $NO_2$ and methane and 1995 levels of PFCs, HFCs and $SF_6$ | Power generation annual allocation (excluding CHP reserve):109.15% of historic sector total (2002-2003 average). Mineral oil refining: 110.28%. Other combustion: 110.27% | Allocation covers 98% of forecasted emissions over the first period. BAU projects annual emissions of 13.1 in excess of KP compliance target. Implementation of domestic reductions still leaves Ireland 3.7 short of its target each year – remainder to be purchased through KP's flexible mechanisms |

**Table 13 (continued)**

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Italy** | 837.4 $MtCO_2$: 239.96 $MtCO_2$ in 2005, 240.57 $MtCO_2$ in 2006, 241.64 $MtCO_2$ in 2007. NER determined by sector; total reserve approximately 67.8 $MtCO_2$. No reserve envisioned for refining activities. ETS covers 47% of GHG emissions and 61% of $CO_2$ | Thermoelectric, refining and other combustion activities: 159.44 $MtCO_2$ in 2005, 158.75 $MtCO_2$ in 2006, 158.47 $MtCO_2$ in 2007. Includes NER: 112.74 $MtCO_2$ | Average annual allocation represents 230.94% of 1990 baseline $CO_2$ emissions | Electricity baseline calculations not specified in NAP | Total 2010 emissions projected at 122% of 1990 amounts: 579.7 $MtCO_2$. KP compliance caps emissions at 83% of projected BAU. First-period allocation covers |
| **Latvia** | 13.73 $MtCO_2$: 4.56 $MtCO_2$ in 2005, 4.59 $MtCO_2$ in 2006, 4.58 $MtCO_2$ in 2007. NER: 1.57 $MtCO_2$, 36% of total | Combustion (obligatory): 9.08 $MtCO_2$ Combustion (voluntary): 0.37 $MtCO_2$ 16 new co-generation plants slated to open before 2007 | Business-as-usual GHG emissions in 2010 45% below emissions in 1990; a "with measures" scenario projects emissions at 51% below 1990 levels | Emissions of electricity installations voluntarily included: 103.4% of 1990 baseline, as calculated by the IEA | Allocations meant to cover 72% of projected emissions for energy production, transport and industry. Emissions from energy production and industrial sectors to comprise 38% of total emissions over the first period |
| **Lithuania** | 0.37 $MtCO_2$. NER .02 $MtCO_2$. ETS covers 51% of total GHG emissions | Energy production: 0.22 $MtCO_2$ Installations generating energy for their own needs and for distribution to paper factories: 0.02 $MtCO_2$ Refining: 0.07 $MtCO_2$ | | | |

http://www.iccfglobal.org/pdf/Economics-Impad-GHG-IT-Eng.PDF

## Table 13 (continued)

### Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Luxembourg** | 10.54 $MtCO_2$. NER: 1.2 $MtCO_2$. ETS covers 26% of GHG emissions and 28% of $CO_2$ | N.C | -5% compared to BAU for included installations. 2008-2012 compliance: 72% of 1990 emissions | | |
| **Malta** | 8.83 $MtCO_2$. NER of 2.29 $MtCO_2$, 35% of total allocation. ETS covers 68% of national GHG emissions for 2001 | Electricity generation: 6.54 $MtCO_2$ | The IEA has calculated that $CO_2$ emissions over the first period will be 22.17% above the electricity sector's 2000 emissions | The IEA has calculated that $CO_2$ emissions over the first period will be 22.17% above the electricity sector's 2000 emissions | +/- 0% compared to BAU for both installations and national greenhouse gas emissions |
| **Netherlands** | 294.9 $MtCO_2$. NER: 12 $MtCO_2$ ETS covers 44% of GHG emissions and 54% of $CO_2$ | Electricity production: 39.8 $MtCO_2$ Electricity production, co-generation: 5.4 $MtCO_2$ Refining: 13.9 $MtCO_2$ For 2005–2007, the total for industry (including energy) set at 115 $MtCO_2$/a. This limit is for all emissions, including those of companies outside the scope of the EU-ETS | N. C 1990 emissions reported are for all emissions, including those of companies outside the scope of the EU-ETS | N. C 1990 emissions reported are for all emissions, including those of companies outside the scope of the EU-ETS | Allocation covers 91.5% of emissions from industry and 96% of energy activities. N.C. |

NC: not communicated.

## Table 13 (continued)

### Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Poland** | 1359.6 $MtCO_2$ including NER. Total GHG emissions capped at 1611 over the first period | Power plants: 143.63 $MtCO_2$, including a .02 $MtCO_2$ co-generation bonus and .87 $MtCO_2$ NER. CHP: 47.94 $MtCO_2$ including 3.14 $MtCO_2$ early action bonus, 3.06 $MtCO_2$ co-generation bonus and 0.75 $MtCO_2$ NER. Heat plants: 14.35 $MtCO_2$ including a 0.55 $MtCO_2$ early action bonus, .002 $MtCO_2$ co-generation bonus and 0.75 $MtCO_2$ NER | Average annual allocation over the first period represents 95.2% of 1988 $CO_2$ emissions and 142.5% of 2001 $CO_2$ emissions. 2001 baseline: 317.8 $MtCO_2$. 2001 emissions 32% below those of Poland's self-selected 1988 baseline | First period emissions in relation to 2001 baseline emissions: Power plants: 118.1% CHP: 111.8% Heat plants: 108.7% Mineral oil refining: 131.1% | Allowances for all sectors 29.5% above projected emissions for 2005 |
| **Portugal** | 116.58 $MtCO_2$. NER: 9.21 $MtCO_2$. ETS covers 43.4% of GHG emissions and 56% of $CO_2$ emissions | Thermoelectric power plants: 59.73 $MtCO_2$ Refining: 8.76 $MtCO_2$ Co-generation: 7.80 $MtCO_2$ Other combustion installations: 1.56 $MtCO_2$ | Allowances relative to 2002 base year emissions: + 6.3% | Allowances relative to 2002 base year emissions: Thermoelectric power: -9.0% Refining: +6.3% Co-generation: +25.5% Other combustion installations: -5.5% | Without emissions reduction measures, the Portuguese government has calculated two reference projections for 2010 emissions: High: 88.8 $MtCO_2$, 47.5% above 1990 levels and KP target; Low: 84.7 $MtCO_2$, 40.7% above 1990 levels and KP target |
| **Slovak Republic** | 104.26 $MtCO_2$. NER: 2.12 $MtCO_2$ | Heating supply: 4.97 $MtCO_2$ | | | |

Table 13 (continued)

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **Slovenia** | 26.33 $MtCO_2$ including an NER of 0.20 $MtCO_2$, 0.76% of total allocation. ETS covers 56% of GHG emissions and 60% of $CO_2$ emissions | 18.43 $MtCO_2$ in tranches of decreasing size | First-period allocation represents 97% of 1999 base-line emissions. KP compliance caps emissions at 8% below 1985 baseline emissions: 18.95 $MtCO_2$ annually over 2008-2012 | ETS compliance stipulates a 4.2% reduction relative to base year emissions for the industrial sector and a 10.6% reduction for power generators by 2008 | First period allocation covers 55% of Slovenia's projected GHG emissions. Allocation covers 92% of projected emissions from ETS installations. Emissions from installations outside ETS projected at 6.5 $MtCO_2$ annually, with only .5 $MtCO_2$ annual reduction potential |
| Spain | 480.84 $MtCO_2$ including an NER of 16.26 $MtCO_2$. An additional 36.09 $MtCO_2$ reserved for co-generation activities beyond Annex 1. ETS covers 40% of GHG emissions | 264 $MtCO_2$ allocated to electricity generation, including new entrants and allowances for energy generated using gases from the iron and steel industry | 0.2% reduction with comparison to 2002 emissions. Between 2008 and 2012, emissions must not exceed 1990 levels by more than 24% | Over the period 2008–2012 emissions will not exceed 115% of 1990 levels for $CO_2$, $CH_4$ and $NO_2$ and 1995 levels of HFCs, PFCs and $SF_6$ | 2010 emissions projected to exceed 1990 levels by 48.3%, 13% above Spain's emissions target over the KP's first period. Power sector's allocations cover 93.6% of projected emissions over 2005-2007 |
| Sweden | 68.7 $MtCO_2$ including an NER: 1.8 $MtCO_2$. ETS covers 31% of GHG emissions and 30% of CO | Under the scheme, the Swedish energy industry sector is to be allocated emission rights or credits corresponding to 17-18 million tonnes of carbon plus 24 million tonnes dioxide to be distributed later N.C in NAP | Allocation represents 156% of 1990 emissions from ETS-covered sectors | The allocation to the energy sector is multiplied by a factor of 0.8 $CO_2$ emissions from power and heat generation have increased since 1990, rising from 10.2 Mt/yr in 1990 to 12.3 Mt/yr in 2002 | 2010 GHG emissions projected to be 98% of 1990 levels |

**Table 13 (continued)**

## Overview of National Allocation Plans

| *Country* | *Allocated allowances over the first period EU-ETS coverage* | *Allowances to energy sector* | *Allowances in relation to base year* | *Relation to base year, energy sector* | *Relation to projections* |
|---|---|---|---|---|---|
| **United Kingdom** | 736 $MtCO_2$. NER of 56.8 $MtCO_2$, 7.7% of the total. ETS covers 38% of GHG emissions and 46% of CO | 143.7, including an NER of 8%. Actual distributed allowances total 132.2 | By 2008, a 12.5% reduction in relation to the base year of 1990. By 2012, a 20% reduction in relation to 1990 | Installation-level baselines calculated from weighted emissions averages over 1998-2003. The IEA has used the energy sector's average emissions to calculate an allocated reduction of 5.7% below baseline period level | Raw 2010 $CO_2$ emissions projected at 572 Mt, a 5.4% reduction on 1990 levels. When accounting for measures implemented under the UK's Carbon Programme, the latest projections indicate 2010 emissions at 14.3% below emissions in 1990. 2010 energy sector emissions are projected to fall to 70.1% of 1990 baseline levels |

# ENERGY EFFICIENCY

## GENERAL TRENDS IN EFFICIENCY POLICIES

High oil prices, concerns regarding global climate change and energy security have greatly raised the profile of energy efficiency in most IEA member countries. In some cases governments have already translated these concerns into new efficiency policies, while other countries are laying the groundwork for new or strengthened policies. Governments have a wide range of tools available to encourage energy conservation and efficiency, including adjusting energy prices, establishing financial instruments to encourage the use of efficient products and practices, mandating minimum efficiency levels, creating voluntary programmes, and energy rationing. In 2004-2005, IEA member countries employed all of these tools (except rationing) to promote energy efficiency. Some of the highlights and trends are described below.

Several external factors have contributed to the heightened interest in efficiency policies. Higher oil prices have certainly influenced short-term energy policies in several IEA member countries (and in numerous developing countries too). Korea, Japan and Spain have all asked their citizens and industries to conserve energy by using less air-conditioning, driving less, and exercising greater vigilance regarding energy use. There is growing concern that oil prices may remain relatively high for some time to come and governments are considering longer-term strategies to reduce oil use.

The increasing evidence of global climate change has focused attention on policies that reduce emissions. There was a strong consensus among IEA member countries regarding the need to strengthen energy efficiency policies at the May 2005 IEA Ministerial, and renewed attention to demand-side policies featured strongly in the Communiqué. In June 2005 the European Commission published a green paper on energy efficiency that establishes an objective of saving 20% of EU energy demand through increased deployment of cost-effective energy efficiency measures. The recent G8 Summit repeatedly stressed the need for policies to increase efficiency and its “Plan of Action” underscored this concern by specifically mentioning several areas where increased efficiency needed to take place, including buildings, transportation and appliances. The US President has also spoken this year about the importance of energy efficiency in energy policy and the new Energy Bill includes several energy efficiency provisions.

At the same time, signatories of the Kyoto Protocol are recognising that they will not meet their goals unless further measures are taken. One reason is that existing conservation policies have not been as effective as expected and will need strengthening. It appears that a gradual shift is occurring from a heavy reliance on market-based mechanisms and voluntary programmes to slightly more reliance on mandatory regulations. California is implementing $CO_2$ limits on motor vehicles while many European countries have now introduced mandatory energy or $CO_2$ labelling for vehicles that complement the European Commission's voluntary agreement with motor vehicle manufacturers to limit the fleet average $CO_2$ emissions of their vehicles. Another example of the renewed emphasis on mandatory regulations is the approval of the European Directive on Energy-using Products (EuP) – the so-called "Ecodesign Directive" – which creates a framework for regulating the efficiency of all energy-using equipment except vehicles. The directive envisages the establishment of voluntary agreements with industry, but empowers the European Commission, aided by a regulatory committee, to set combined mandatory efficiency and ecological requirements for energy-using equipment should it not be possible to negotiate satisfactory voluntary commitments. A programme of work initially addressing fourteen domestic and commercial equipment types has been developed and is expected to lead to new measures within 2 to 3 years. California approved its own minimum energy performance standards to cover products not covered by federal legislation. These are principally directed towards limiting the expanding electricity consumption by consumer electronics, but they also require efficiency improvements in traditional incandescent lights, pool pumps and spas, evaporative coolers, ceiling fans, exhaust fans, commercial ice-making machines, refrigerators and freezers, and vending machines. The wide range of products covered by these standards reflects the increasing fragmentation of end-uses. Over the last year, minimum energy performance standards for appliances and other equipment have been significantly broadened in Australia and New Zealand and have continued to evolve in Canada, Japan, Korea and the USA. Outside the OECD, there have also been many new developments in equipment energy labelling and standards, most notably the launch of new mandatory energy labels for refrigerators and air-conditioners in China.

Besides continuing to strengthen initiatives for specific equipment types, the year 2005 has also witnessed a great deal of activity with respect to building codes and other policy measures aimed at improving the energy efficiency of buildings. The most significant activity has occurred in Europe as EU member States continue to implement the provisions of the Energy Performance in Buildings Directive. This directive requires all 25 current member States, as well as the EU Accession States, to introduce mandatory building energy performance codes using a whole building energy performance approach. Almost all EU national codes have required revision to go beyond simple prescriptive requirements addressing some aspects of a building's energy performance towards a comprehensive energy performance approach that addresses all aspects of building energy use. In practice, this is resulting in additional assessment methodologies and minimum performance requirements applying to lighting, ventilation and air-conditioning, compared to older codes that merely focused on thermal fabric losses. A wide array of technical standards is under development to support this directive and is being incorporated into most national energy performance assessment methodologies. The directive also mandates many other significant requirements, including mandatory building energy performance certification, the regular certification of heating and cooling systems energy performance, and the public display of building energy performance for public buildings. Several EU member States have now revised their codes to incorporate these requirements, while others are in the process of doing so. At the same time, most EU member States have also strengthened their existing requirements. Outside of the EU, there has also been continuing activity in building code development. Some 46 US states have now implemented requirements for residential or commercial buildings. Of these, 38 states have adopted commercial building codes that meet or surpass the ASHRAE 90.1-1999 model codes and many have adopted tougher requirements in line with ASHRAE 90.1-2001 or IECC-2003. Some 46 states have adopted residential building codes and 31 of these meet or surpass the IECC-2000 model code requirements. In October 2005 California will update its Title-24 codes to include many new and more stringent requirements. A key aspect of the more recent Title-24 codes is the focus on time-sensitive energy saving measures that reduce peak power demand, which marks a significant evolution over traditional approaches to building codes.

The trend towards mandatory efficiency measures has also seen some important developments in utility regulation. In April 2002 the UK government imposed an obligation, known as the "Energy Efficiency Commitment" on energy utilities supplying the residential sector, with the goal of implementing energy efficiency measures that would save 62 TWh by March 2005. This target has now been successfully met through a mixture of subsidies for: compact fluorescent lamps, cavity wall insulation, gas condensing boilers and efficient appliances. Since April 2005 the government has extended the EEC scheme to 2011 subject to a review in 2007, and has set a new energy-saving target to 2008 that is double the previous round's target. Overall, this is expected to lead to investments of over GBP 2 billion and to save customers GBP 4 billion from their energy bills to 2020. In Italy and France, efficiency obligations have been established for energy utilities via the introduction of white certificate schemes. The Italian scheme is more established and sets energy-saving obligations for utilities whose fulfilment is certified by the regulator via the issue of a white certificate. The obligations can be traded between utilities and with other market actors in a similar way to carbon permits. The Italian scheme is open-ended in that any energy-saving measure is considered eligible for a certificate. This necessitates that the regulator establish verification methodologies for each savings activity upon application. Legislation establishing the French scheme was passed in 2005 and so it will be some time before it is fully implemented.

In the USA, the traditional home of utility-led market transformation and demand-side management schemes, state regulators have been increasingly establishing system benefits charges to fund energy efficiency programmes, and there has been a general expansion in the number of utility-administered efficiency schemes.

While many national governments have devoted this year to consolidating or preparing new efficiency programmes, local governments have launched numerous initiatives. Individual states and regions in the United States, Australia, Canada, and Europe have all implemented important legislation either mandating or promoting energy efficiency in their respective localities. Several states in the United States copied California's mandatory appliance efficiency regulations (mentioned above) and more are likely to do so. Several countries have also reinforced their government procurement specifications to encourage the purchase of more efficient equipment. Denmark, for example, requires all ministries and government institutions to purchase energy-efficient products from special lists and to implement all energy-saving investments with up to 5 years' payback time. Countries (and communities) are also requiring their governments to procure energy-efficient buildings. Such regulations are now practical because the methodologies for rating and certifying low-energy buildings have rapidly evolved and achieved widespread acceptance. These measures create a firm demand for energy-efficient equipment and help transform the market.

Voluntary programmes continue to play a key role in many countries' efficiency policies. The most significant new voluntary programme began in Canada, where automobile manufacturers agreed to limit $CO_2$ emissions from new vehicles (a voluntary programme already exists in Europe, as mentioned above). Voluntary programmes still appear to be the preferred policy when seeking efficiency improvements in industry. New programmes have been established in the United States, Europe, Canada, and elsewhere. At the same time, the effectiveness of such programmes is being questioned more often. It is difficult to separate energy savings (and emissions reductions) actions that were directly stimulated by the programmes from those that industry would have taken anyway. While Japan has recently expanded requirements for industry to report energy use, establish targets for savings, and document progress, it still has a number of important government initiatives to stimulate industrial energy efficiency which mix voluntary measures with fiscal encouragements. Several European countries, including Finland, the Netherlands, the UK and Denmark, continue to develop long-term agreements with industry aimed at curbing their $CO_2$ emissions via measures that include the adoption of higher-efficiency equipment and processes. While the establishment of these schemes is voluntary in nature, most governments offer reduced energy or $CO_2$ taxes for participants to help leverage participation. The success of such long-term agreements (LTAs) is thus partly contingent on the introduction of fiscal instruments to provide a stimulus for engagement. Fiscal encouragements aside, there are ongoing efforts to enable better benchmarking of industrial energy efficiency to both aid companies to identify best practice and to guide the development of future agreements.

Fresh and innovative developments to stimulate the market for efficient appliances and equipment continue to flourish. Japan has sought to raise the overall effectiveness of its TopRunner appliance standards by targeting retailers. It has recently begun to identify and award "Outlets that Excel at Promoting Energy-Efficient Products". This measure encourages retailers to focus on high-efficiency products and makes it simpler for consumers to find those products. (See Figure 41)

This year more attention was devoted to understanding (and reducing) the total energy use of electronic equipment, appliances and motor vehicles. The international Energy Star programme (covering computers, copiers, displays and other office equipment) began expanding its specifications to cover the products' total energy use. This not only reflects Energy Star's success at reducing sleep and standby power use but also the growing amount of energy consumption taking place in other modes. The IEA recently sponsored a workshop to address electricity use in television set-top boxes (decoders). Most of these devices' energy consumption occurs while they are switched off or not performing their primary function. Energy use of set-top boxes is expected to climb rapidly in the next decade when consumers buy a billion of them (see Figure 42), unless immediate action is taken.

Figure 41

**Japanese Logo of "Outlets that Excel at Promoting Energy-Efficient Products"**


Source: Ministry of Economics, Trade and Industry, Japan, 2005.

Australia began revising its test procedures and efficiency standards for other appliances to capture the energy use of these products while in standby and other low-power modes. Energy Star also successfully co-ordinated international efforts to improve the efficiency of external power supplies. As a result, voluntary programmes in Australia, China, the European Union, and the United States have similar test procedures and specifications for this important – but easily overlooked –energy-using product. The state of California and Australia are further co-ordinating mandatory efficiency regulations.

Motor vehicles also use considerable energy in situations not fully captured in official test procedures (such as by the air-conditioner). A recent study by the European Conference of Ministers of Transport stressed the importance of improving the on-road efficiency of cars rather than only in test situations. Some measures, such as reducing the rolling resistance in tyres or improving driving skills through sensors and feedback, have the potential to offer surprisingly large savings, in part because they can be applied to all vehicles.

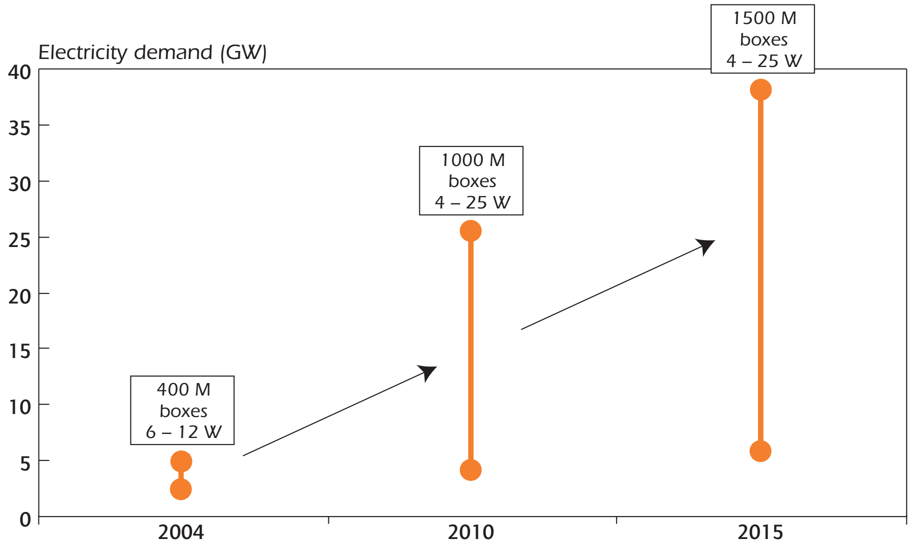
## SAVING ELECTRICITY IN A HURRY

Many regions, notably Ontario, California, Greece, and parts of Australia during the summer of 2005, are continuing to experience uncertainties in electricity supplies, either as a result of temporary shortfalls in supplies – such as caused by a failure of a key power plant or in a major transmission line – or unanticipated growth in demand. These regions were forced to implement massive conservation programmes and "save electricity in a hurry". The IEA published a book on the problem of temporary electricity shortfalls and strategies to quickly reduce electricity demand. Figure 43 shows that some were able to achieve reductions in demand of over 15% for several months, without major harm to their economies. Market liberalisation of the electricity sectors, while not necessarily a contributor to these shortfalls, has created uncertainty about which entity is responsible for co-ordinating conservation programmes in both the short and long term.

This summary has focused on recent changes and trends in energy efficiency policies. This in no way detracts from the impact of continuing policies, such as the TopRunner appliance efficiency standards in Japan and similar programmes in the United States, Korea, and Australia. Existing building codes are also quietly saving energy in many countries. At the same time, existing energy efficiency policies have been improved in hundreds of small ways, solidifying and expanding their already impressive savings.

Figure 42

**Estimates of Energy Use of Set-top Boxes**

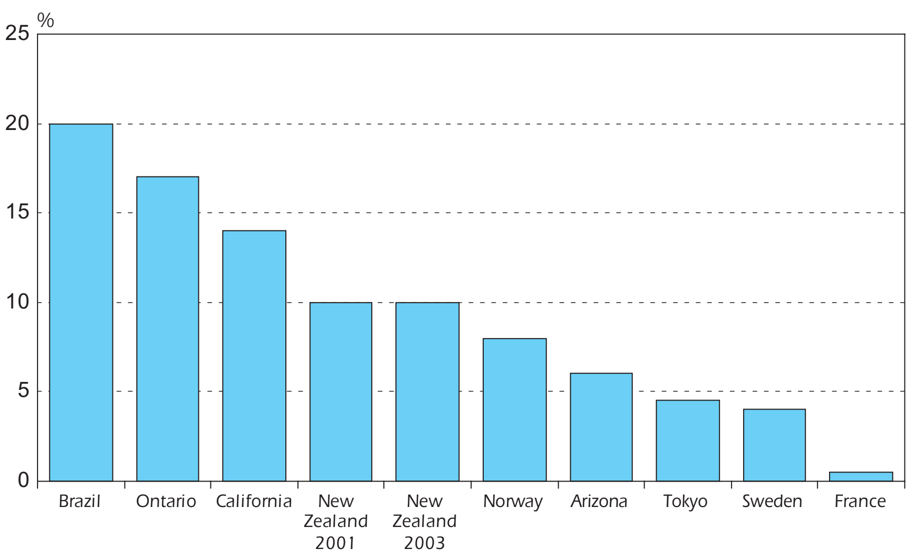



M: million.

Source: International Energy Agency estimates, 2005.

Figure 43

**Estimated Savings Achieved in Regions through Saving Electricity in a Hurry**




Source: *Saving Electricity in a Hurry*, IEA/OECD Paris, 2005.

# RENEWABLE ENERGY

## RD&D PRIORITIES

Global developments point to a cautiously optimistic future for renewable energy. Renewable energy is expected to steadily increase its share in energy markets over the next few decades. As a result of this expected growth, the substitution for existing as well as new energy supplies by sustainable renewable options will have positive impacts on the environment as well as on local and regional economies.

Renewable energy shows great potential for contributing to the solution of some of today's energy security and environmental challenges, but more attention must be paid to what is really happening with renewable energy policies and markets, with particular consideration given to cost-effectiveness. Renewables could play a key role in the global energy mix with further commitment to research and development and technology innovation. In terms of potential business opportunities, renewable energy technologies could succeed in accelerating their market acceptance through the technology and market cycles.

If renewables are to be successfully incorporated into the energy mix, it will be necessary to accelerate technological advances and reduce the costs of all renewable technologies. It will also require novel applications and deployment in the context of distributed generation, global production and trading of fuels, and bulk transmission of renewables-generated electricity.

## STATUS OF RENEWABLE ENERGY

Although the amount of renewable energy in IEA countries doubled in absolute terms from 141.5 Mtoe to 304.2 Mtoe between 1970 and 2002, its share in total primary energy supply increased from 4.6% in 1970 to only 5.7% in 2002. Most of this increase occurred between 1970 and 1990, when renewables supply grew by 2.8% per year. Subsequently, between 1990 and 2002, slower growth was evident in some renewables, including hydropower and traditional bioenergy. As a result, the share of electricity generated by renewable energy actually declined from 24% in 1970 to only 15% by 2002. The contribution of mature technologies such as hydro and geothermal power either remained constant or decreased over the period 1990 to 2002. Nevertheless, hydropower remains the major source of renewable energy for electricity generation, accounting for over 86% of the total contribution of renewables. At least six IEA countries derive over 50% of their electricity production from renewables – primarily hydro. They include Austria (70%), Canada (58%), New Zealand (63%), Norway (99.6%), Switzerland (60%) and Sweden (60%). The European Union has set a target to increase electricity generation from renewable energy sources to 21% by 2010[17].

Over the last few years, the phenomenal increase of emerging renewables such as wind and solar electricity generation as well as modern bioenergy plants, is starting to show up in the statistics and currently accounts for 2.3% of total IEA electricity generation. The contribution of these emerging options is becoming significant in some IEA countries. In Denmark, for example, the contribution of wind and to a lesser degree biomass to electricity generation has grown from about 0.1% in 1970 to 17.6% in 2001. Countries that have significantly increased the commercialisation of solar and wind energy include Denmark, Germany, Spain, the United States and Japan.

Globally, renewable energy sources account for 13.4% of the world's total primary energy supply[18], mainly in the form of traditional biomass for heating and cooking in rural areas, modern biomass combustion, and hydropower. In an energy future based to a large extent on renewable energy, a wide range of "new renewable energy technologies" would have to contribute a major and continuously growing share to the world's energy portfolio. According to past work by the IEA, without major technology and policy intervention, renewables would increase by only 1.3% per year over the next thirty years while global energy demand would grow by 1.7% per year. It is therefore necessary to accelerate the rate of technology development in order to advance cost-effectiveness and market penetration of these sustainable energy options.

## LESSONS LEARNED

The principal lessons learned over the last thirty years are that the move towards sustainable renewable energy options depends on resource availability, technical maturity and finally a policy environment that is conducive to both technology improvements and commercialisation. Given the diverse nature of renewable sources of energy, it is important that each country or region promote technologies and options that are well suited to specific resource availability. Unlike the current energy system based on fossil fuels, the transition to renewable sources will have to be based on heterogeneity of technologies and applications.

Technology improvements have been impressive over the last three decades and have resulted in significantly lower costs for delivered energy. There is a clear understanding that environmental credits will play a role in deciding on new energy projects. There is already a market for greenhouse gas credits.

Another very important lesson on RD&D in renewables is the generally limited involvement of the private sector, despite the fact that RD&D is the driving

17. Directive 2001/77/EC

18. *Renewables Information 2004,* OECD/IEA, 2004.

force for innovation, cost reduction and market deployment opportunities[19]. Although there have been exceptions to this rule in some countries and by some large corporations in newer technologies such as photovoltaics (PV) and wind, the public sector has been the main funding source with the concomitant constraints of ownership of the resulting intellectual knowledge. It is well understood though that private sector companies are better suited to carry out applied research with internal resources because they would have a free hand in proceeding to commercialisation. Technology development and market experience are strongly linked and can function as a virtuous cycle in advancing technology improvements through market implementation lessons. A public policy environment to encourage more private-sector involvement could enhance renewable energy technology development and commercialisation.

## SUPPORT FOR RD&D

Although support for technology development by IEA member countries has been significant over the last few decades, it has not always been consistent. The recent IEA publication *Renewable Energy Market and Policy Trends in IEA Countries* highlighted a number of conclusions related to renewables RD&D. The findings of the study can be seen in Figures 44 to 47 and can be summarised as follows:

- Total government energy research, development and demonstration (RD&D) budgets in IEA member countries increased sharply after the oil price shocks in the 1970s. Budgets subsequently declined to about half of their peak levels by 1987 and remained relatively stable until 2002. As a percentage of total RD&D funding, funding for renewables was higher from 1974 through 1986 than in the period since 1987.

- Renewable energy technologies accounted for just 8.2% of total government energy RD&D funding from 1974 to 2001. Table 14 presents shares of renewables in all energy RD&D in IEA countries by technology in million US dollars (2002 prices and exchange rates).

  The United States, Japan and Germany accounted for 70.4% of IEA government renewable energy RD&D funding in the 1974-2002 period.

  The decreasing share of public funding for energy RD&D allocated to renewable energy appears to be inconsistent with presumed political intentions in many IEA countries to increase the share of renewables in TPES.

  RD&D spending on renewable energy by the private sector has been gradually and selectively growing over the last thirty years.

  Renewable energy technologies such as solar photovoltaic, solar heating and cooling and ocean energy are heavily dependent on public RD&D budgets.

19. *Renewable Energy Market & Policy Trends in IEA Countries,* OECD/IEA, 2004.

Table 14

**Shares of Renewables in All Energy RD&D Spending by IEA Countries (%)**

| | *1974-2001* | *1974-1986* | *1987-2001* |
|---|---|---|---|
| Renewable energy total | 8.2 | 8.7 | 7.6 |
| Solar heating & cooling | 1.1 | 1.4 | 0.7 |
| Solar photo-electric | 2.2 | 1.8 | 2.7 |
| Solar thermal-electric | 0.9 | 1.3 | 0.5 |
| Wind | 1.0 | 1.0 | 1.1 |
| Ocean | 0.3 | 0.4 | 0.1 |
| Biomass | 1.2 | 0.9 | 1.5 |
| Geothermal | 1.5 | 1.9 | 0.9 |
| Large hydro (>10 MW) | 0.0 | 0.0 | 0.1 |
| Small hydro (<10 MW) | 0.0 | 0.0 | 0.0 |

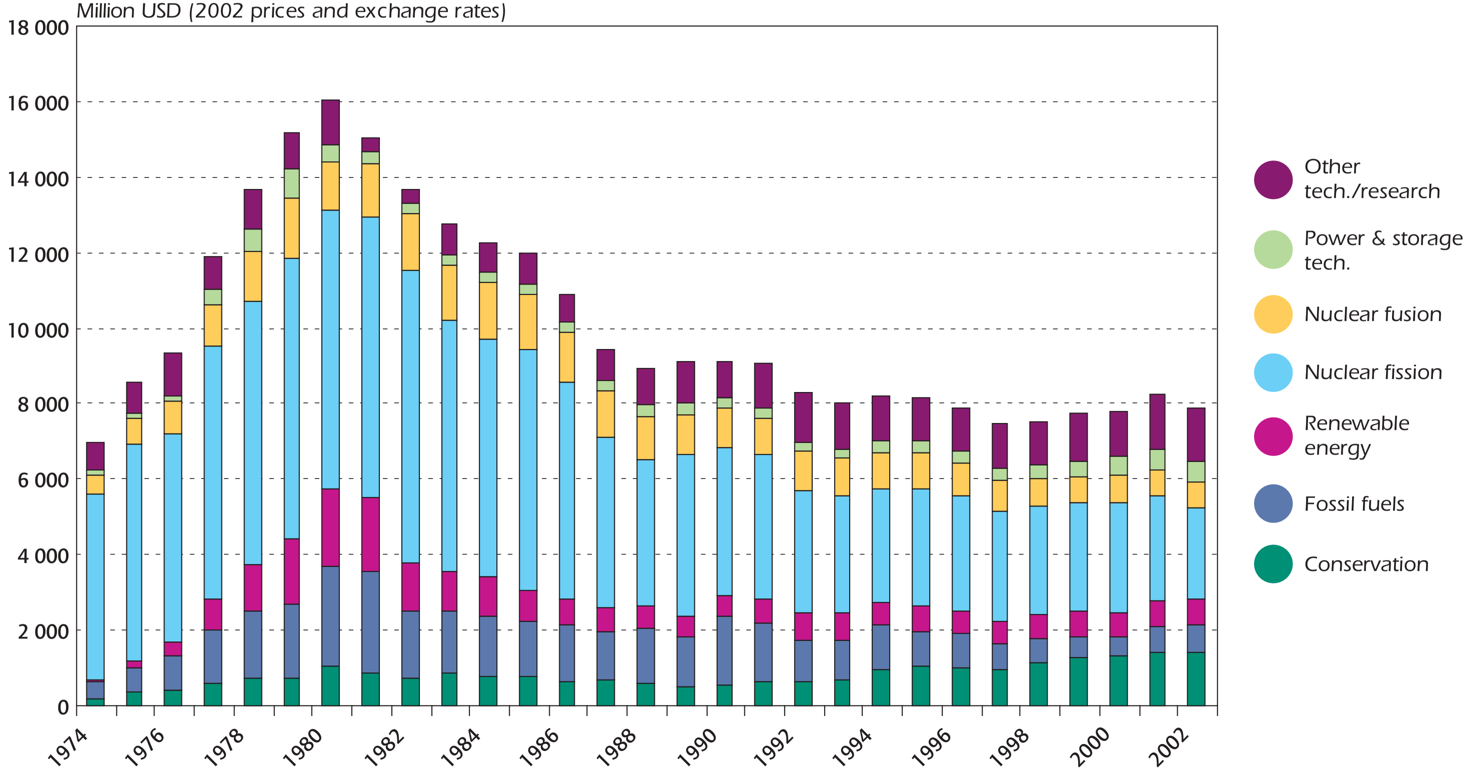
Government RD&D expenditures towards energy technologies in IEA member countries were about USD 291 billion (2002 prices and exchange rates from 1974 to 2002). Figure 44 shows government budget outlays for energy RD&D in this period. In 1974, total IEA government investment for energy RD&D was about USD 6 billion, of which only USD 60 million was for renewable energy. Budget outlays peaked in 1981 at USD 16 billion, but then declined to about USD 9 billion in 1987. From 1987 to 2002, funding was relatively stable, averaging about USD 9 billion from 1987 to 1991 and USD 7.5 to 8 billion in the 1990s. Total energy RD&D expenditures in 2002 were just under USD 8 billion (49% of the 1980 value). Renewable energy RD&D expenditures in 2001, at USD 696 million, were about 35% of the 1980 value.

Aggregate IEA energy RD&D budget outlays for nuclear fission, fossil fuels and renewables decreased in the late 1980s and 1990s, while funding for nuclear fusion, conservation and power and storage technologies increased. RD&D investments in hydrogen and fuel cells (included in the "other technology" category) rose considerably in the 1990s and early 2000.

From 1974 to 2002, **renewable energy RD&D budgets** of IEA countries totalled about USD 23.55 billion, some 8% of total energy RD&D funding in the period. Expenditures for renewables RD&D grew rapidly in the late 1970s and peaked in 1980 at just under USD 2 billion. Expenditures declined by about two-thirds in the early 1980s but have been relatively stable since the late 1980s, in the range of USD 550 million to USD 700 million. Annual expenditures on renewables RD&D for all IEA countries averaged about USD 650 million from 1990 to 2002, 7.7% of total government energy RD&D budgets (Figure 45).

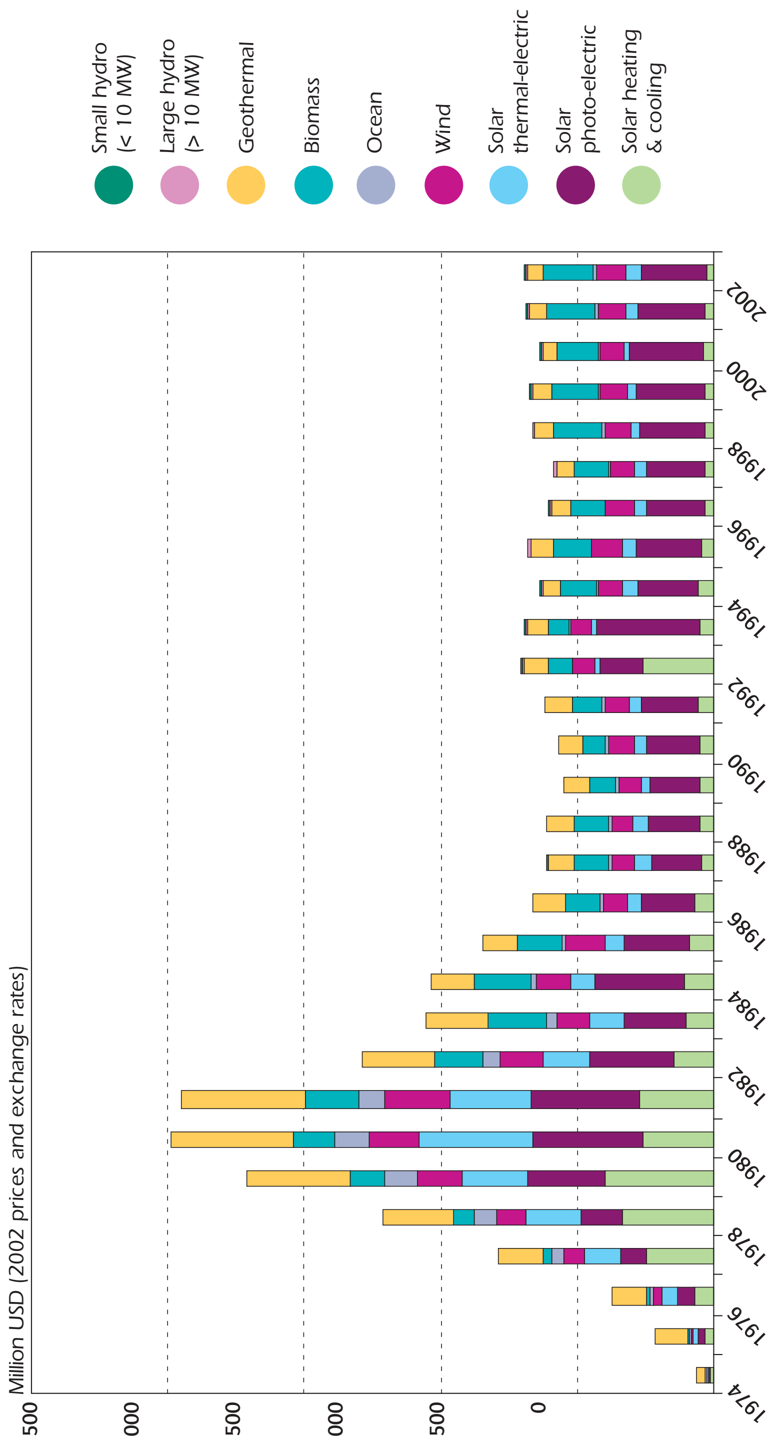
Figure 44

**Government Energy RD&D Budgets in IEA Countries, 1974 to 2002**




Source: *Renewable Energy Market & Policy Trends in IEA Countries*, OECD/IEA, 2004.

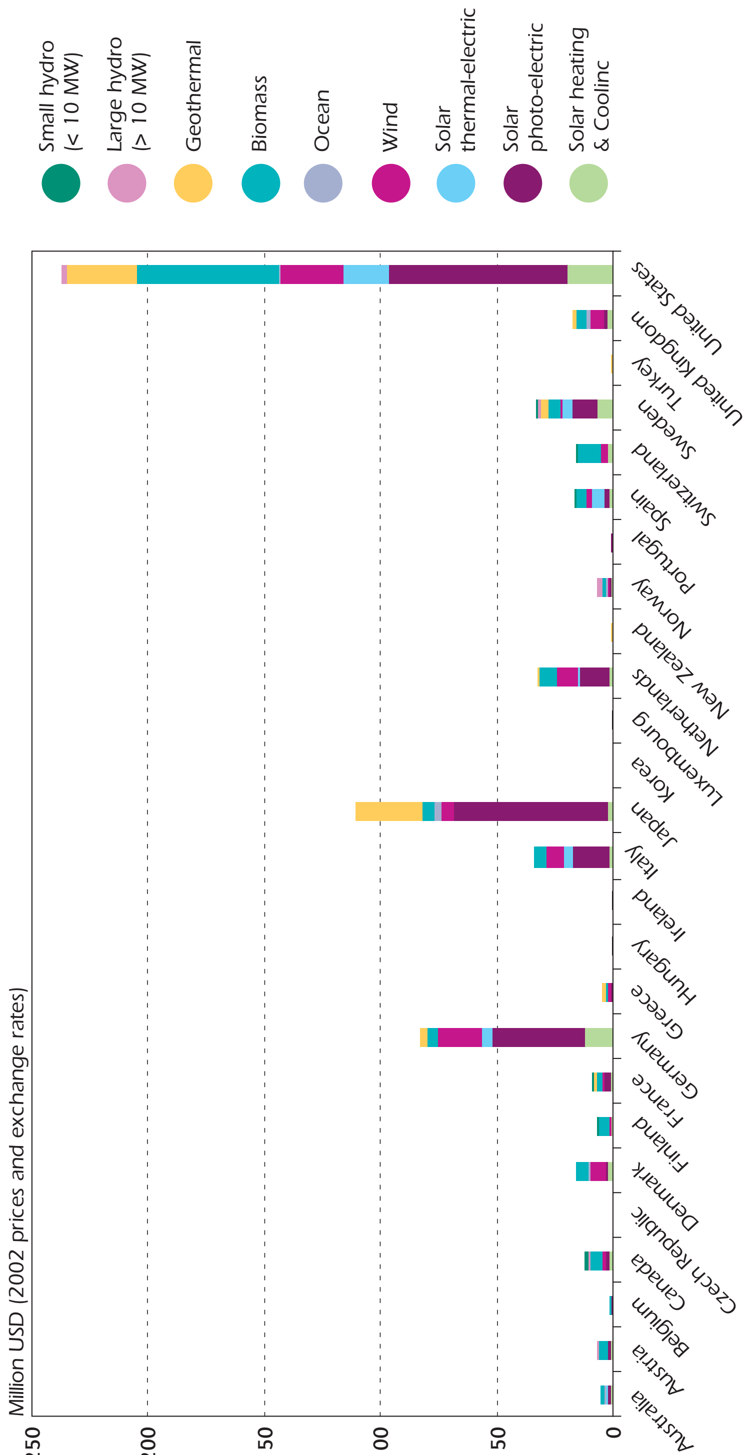
Figure 45
**Government Renewable Energy RD&D Budgets for IEA Countries, 1974 to 2002**




Source: *Renewable Energy Market & Policy Trends in IEA Countries*, OECD/IEA, 2004.

**Figure 46**

## Average Annual Renewable RD&D Budgets in IEA Countries, 1990 to 2002

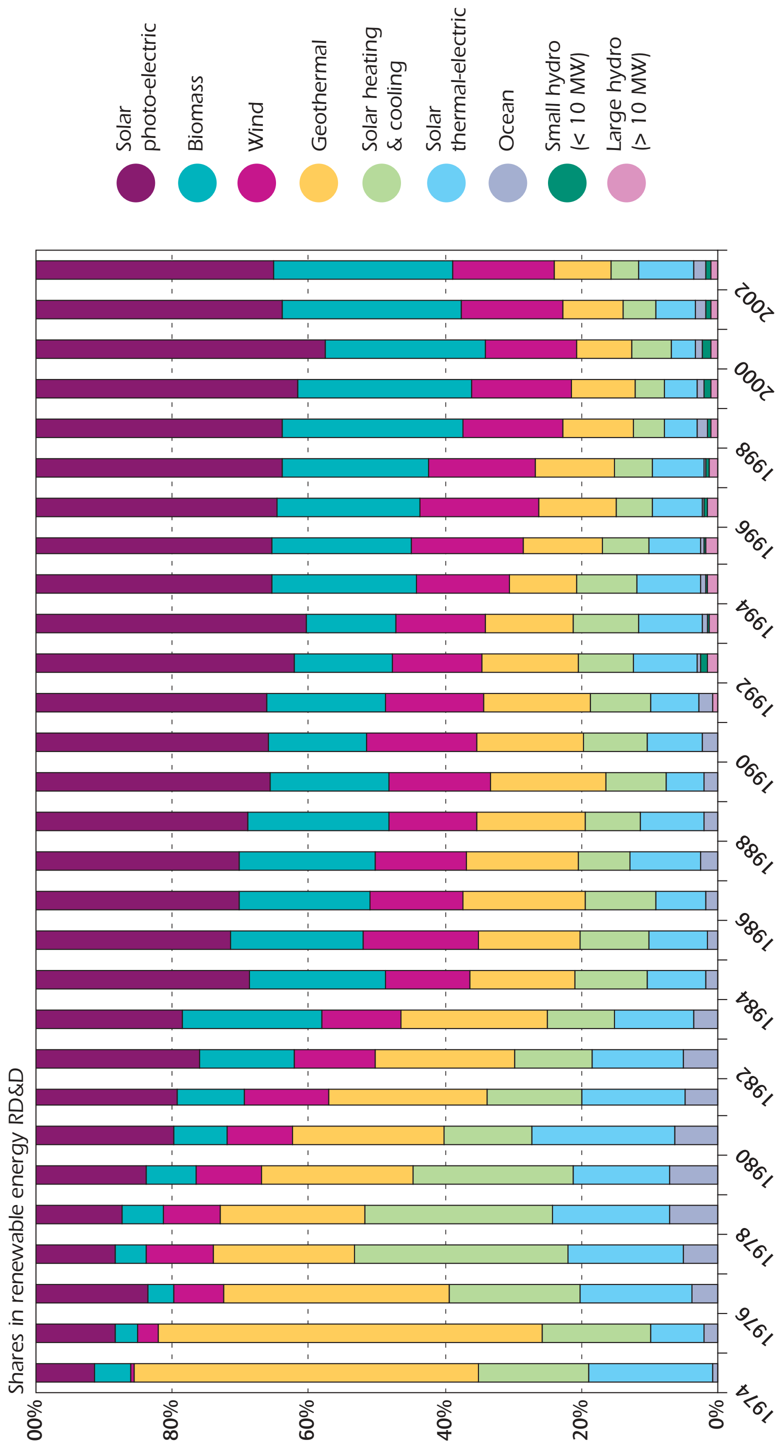



Source: *Renewable Energy Market & Policy Trends in IEA Countries*, OECD/IEA, 2004.

Figure 47

## Shares of Renewable Energy Technology RD&D, 1974 to 2002

(IEA total)




Source: *Renewable Energy Market & Policy Trends in IEA Countries*, OECD/IEA, 2004.

Germany, Japan and the United States accounted for about 66% of total renewables RD&D funding in the period 1990 to 2002. Italy, the Netherlands and Switzerland accounted for an additional 15%. These six countries combined invested USD 531 million per year on average for renewable energy RD&D. The United States had the highest average renewables RD&D budget of USD 236.9 million per year. Between 1990 and 2002 the average annual budget in Japan was USD 110.9 million and in Germany USD 82.8 million.

Renewable energy RD&D funding priorities usually reflect resource endowments. For example, New Zealand and Turkey have major geothermal resources, and 70% of RD&D funding in New Zealand and 45% in Turkey was for geothermal in the 1990-2002 period. Norway allocated 35% of its renewables RD&D to large hydropower. On average, biomass accounts for more than 40% of the renewables RD&D budgets in Austria, Canada, Finland, Hungary and Sweden. About 43% of renewables RD&D in Denmark and 37% in the United Kingdom went to wind energy. Both countries have significant wind energy potential. Natural resource endowments, however, do not always dictate renewable energy RD&D priorities. Potential industrial opportunities often play a role in resource allocation. Germany has limited solar resources, but its budget for solar PV represented 48% of its renewable energy RD&D budget from 1990 to 2002. RD&D budget priorities in the six IEA countries with the largest public-sector outlays for renewable energy from 1990 to 2002 are outlined in Figure 46. The differentiation among technologies in other countries is indicated too.

With regard to the shares of RD&D renewable energy technology funded through public resources, as can be seen in Figure 47 geothermal, solar heating & cooling and solar thermal-electric accounted for 84.9% of renewable energy RD&D in 1974, although the trend has been reversed since then. In 2002, predominant technologies were solar photo-electric, biomass and wind, accounting for 76% of renewable energy RD&D, while only 20.5% went into the former leader technologies.

Despite the drop in total RD&D expenditures on solar PV in the early 1980s (from USD 400 million in 1980 to USD 182 million in 1987), its relative importance in the renewable energy RD&D portfolio has been increasing steadily. While the share of solar PV stood at 8.6% in 1974, it rose to 34.7% of the total reported renewable energy RD&D funding for 2002. The peak was reached in the year 2000, when 42.5% or some USD 271 million of the budget was attributed to solar PV.

A similar observation can be made when looking at RD&D expenditures for biomass and wind technologies. While the actual budget on biomass RD&D shrank from some USD 213 million in 1983 to only about USD 76 million in 1993, the relative importance increased steadily from 5.4% to 26.3% in the period from 1974 to 2002. Wind power received only 0.3% of the total budget in 1974, but 15.1% in 2002. The relative attention paid to wind was rather stable throughout the 1980s and 1990s, with shares varying between 11.9%

(1981 value, when the total budget spent on wind power actually peaked with some USD 242 million) and 17.4% (1996 value).

Geothermal, on the other hand, experienced a very significant drop of RD&D expenditure: its share in the total renewables RD&D budget decreased sharply from 33.1% attributed in 1974 to only 8.3% in 2002. Almost the entire budget came from the US and Japan, which together made up for some 80-90% of the geothermal RD&D budget throughout most of the period.

Solar thermal-electric technologies faced similar trends. While up to 21% (1980 value) of the renewables budget was attributed to them in the late 1970s and early 1980s, the trend changed through the lessons learned on the potential pay-off of RD&D in this area. Resource allocations among technologies have changed, with the result that only about 3.4% of the total funding went to this technology in 2000. Since then, it increased again to reach 8.2% in 2002.

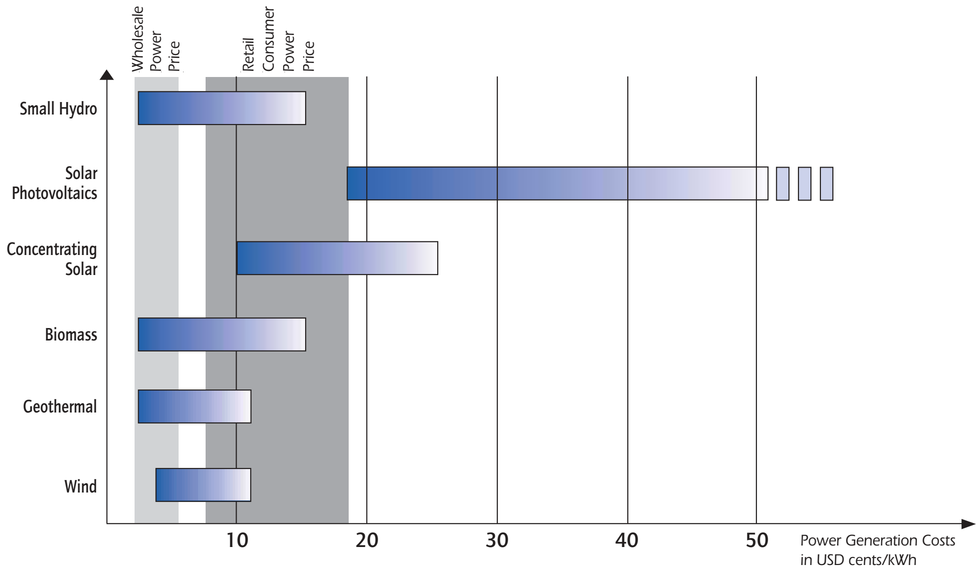
## IMPACT OF PAST MARKET AND POLICY TRENDS IN RENEWABLE ENERGY

The principal constraint in advancing renewable energy over the last few decades has been cost-effectiveness. With the exception of large hydropower, combustible biomass (for heat) and larger geothermal projects (>30 $MW_e$), the average costs of renewable energy are generally not competitive with wholesale electricity and fossil fuel prices. For power generation technologies, this point is well summarised in Figure 48. On the other hand, for specific small-scale applications, there are several renewable energy options that compete in the marketplace. These include hot water from solar collectors and electricity from small hydro and other technologies.

The challenge facing renewable energy technologies is to advance the state of the art to the point where more renewable options can generate energy at costs that are competitive with conventional sources. With the worldwide adoption of stricter environmental standards and guidelines for greenhouse gas emissions, it is becoming clear that renewable energy systems will be credited for their inherent advantage in lowering emissions. These environmental credits will contribute towards making the delivered costs for renewable energy more attractive, and they have already been the driving force in policy initiatives in many IEA countries. Nevertheless, substantial breakthroughs of technologies to improve their cost-competitiveness will still be a priority. Past policy initiatives in support of renewable energy in many IEA countries have concentrated on research and innovation, market deployment and market-based energy. Although the purpose of the current initiative is to refocus the RD&D component of the above, there will be a need to ensure that market-oriented policies complement technology initiatives. In view of the experience to date, the following observations can be made regarding deployment:

Figure 48

**Cost Competitiveness of Selected Renewable Power Technologies**




Source: *Renewables for Power Generation, Status and Prospects*, IEA/OECD Paris, 2003.

- Significant market growth in renewable energy technologies has resulted from a combination of policies that address specific barriers and/or complement existing ones.
- Longevity and predictability of policy support is important to overall market success. A "stop and go" policy environment does not provide a sound basis for private-sector involvement.
- With the trend towards market liberalisation, early support policies for emerging renewable energy technologies must be tailored carefully to ensure against the impact of significant drops in overall energy prices.

## RENEWABLE ENERGY RD&D NEEDS

If the renewable energy objectives set out by governments are to be reached, a clear strategy must be at the centre of every transformation path into a more renewable energy future. The strategy should include a significant acceleration in technical development of technologies. Although new and improved renewable energy technologies currently being developed are aiming at lower capital costs, improved reliability and higher conversion efficiencies, much more work will be needed over the next 50 years. Developments in R&D that will lead to improved and lower-cost technologies will be crucial.

At the International Conference for Renewable Energies in Bonn in June 2004[20], the Executive Director of the IEA said that particular consideration should be given to achieving cost-effectiveness. He emphasised that the world needs a new generation of renewable energy technologies to reach the mainstream market for heat and for fuels, as well as for electricity, and that we need to use public funds as effectively as possible.

The technologies that were close to competitiveness in 1973, such as large hydropower, biomass combustion, and geothermal, have plateaued at about 5% of TPES. Although they still have considerable potential for market penetration because of their attractive cost-competitiveness, newer options such as wind power, several forms of advanced bioenergy (*e.g.* anaerobic digestion) and to some degree photovoltaics, have advanced through the RD&D pipeline. Nevertheless, these newer technologies have not yet grown enough to significantly increase the overall market share of renewables.

In view of the above, the IEA proposed major changes to the renewable energy strategy of IEA member countries, the most important of which was a call to increase targeted renewables RD&D funding.

The IEA Secretariat continued collaborative efforts with the Renewable Energy Implementing Agreements to define the targeted RD&D for renewables. The IEA prepared a questionnaire and set up a process of information exchange. On the basis of the information provided by the Implementing Agreements, it was possible to draw some conclusions as to the major issues concerning technological development and related policy issues. They include the following:

- There is significant progress in the area of renewable energy technologies.
- The cost of energy delivered from renewable energy sources has come down dramatically through technology development and market feedback. The current cost of generating electricity is comparable with conventional forms of energy in the case of hydro, many forms of bioenergy and geothermal, and in niche markets for many other technologies. There is overall agreement that more effort towards cost-effectiveness is the most important issue.
- Physical and technical potential of each and all technologies is very large to unlimited; there is of course geographic influence on the choice of option and technology.
- Stability and predictability of funding for technology and industry development is a must for proper planning and development of expertise.
- There is need for assistance towards ways and means of expediting major projects for mature renewable energy technologies.

20. www.renewables2004.de

- There is need for assistance in adopting new technologies in the appropriate sectors of the economy (energy generation and transmission, buildings).
- There is need for help to increase manufacturing infrastructure in the emerging technologies.
- There is need for improved information dissemination of the merits of renewable energy options.
- There is significant and growing private-sector involvement, especially in: hydro, wind, photovoltaics and bioenergy.
- There is need for long-term and stable policy initiatives that credit renewable energy for the environmental and sustainable benefits it merits.
- Successful policies for the commercialisation of emerging renewable energy technologies include capital assistance, premium prices for green energy generated, tax incentives, and mandated quotas, among others.

The policy-related ideas refer to what has been reported in the past. The most important policy themes relate to the need for crediting renewable energy with the environmental benefits it provides followed by stability of policy initiatives as opposed to the stop-and-go measures. In addition, policy initiatives are country-specific.

## RENEWABLE ENERGY TECHNOLOGY DEPLOYMENT IMPLEMENTING AGREEMENT

Over the past several years, following the guidance of the Renewable Energy Working Party (REWP), the renewable energy Implementing Agreements (Bioenergy, Geothermal, Ocean Energy Systems, Photovoltaic Power Systems, Solar Heating and Cooling, Solar Power and Chemical Energy Systems, and Wind Energy Systems) have undertaken to discuss deployment tasks that would complement and extend their technology-specific work. These discussions have achieved mixed results. Several Implementing Agreements established annexes related to technology deployment as an extension of technology development work. However, in a number of cases, discussions failed due to the science and technology orientation of the particular Implementing Agreements; in other cases, efforts failed due to concerns of the current Implementing Agreements about engaging in cross-cutting issues outside their traditional scope of work.

Having evaluated the state of the art regarding deployment efforts, several governments expressed interest in establishing an Implementing Agreement (IA) that could fill the technology deployment gap, particularly with regard to cross-cutting issues. An informal *ad hoc* group of IEA member country representatives agreed to prepare a working concept for a new Implementing Agreement.

The issue of renewable energy technology deployment was periodically discussed by the REWP. At its 45th meeting in March 2004, the REWP discussed creation of a vehicle, within the framework of the IEA Implementing Agreements that could address these issues. The REWP recommended that a new IA be formed to complement the technology R&D work of the existing renewable energy Implementing Agreements and the IEA Secretariat's policy analysis work by identifying barriers and recommending solutions to commercial deployment of renewable energy technologies as a means to further enhance technology development.

Following the 45th REWP meeting in March 2004, the REWP circulated to its members the concept for a new technology deployment IA. At the International Conference for Renewable Energies in Bonn in June 2004, six IEA member countries, Denmark, France, Ireland, Italy, Germany and Norway, with inputs from the European Commission, announced their intentions to work towards establishing a Renewable Energy Technology Deployment Implementing Agreement and signed a joint declaration. RETD became an action of that conference.

Five of the six interested countries met on 24 June 2004 to further develop the proposal for a new Implementing Agreement. They determined programme priorities for the new IA, addressed administrative issues, including budget and structure, and formed an Interim Executive Committee with two co-chairs: France and Germany.

The following are the three agreed main objectives for RETD:

- To elaborate and present options for "best practice" policy measures and mechanisms for cost reduction, enabling increased use of renewable energy in competitive energy markets through strengthened international collaboration.
- To elaborate and present options for innovative business strategies and projects that will encourage renewable energy technology deployment to public- and private-sector stakeholders.
- Building from the unique framework of the IEA, to disseminate information and enhance knowledge about renewable technology deployment, complementing other information programmes in supporting improved public- and private-sector decision-making.

The IEA Governing Board established the Implementing Agreement for Renewable Energy Technology Deployment on 15 September 2005.

## ASSESSING THE BIOFUELS OPTION

Biofuels have had a long history of use in the transport sector. This began in the 1970s and early 1980s when a substantial increase in biofuels production and use in many countries resulted from high oil prices. But biofuels became less competitive vis-à-vis fossil fuels after the collapse of oil prices in the mid-

1980s, and global interest in biofuels for transport waned considerably in the 1990s and the first years of the 21st century.

The recent sustained increase in international oil prices has once again highlighted the potential for biofuels to contribute to transport fuel demand, particularly in countries that import the bulk of fossil fuel supplies. Global concerns about the effects of fossil fuel use on the environment, as well as recognition of the benefits of energy supply diversification also support increasing biofuels production and use.

The IEA facilitated a high-level seminar in June 2005 to explore the near-term and longer-term global prospects for biofuels for transport, focusing mainly on the development of new markets. Various models for development of a national biofuels market were highlighted. The seminar explored the elements of a sound national strategy, and addressed not just the biofuels-for-transport angle, as critically important as that is, but also the socio-economic/sustainable development component which involves, among other matters, rural community development, environmental impacts and income generation. Finally, the seminar sought to clarify the opportunities for international co-operation to expand biofuels production and use on a cost-effective, environmentally sustainable basis.

The main conclusions from the seminar are reported below.

There is high potential to increase the sustainable production of biomass for energy and even higher potential to increase the efficiency of its use. There are numerous factors that are converging globally to encourage greater biofuels production and use. They encompass high oil prices and energy security considerations, agriculture and trade reform, provision of energy to the rural poor and associated economic and social benefits, local and global environmental challenges, more efficient conversion technologies and compatibility with current vehicles and infrastructure. The response to these forces has been a remarkable upsurge of new policies to expand biofuels production and use, in both developing countries and industrialised countries. This has been coupled with a great amount of new investment in both biofuels production, as well as innovations of new conversion and application technologies.

Large-scale conversion of biomass to liquid transport fuels for use in flexible-fuel and dedicated biofuel vehicles could transform the world's fuel markets, empowering consumers with competitive options and reducing both the demand for oil and the economic and security risks associated with it. Addressing this issue, multilateral institutions, including the IEA, the United Nations Conference on Trade and Development (UNCTAD), the United Nations Development Programme (UNDP), the World Bank, and others could closely interact among themselves focusing on macroeconomic analysis of the interaction of fossil fuel and biofuel markets, cost-benefit analysis and best practice policy development, research agenda for technology development and adaptation and addressing trade barriers, especially import tariffs and agricultural subsidies.

Increased international trade in biofuels could benefit all countries. It is in the interest of IEA countries to diversify fuel supplies as a strategic fuel hedge as well as to reduce greenhouse gas emissions. These countries should consider partnerships with producing countries, either directly or through joint energy facilities, to accelerate the cost-effective use of biofuels.

## VARIABILITY OF WIND POWER AND OTHER RENEWABLES

Some IEA member countries have substantially increased their share of renewables in power generation, and others have set themselves ambitious targets for technology deployment. In view of this, concerns about the integration of renewables into electricity grids have recently received a great deal of public attention, and the intermittency of wind power has been discussed most prominently.

The study *Variability of Wind Power and Other Renewables - Management Options and Strategies*, draws mainly on experiences in Denmark and Germany and some theoretical analyses, and reviews existing literature from a number of countries and puts it into the context of the current debate. It shows how wind intermittency is part of the natural resource variability affecting all renewables, and presents the current thinking on the technical and policy implications of variable electricity supply from renewables.

The study concludes that a number of measures are necessary to integrate wind energy and other renewables into modern electricity grids, even though the fundamental technical principles are not new. The geographical aggregation of generators such as wind turbines reduces the volatility of output. Improved forecasting methods will make it more predictable. Both aspects are already widely used in electricity markets. Furthermore, careful attention needs to be paid to the timely extension of transmission and distribution grids in order to ensure system stability at all times. In particular, transboundary electricity exchange is going to play an increasing role which will have to be assessed. Although these issues are also central to market liberalisation and security of supply concerns, they will become even more important with increasing market penetration of wind power. Finally, as each renewable energy technology fluctuates over a different time-scale, one can expect gains from the complementarity of these cycles, subject to resource availability.

Apart from the technical issues, the extent to which the intermittency of natural resources constitutes a barrier to the deployment of renewables is mainly a question of economics and market organisation. Grid extensions and the provision of reserves which are attributable to wind power come at costs which have to be taken into account when considering the overall economics of wind power. The precise costs depend on a number of factors, including the level of market penetration of wind power, the availability of the renewable resource, the state of the existing grid and current technology mix. Transparent, inter-connected and well-functioning markets help to minimise these grid integration costs, as will experience with these systems over time.

## OFFSHORE WIND EXPERIENCES

The IEA study *Offshore Wind Experiences* (2005) reviews the experiences of the first series of commercial-scale offshore wind installations. The study concentrates on the pioneering Northern European projects, implemented between 2000 and 2004. It addresses all aspects of the barriers and achievements encountered in these early developments. It has specifically involved five offshore wind farms with interviews of key individuals associated with those projects.

The study highlights the importance of thorough planning and attention to detail. Technology associated costs have tended to be higher than anticipated. There remains a role for RD&D in offshore specific areas as well as collaborative project work.

The report confirms that political support which feeds to a shared agenda across government departments has been instrumental in successful implementation. Stable framework conditions have supported the start-up phase of this new technology and their absence has led to delays in investment. The provision by government of "one-stop shops" – whereby developers have to communicate with only one official contact point to handle administrative and legal matters – has been a success. Strategic Environmental Assessment (SEA) is a helpful tool for consenting authorities and for developers as it allows early warning on potential impacts and has reduced individual project consent time-scales.

The study reveals that given the large number of projects planned in the North and Baltic Seas, there is significant potential for the sharing of transmission lines and costs. Governments need to establish clear rules for the allocation of costs and access to the grid.

# TECHNOLOGY AND RESEARCH AND DEVELOPMENT POLICY

This chapter provides an overview of member countries' recent activities in three of the long-term RD&D areas that are likely to shape energy supply in the year 2020 and beyond, namely, $CO_2$ capture and storage (CCS); hydrogen and fuel cells; and basic science and energy technologies.

## $CO_2$ CAPTURE AND STORAGE (CCS)

Capture and storage of $CO_2$ from fossil fuel combustion is a promising emissions reduction option with potentially important environmental, economic and energy supply security benefits. National R&D programmes on CCS are being pursued by Australia, Canada, Germany, Japan, Norway, the United Kingdom, the United States and other countries. International R&D programmes include the activities of the European Union, as well as IEA activities (*e.g.* the IEA Working Party on Fossil Fuels (WPFF), the IEA Greenhouse Gas R&D Programme (the IEA Implementing Agreement[21]) and the Carbon Sequestration Leadership Forum (CSLF).

### MAJOR NATIONAL ACTIVITIES PLUS EUROPEAN UNION ACTIVITIES[22]

#### Australia

As the largest coal exporter in the world, heavily dependent on coal for its own power generation, Australia has important business interests in developing CCS technology. The federal and state governments are working with industry to support CCS R&D. The Australian government is spending about USD 20 million per year on clean coal technology research, a significant portion of which is directed to CCS R&D. The Co-operative Research Centres (CRC) Programme, which links researchers and research users both in the public and private sectors, plays an important role. For example, the $CO_2$ CRC (Co-operative Research Centre for greenhouse gas technologies) has co-ordinated a carbon capture and storage technology road mapping exercise. The Australian Petroleum Co-operative Research Centre (APCRC) has carried out research which shows that Australia has very high potential for cost-effective geological storage of $CO_2$. The

21. International energy technology collaborative programme.
22. Much information included here comes from the IEA publication *Prospects for $CO_2$ Capture and Storage*.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) is also active in this area, identifying carbon dioxide geological sequestration as a key component of one of their most important areas of research. CSIRO also has links with the CRCs.

## Canada

One of the important aims of Canadian programmes is to find out whether it is worth applying CCS to enhanced oil recovery (EOR), especially given its extensive oil-sand reserves. Canada is also active in coal power plant CCS, probably due to its large share in electricity generation. Canadian $CO_2$ Capture and Storage Technology Network (CCCSTN), Natural Resources Canada, has been co-ordinating a range of activities undertaken by various entities. The Canadian Clean Coal Coalition – formed by an association of seven Canadian utilities and coal producers, together with the US's Electric Power Research Institute (EPRI) – is one of these entities. It is carrying out a demonstration project which will look at capturing $CO_2$ from an existing coal-fired power plant. As for $CO_2$ storage, the Weyburn project is investigating the possible use of $CO_2$ for enhanced oil recovery with special emphasis on monitoring and validation. The province of Alberta, where oil-sands are concentrated, is also actively supporting R&D on CCS technology (*e.g.* $CO_2$ EOR projects).

## Germany

The Federal Ministry of Economics and Labour has initiated a large RD&D programme called COORETEC ($CO_2$ Reduction Technologies for fossil-fuelled power plants) for the purpose of developing and demonstrating energy-efficient fossil fuel power plants including CCS technologies. One of its goals is to maintain Germany's leading role as a power plant supplier. The COORETEC Working Groups, consisting of high-level experts from research and industry, drew up essential requirements including *i)* the most efficient power plants, *ii)* $CO_2$ capture installation in power plants and *iii)* development of $CO_2$ storage options for captured $CO_2$. The COORETEC has also published a road-map to further increase efficiency by 20% by 2020, which is in line with R&D's focus on materials and systems design for high-efficiency steam cycles.

## Japan

Earlier estimates by the Engineer Advancement Association of Japan (ENAA) indicated the significant potential of both geological reservoirs and offshore aquifers in Japan, although uneven distribution would limit the practical storage potential. Based on this work, the Research Institute of Innovative Technology for the Earth (RITE) has been conducting "Research and Development of Geological Sequestration Technology for Carbon Dioxide" in co-operation with ENAA. This research includes $CO_2$ injection into an aquifer and its monitoring.

## Norway

Norway is active on CCS technology, in particular with respect to gas-fuelled power plants. For example, the government agency "Gassnova" was established in January 2005 to co-fund pilot and demonstration plants. Norway is particularly active in the field of subsea aquifer storage. For example, in the Sleipner field, $CO_2$ is captured from natural gas and injected into the Utsira sandstone formation. The Snøhvit $CO_2$ reinjection programme includes $CO_2$ capture from natural gas, $CO_2$ transportation (160 km) and $CO_2$ subsea injection (330m in depth). Norway also has considerable RD&D activities to develop gas power units with $CO_2$ separation, transport and storage.

## United Kingdom

In the UK, there is substantial interest in low-emission fossil fuel combustion plant including CCS. The Department of Trade and Industry's Carbon Abatement Technologies (CAT) programme has developed a strategy for this, and the new CAT strategy named "A strategy for developing carbon abatement technologies for fossil fuel use"[23] was published in June 2005. This strategy identifies CCS as an area of technology which appears to offer opportunities for more radical $CO_2$ reductions from fossil fuel use. It also regards the design of an appropriate regulatory regime for safe and reliable storage as a key factor.

## United States

Driven by its large indigenous coal reserves, the US has significant RD&D programmes investigating the potential application of CCS. More than 70 projects have received funding. These projects cover pre- or post-combustion capture, $CO_2$ storage, monitoring and basic research. As for $CO_2$ capture, various technologies for power plants are being investigated to reduce the cost increase of $CO_2$ capture. For example, the FutureGen power generation project, one of the US's major planned initiatives for CCS using gasification combined cycle technology to produce both electricity and hydrogen, is projected to be ready in 2012. The North Dakota Gasification plant is currently capturing and transporting $CO_2$ to Saskatchewan oilfield in Canada for an EOR project. In addition, an EOR project in Wyoming known as Teapot Dome would store $CO_2$ from a natural gas processing plant that is transported over more than 500 kilometres. A detailed study is being carried out on the storage potential of the Mt. Simon aquifer, which could be very large. The Regional Carbon Sequestration Partnerships was initiated in 2002. The achievements of Phase 1 (2002-2004) include *i)* establishment of a national network of companies and professionals, *ii)* creation of a carbon sequestration atlas for the United States, and *iii)* increased awareness and support for carbon sequestration as a greenhouse gas mitigation option, both with industry and the general public.

23. The full text can be downloaded from http://www.dti.gov.uk/energy/coal/cfft/catstrategy.shtml.

### European Union (EU)

The EU's activities include $CO_2$ capture and storage. For example, the EU's CASTOR project led by the Institut Français du Pétrole (IFP) involves 30 companies and research institutions from eleven European Union countries. Norway is a partner in this project. Much of its research on capture will focus on a pilot plant, while storage research will take place at four sites. The EU is also co-funding various storage projects, such as the first $CO_2$ storage in an onshore aquifer in Germany known as $CO_2$Sink and an EU-funded pilot/demo project for $CO_2$ Enhanced Coal-bed Methane recovery (ECBM).

## MAJOR INTERNATIONAL ACTIVITIES

### IEA Working Party on Fossil Fuels (WPFF)

The Zero Emissions Technologies (ZETs) Initiative was started by the IEA Working Party on Fossil Fuels (WPFF) in 2001. Its objective is to advance the development and deployment of ZETs for fossil fuels through international collaboration and dialogue. CCS is a central component of ZETs. Early on, the WPFF determined that a major challenge was the widespread lack of knowledge about the potential of ZETs and CCS. Therefore, much of the initial activity focused on communications. Highlights included highly successful conferences in Berlin, Germany; Gold Coast, Australia; and Paris, France to introduce ZETs to a wide range of stakeholders. The WPFF also created a number of communications materials in various media. The WPFF worked with several IEA Implementing Agreements such as the IEA Clean Coal Centre and the IEA Greenhouse Gas Programme to focus their activities on ZETs. A significant activity was a July 2004 workshop on legal issues related to carbon dioxide storage held jointly with the Carbon Sequestration Leadership Forum. Co-operative activities to promote the ZETs concept in developing countries took place with China, the United Nations, Asia Pacific Economic Co-operation (APEC) and the US-China Environmental Centre. WPFF is now beginning to implement the second phase of the ZETs Initiative. This phase will build on earlier achievements in two areas: improving public and political awareness and contributing to sustainable energy supply. Within these areas, a wide range of activities are planned. These involve networking and conferences, technology development, capacity building and legal issues. Extensive collaboration outside of the IEA is anticipated.

The IEA Greenhouse Gas R&D Programme (GHG IA)[24], which was established in 1991, is a leading international collaborative research programme that focuses on studying technologies to reduce greenhouse gas emissions from the use of fossil

24. Most of the information included here comes from the IEA publication on Implementing Agreements, *Energy Technologies at the Cutting Edge*, 2005.

fuels, especially CCS. Recent studies include "$CO_2$ capture with solvent scrubbing of combustion flue gases as a leading near commercial option". The participants include 16 member countries, the European Commission and 10 multinational industrial sponsors[25]. Phase 4 of GHG IA was completed in October 2004. During this phase CCS moved from a technical possibility onto the policy agenda, so the activities included research facilitation and communications initiatives. During the current phase (phase 5), progress towards the establishment of CCS technology is expected to accelerate. GHG IA has also been supporting important initiatives such as the preparation of the Intergovernmental Panel on Climate Change (IPCC) Special Report on $CO_2$ capture and storage, to be published in November 2005, and the Carbon Sequestration Leadership Forum (CSLF), by linking it to the GHG database of practical projects in $CO_2$ capture and storage. GHG IA also organises global conferences such as the "seventh International Conference on Greenhouse Gas Control Technologies", held in Vancouver in September 2004. International experts actively participate in the GHG IA research networks such as the $CO_2$ monitoring network including two key monitoring projects, Sleipner and Weyburn.

## Carbon Sequestration Leadership Forum (CSLF)

In 2003, the US hosted the inaugural ministerial meeting for the Carbon Sequestration Leadership Forum (CSLF)[26], an international climate change initiative that focuses on development of improved cost-effective CCS technologies. The purpose of the CSLF is to make these technologies broadly available internationally by promoting the appropriate technical, political, and regulatory environments, including endorsement of CCS projects. The endorsement of ten international co-operation projects was announced at the second CSLF ministerial meeting in Melbourne, Australia, in September 2004. The second CSLF ministerial also adopted the CSLF Technology Roadmap which describes possible routes to future carbon dioxide capture, transport and storage needs. This road-map has identified key milestones for the development of improved cost-effective technologies for $CO_2$ capture, transport and storage concerning cost reduction, securing places for storage and monitoring as follows.

25. Members of the Greenhouse Gas R&D Programme include Australia, Canada, the Commission of European Communities, Denmark, Finland, France, India, Japan, Korea, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, the United States, Venezuela, and several sponsors: ALSTOM Power Technology, BP, ChevronTexaco, EniTecnologie SpA, EPRI, ExxonMobil, RWE AG, Shell International, TotalFinaELf, and Repsol YPF.
26. Members of the CSLF are Australia, Brazil, Canada, China, Colombia, the European Commission, France, Germany, India, Italy, Japan, Mexico, Norway, the Russian Federation, South Africa, the United Kingdom and the United States (www.cslforum.org).

Table 15

**CSLF Milestones by Topics and Time-scales**

| *Cost reduction* | *Identifying possible pathways and setting cost goals* | *Initiating pilot or demonstration projects for promising pathways* | *Achieving cost goals* |
|---|---|---|---|
| Securing places for storage | Identifying promising reservoirs and initiating field experiments | Estimating worldwide capacity and developing selection criteria | Implementing on a large scale |
| Monitoring | Identifying monitoring needs and assessing potential options | Performing field tests | Making monitoring technologies commercially available |
| | By 2008 | By 2014 | After 2014 |

Source: CSLF Technology Roadmap, 2005.

# HYDROGEN AND FUEL CELLS (HFC)[27]

Hydrogen and fuels cells are emerging as high-potential options to ensure a $CO_2$-free, secure energy future. Driven by recent technical advances and the growing need for diversified and sustainable technologies, OECD governments have recently intensified their R&D efforts on hydrogen and fuel cells. These governmental R&D efforts are complemented by international activities including three major international co-operation initiatives.

## MAJOR NATIONAL ACTIVITIES

### Australia

The Australian government recognises that the country should be prepared for a possible transition to a hydrogen economy. In particular, the government is focusing on ensuring that appropriate international codes and standards are put in place. Commonwealth Scientific and Industrial Research Organisation (CSIRO) and a number of universities are active in hydrogen R&D. Hydrogen research is also an element of the COAL21 programme, which includes hydrogen production from coal with carbon sequestration. As for the private sector, an Australian company, Ceramic Fuel Cells Limited (CFCL), which spun off from CSIRO, is a world leader in Solid Oxide Fuel Cell (SOFC) technology, which is focused on stationary power (electricity).

27. Most of the information included here comes from the IEA publication *Hydrogen & Fuel Cells: Review of National R&D Programmes.*

## Canada

Canada has a long-standing involvement in the development of hydrogen and fuel cell technologies, with government investment of some 200 million Canadian dollars since the early 1980s. The HFC R&D programme which has been managed by Natural Resources Canada (NRCan) is largely based on cost-shared R&D partnerships with the private sector, and focuses on hydrogen production and storage; fuel cell commercialisation; and the development of co-ordinated hydrogen and fuel cell standards. Two of Canada's most successful technology developments have been the Ballard proton exchange membrane fuel cells which are currently fuelling a number of demonstration buses in European and North American cities, and the Stuart Energy alkaline water electrolyser. HFC R&D efforts have recently been strengthened by the "Climate Change Plan for Canada" which allocates 85 million Canadian dollars to support HFC R&D activities.

## Germany

Germany is one of the European and world leaders in hydrogen and fuel cell technology development and implementation. The Federal Ministry of Economy and Labour (BMWA) supports RD&D within the Federal Programme for Energy Research and Technologies. Intensive RD&D on hydrogen technologies started in Germany in 1988 and focused on developing specific technologies like hydrogen production using electrolysis, hydrogen storage, and on larger projects to demonstrate the complete chain of solar hydrogen energy production. This work was completed in 1995-1999 with the conclusion that although the main components were developed and functioning, commercial viability was not proved. As a result, since 1995 RD&D efforts with support of an annual BMWA budget of EUR 8-10 million per year have been focused on new materials, improved components, and system integration. The Programme on Investment into the Future (ZIP) which was started in 2001 includes some 40 projects related to hydrogen technology, such as demonstration of infrastructure for fuel-cell buses.

## Japan

Japan is one of the world's leading countries in hydrogen and fuel cell development, with strong private-sector involvement. Japan has invested in research and development into various fuel cell technologies, beginning with phosphoric acid (PAFC) and molten carbonate (MCFC). R&D on proton exchange membrane fuel cell (PEM), which is also referred to as the polymer electrolyte fuel cell (PEFC), was launched in 1992, and has been the focus of Japan's fuel cell R&D. In 1993, Japan launched WE-NET, the international Clean Energy Network using hydrogen conversion, which initially focused R&D on core technologies necessary for establishing a hydrogen infrastructure, and then later on the utilisation of hydrogen and construction of fuelling stations.

Under the guidance of the Ministry of Economy, Trade and Industry (METI), the New Hydrogen Project (NHP) extends the work initiated in WE-NET, and integrates fuel cell development, hydrogen production, transportation and storage technologies, concurrently with the implementation of demonstration programmes, vehicle sales, construction of refuelling infrastructure, establishment of codes and standards, and a general push to enlarge the consumer market for both stationary and automotive fuel cells. As a result, Japan provides exceptional examples of fully-integrated, highly-funded HFC programmes.

### The United States

The US also provides exceptional examples of fully-integrated, highly-funded (USD 1.7 billion over the next 5 years) HFC programmes covering virtually all aspects of HFC R&D and demonstration with strong involvement of industry and state governments. The vast majority of its HFD R&D is conducted under the Hydrogen, Fuel Cells and Infrastructure Technologies Programme which funds research, development and validation activities linked to public-private partnerships. The programme is led by the US Department of Energy (DOE) and integrates the activities of a number of US government agencies, including the Department of Defence, the Department of Transportation and the Environmental Protection Agency. The government's current role is to concentrate funding on high-risk, applied research in the early phases of development to the point where the private sector can make informed decisions on whether or not, and how best to commercialise these technologies. "The US National Hydrogen Energy Roadmap" published in November 2002 describes the principal challenges to be overcome and suggests ways the US can achieve its national vision for hydrogen outlined in "National Vision of America's Transition to a Hydrogen Economy – to 2030 and beyond". The Roadmap stresses the need for parallel development of model building codes and equipment standards to enable technology integration into commercial energy systems and outreach programmes to effectively educate local government officials and the public, who will determine the long-term acceptance of these technologies.

## MAJOR INTERNATIONAL ACTIVITIES

Close international co-operation among national governments and with the industry will be the key to developing this technology option in an efficient and co-ordinated way. Three major international co-operation initiatives have recently been established: the IEA Hydrogen Co-ordination Group (IEA-HCG in April 2003); the International Partnership on Hydrogen Economy (IPHE, in November 2003); and the European Hydrogen and Fuel Cell Technology Platform (in January 2004). Whilst the European Technology Platform is a cluster of EU public/private initiatives building on the R&D projects of the

6th Framework Programme of the European Commission, and the IPHE is a sort of global, political interface with the RD&D world and the private sector, the IEA HCG was established by the IEA Executive Director with the primary objective of enhancing co-operation in the R&D and policy programmes of IEA member countries.

### IEA Hydrogen Co-ordination Group

Under the guidance of the IEA Committee of Energy Research and Technology (CERT), the HCG builds on the IEA international co-operation framework for energy technologies. This includes relevant R&D co-operation projects, such as the IEA Implementing Agreements on Hydrogen, Advanced Fuel Cells, the Greenhouse Gas R&D Programme, and other agreements with interests in specific hydrogen and fuel cell topics (Clean Coal Centre, Bioenergy, Advanced Motor Fuels, Hybrid Vehicles, and Energy Technology System Analysis Project). The HCG's tasks include[28]:

- Developing a comparative review of national programmes in IEA member countries.
- Reviewing ongoing activities and recommending additional collaboration in the IEA Implementing Agreements.
- Identifying analyses and support that will be needed to help guide the IEA work.

### International Partnership on Hydrogen Economy (IPHE)[29]

The purposes of IPHE are to serve as a mechanism to organise and implement effective, efficient, and focused international RD&D and commercial utilisation activities related to HFC technologies. It also provides a forum for advancing policies, as well as common codes and standards that can accelerate the cost-effective transition to a global hydrogen economy.

### European Hydrogen and Fuel Cell Technology Platform (TP)[30]

The European Hydrogen and Fuel Cell Technology Platform (TP) aims at accelerating the development and deployment of these key technologies in Europe. The TP assists in the efficient co-ordination of European, national, regional and local RD&D programmes and initiatives and ensures a balanced and active participation of the major stakeholders, including:

- Research community - public and private; technical and socio-economic.

28. Most of the information comes from the IEA publication *Mobilising Energy Technology*, 2005.
29. Source: the IPHE Home Page (http://www.iphe.net/iphepurpose&functions.htm)
30. Source: The European Hydrogen and Fuel Cell Technology Platform Home Page (http://europa.eu.int/comm/research/energy/nn/nn_rt/nn_rt_hlg/article_1261_en.htm)

- Industry (including SMEs) - embracing the whole production and supply chain.
- Public authorities - European, national, regional, local.
- Financial community - banks, venture capital, insurance.
- Users and consumers - to ensure markets for products.
- Civil society - to enhance public awareness.

## LINKAGE BETWEEN BASIC SCIENCE AND ENERGY TECHNOLOGIES

As stated in the *World Energy Outlook* (WEO-2004), achieving a truly sustainable future energy system will call for technology breakthroughs that radically alter how we produce and use energy. However, the fact that the linkage between basic sciences and energy technologies could help bring about these breakthroughs is less well known. The IEA Conference on Linking Basic Science and the Development of New Energy Technologies, held in Paris in April 2003, addressed this topic. The Ad Hoc Group on Science and Energy Technologies (AHGSET) was established in March 2004 to reflect a commitment by the IEA to continue this important work and to extend the initial progress over the foreseeable future.

AHGSET is under the Committee of Energy Research and Technology (CERT). Australia, Austria (as an observer), Belgium, Canada, France, Germany, Greece, Korea (as an observer), Italy (as an observer), Japan, the Netherlands (as an observer), Portugal, Sweden, the United Kingdom, the United States, the European Commission and the OECD Global Science Forum participate in AHGSET.

One of AHGSET's most important activities is to organise workshops to bring key stakeholders together in areas of mutual interest. These stakeholders include scientists, energy technologists and public policy officials. The aim of these workshops is to explore what energy technologists need from basic scientists (demand pull), and to explore what the results of basic science can contribute to energy technologists' needs (science mining).

Two workshops on specific topics sponsored by Germany and France have taken place so far and another sponsored by the United States is scheduled for November 2005. The key points of the AHGSET workshops are as follows.

The AHGSET workshop on *Computational Approach* sponsored jointly by the German Federal Ministry of Economics and Labour (BMWA), the German Federal Ministry of Education and Research (BMBF) – together with PTJ, the Project Management Organisation, Juelich – took place in Berlin 8-9 November 2004. The programme addressed the technical "pull" from engineers and the scientific "push" from applied mathematicians. The topics covered issues relating to energy generation, conversion and end-use, as well as energy modelling and mismatches between modelling requirements and data availability. Invited speakers included scientists involved in nationally supported activities and experts representing IEA's Implementing Agreements.

As its principal outcome, the workshop highlighted the view that a precondition for strengthening the bridges between science and applied energy technology lay in engineers' ability to formulate the problems that the mathematicians would then try to solve. On the other hand, new results and processes developed by mathematicians must be made available, in an understandable form, to engineers and physicists. Furthermore, differences in time frames between curiosity-driven science and applied energy research have to be balanced.

The AHGSET workshop on *Methodologies and Tools for Multicriteria Evaluation of Energy Chains and for Energy Technology Perspectives,* sponsored by France, was held on 3-4 March 2005 in Paris. The main focus of the workshop was to address the need for more advanced socio-economic decision-aiding tools and methodologies for the prioritisation of long-term energy R&D options. The workshop reviewed the different types of existing tools and discussed strengths and weaknesses with each approach.

The main recommendations from the workshop are the following:

- To develop new approaches, with deeper integration of the social sciences. A prerequisite is to enhance the dialogue between economists and social scientists, in particular in order to improve the understanding and representation of consumer behaviour and preferences.
- To develop capabilities of models to exchange information between them in order to facilitate their combined use.
- To enhance the relevance, consistency and transparency of models and associated data.
- To promote a better sharing of the data and its underlying information, as data handling is costly and very demanding.
- To understand better the drivers of new paradigms and the mechanisms underlying learning curves and innovation processes.
- To develop a common expertise to set with « realism » contextual conditions and reference scenarios suited to R&D long-term targets.

The US-sponsored AHGSET workshop on *Strengthening the Critical Connections between Science and Energy Technology Programmes* will be held in the United States in November 2005. The workshop will bring together key representatives from the science, technology, and policy communities. Its purpose is to engage these various communities in group dialogue and to obtain feedback and recommendations for specific strategies that would serve as inputs to the preparation of an AHGSET strategic plan. On a general level, this seminal autumn 2005 workshop will attempt to answer four basic questions: Why basic research? What is required for success? How do we do it?

How can basic science help improve the existing suite of energy technologies as well as foster the development of wholly new, innovative technologies? This major planning workshop will be followed by a companion activity of the OECD's Global Science Forum. The organisers of both workshops are working closely together towards a seamless process that builds on the mission and strengths of these two organisations and the unique focus and topics for each workshop.

# ENERGY POLICIES IN NON-MEMBER COUNTRIES

## CHINA

Rapid economic growth continued to intensify strains on the Chinese energy sector in 2004 and early 2005. While official GDP growth has been measured at close to 10% in this period, other proxies in the economy suggest even faster growth. Analysts continue to debate whether China can achieve a softer landing, but data uncertainties may make it impossible to tell when and if the economy has reached a more sustainable level of growth.

China's energy sector continues to suffer from weak governmental co-ordination and planning. As a result, the country's policy framework is ill-equipped to prioritise objectives and allow market signals to guide investment and consumption decisions. Environmental considerations are often ignored or not enforced. While several strategic studies on the future of China's energy sector were delivered to Premier Wen Jiabao in 2004, little follow-through has yet appeared. A new energy task force was created in early 2005 with the goal of better integrating energy policy, but it falls short of what many deem necessary. On the Basis of information available at the time of writing, although the new task force is a step in the right direction, it may be necessary to create a new Chinese energy ministry to make energy reliable, sustainable and affordable in the future.

In spite of the policy drawbacks, China should be recognised for its ability to largely meet its energy needs (outside the power sector) despite such powerful economic growth. Double digit expansion in virtually all energy subsectors over a two-year period is a remarkable physical accomplishment, even if the environmental consequences of such growth will be felt for many decades. Energy has enabled the economy to grow so rapidly and lift hundreds of millions of Chinese out of poverty since reforms began over 25 years ago.

China's electric power sector continues to operate in shortage, although the gap between supply and demand will begin to close in the second half of 2005. Needed reforms in the power sector continue to take a back seat to measures to address the shortages. The lack of generating capacity has been intensified by shortages of (inexpensive) coal, rail capacity, and rainfall in hydro-reliant areas. Shortages totalling 30 gigawatts are expected in the summer of 2005 in cities like Shanghai, Nanjing, Beijing and Guangzhou. Municipal officials are again implementing emergency measures to control peak load by staggering work times, adjusting prices, and closing facilities. Given the recent shortages, government officials are again paying great attention to demand-side issues when discussing overall energy policy. The IEA Secretariat kicked off a major study of power reform options during a November 2004 workshop in Beijing and anticipates completion of the study in late 2005 or early 2006.

One positive measure was announced in late 2004 to address distortions in the electricity sector. It will be permitted to reflect changes in coal prices in electricity tariffs without prior approval by the National Development and Reform Commission. Over the past few years, coal prices have risen significantly while electricity prices were held largely stable in order to control inflation. If this new pricing measure occurs as planned, it should help build incentives for more coal mining, coal transport, and power generation.

The Energy Bureau in China's National Development Reform Commission has moved quickly to encourage the building of new plants, with about 50 gigawatts of capacity brought on line in 2004, and even more expected in 2005. There is growing concern, however, that China will overshoot the target and again experience overcapacity in power generation by 2007 or 2008 if either or both of the following situations occur: *i)* the economy slows suddenly, or *ii)* too many plants are built that have not been approved by the government. The difficulty of balancing power demand and supply in a country with such rapid growth cannot be overstated. But reforms to influence investor and consumer behaviour would clearly help bring the two into better balance. A revision to the Electricity Law may be published in 2005, but analysts are concerned that it will be too general to bring about the needed changes by itself.

Chinese petroleum demand has also grown explosively, with 40% now imported from abroad. In 2003, Chinese crude oil imports jumped by 31%, to 91 million tonnes. Crude imports grew by one-third again in 2004 to 123 million tonnes. China accounted for 32% of the incremental growth in global oil demand in 2004. To address the growing insecurity of supply, China has intensified efforts to purchase overseas oil assets, acquire other companies, improve domestic efficiency, substitute other products for oil, and import more oil via pipeline.

One apparent bright spot in the Chinese energy sector so far in 2005 is the slow-down in the demand for petroleum. Demand in the first half of 2005 has grown only half as quickly as it did in 2004. Total incremental demand for 2005 is currently projected at roughly 460 thousand barrels per day compared to the 860 thousand barrels per day in 2004. Through June 2005, there were no signs of such a dramatic slow-down in the other Chinese energy sectors.

China has also continued the construction of its strategic petroleum reserves, although little official information on progress or strategy has been released. Four sites are reportedly under construction, with at least one ready for stockpiling in the third quarter of 2005. Two of the depots are located in Zhejiang Province, with the other two in Liaoning and Shandong. Total coverage after the four depots are complete is estimated at 35 days of imports, or 100 million tonnes. Chinese policy-makers claim that global oil prices have been too high recently to actually begin storing oil at the facilities. The IEA Secretariat has held two workshops with the Chinese on how to build and operate strategic reserves, and plans to continue collaboration on operational aspects in 2005.

China's natural gas sector continues to attract great attention and is at the heart of the country's priority to rationalise its energy supply structure. In 2004, China produced just over 40 bcm of natural gas, ranking approximately 18th in the world. It accounted for about 2.5% of the country's total energy consumption, compared to the world average of 24%. Government planners envision gas demand rising to 200 bcm by 2020 (about 10% of the total energy share then), with roughly a third imported from abroad and two-thirds produced domestically.

Actions that support the government's new attention to gas include:

- Completion of the 3 900-km-long East-West pipeline that will eventually deliver 12 bcm of gas from Xinjiang to Shanghai; the pipeline began operations in late 2004, a year ahead of schedule and is ramping up gas delivery to Shanghai.
- Construction of two LNG import terminals (Guangdong and Fujian), with plans for up to a dozen others in the near future. LNG has attracted huge attention recently as domestic coal prices have soared and the clean fuel now looks much more competitive.
- Detailed discussions and a feasibility study to import approximately 20 bcm of natural gas from Russia's Kovytka field to north-east China beginning perhaps in 2008.
- Acceleration of other smaller domestic and offshore pipelines to bring gas to urban areas.

The IEA Secretariat followed up on a 2002 study of Chinese gas issues by participating in a high-level policy seminar in July 2004 in Beijing. Major barriers preventing greater gas utilisation include the creation of enforced take-or-pay contracts and environmental pricing mechanisms to make gas more competitive against coal.

China's coal sector has expanded output enormously in the past few years, but shortages still result in lost economic output. Coal production increased by nearly 16% in 2004 after exhibiting similar growth in 2003. Statistics that track coal-related emissions of sulfur oxides, particulates and carbon dioxide are also up sharply for the first time since the mid-1990s. The Secretariat continues to engage China's coal sector after participating in a round table at the highest level in Beijing in mid-2004.

China is also likely to give greater attention to renewable energy supply in the coming years. A new law on renewable energy was issued in early 2005 with the aim of promoting investment in small hydro, wind power, and photovoltaics. These sources of "new energy" could play a significant role in meeting development needs in remote areas, but their overall impact in developed, urban areas of China has been hindered by high cost, technical difficulty, and distorted markets. There is growing talk in China of introducing more significant energy taxes, which could provide greater incentives for clean energy and demand-side energy management.

# INDIA

India's efforts to enhance its energy security have intensified significantly since 2004. India increasingly sees energy security as a national priority and central aspect of its foreign policy. This is mainly driven by the recognition of the country's increasing oil and gas import dependence and the need to employ a multi-pronged strategy to address its energy security concerns. The development of an integrated national energy policy is seen as key in the country's quest for energy security and is also essential to India meeting its declared policy objective of providing affordable energy to all.

## NATIONAL ENERGY POLICY AND SECURITY

Several committees have been working on Indian energy policy and security issues over the last year. The first committee was constituted in early 2004 under the lead of the Ministry of Power while the second was created shortly after the current government assumed office in mid-2004 and is working under the Planning Commission. The latter committee issued a "draft integrated energy policy" in mid-2005. In late 2004, an Advisory Committee on Oil Diplomacy was created, which was subsequently tasked by the Ministry of Petroleum and Natural Gas with preparing the so-called "India Energy Security Vision 2025". The Vision is to be issued by the end of 2005 and will outline a road-map for ensuring the availability of energy at all times, in various forms, in sufficient quantities and at affordable prices.

However, in July 2005 the Indian Prime Minister announced the establishment of an "Energy Co-ordination Committee" to guide the country's energy policy. The ECC will be tasked with formulating a co-ordinated policy response cutting across ministries so as to improve the overall energy scenario in the country while addressing energy security concerns. The ECC will enable the government to take a holistic view of India's energy needs and policy options.

The EEC will, among other things, identify key areas requiring energy policy initiatives; monitor vulnerabilities that directly impinge on energy security aspects; outline the follow-up action needed for implementing identified policy initiatives; identify institutional mechanisms for implementing policies; and periodically monitor key policy decisions. The creation of the EEC and its wide-ranging responsibilities could be the first step towards the creation of an energy ministry in the country although the government has not yet made any official announcement in this regard.

The government is also moving ahead with its plans for the creation of strategic oil stocks. The Indian Strategic Petroleum Reserves Limited (ISPRL) was created in June 2004 and a general agreement was reached about the financing mechanism. While construction of the storage facilities has yet to start, the government expects to have 5 million tonnes of strategic reserves in place by 2009.

## POWER SECTOR

Since the enactment of the Electricity Act 2003, the government has undertaken follow-up action to implement the act through the issuance of several orders, rules and policies. The act defines the role of the central and state governments to provide overall policy guidance to the power sector and in particular stipulates the preparation of a National Electricity Policy and a Tariff Policy. In early 2005, the Ministry of Power issued guidelines for competitive bidding and published the National Electricity Policy that outlines the overall government objectives with regard to the power sector, including provision of electricity to all households by 2012 and the financial turn around towards commercial viability of the electricity sector. A Draft Tariff Policy has also been circulated for wide-ranging discussion among stakeholders and is expected to be introduced for Cabinet approval during 2005. In response to other provisions in the act, national policies on stand-alone systems for rural areas and non-conventional energy systems, and for local distribution systems in rural areas have been drafted and are being discussed. These last two policies reflect the recognition that meeting the objective of power-for-all by 2012 can only be achieved if alternative power generation and innovative distribution schemes are implemented successfully. Thus, it will be important that the Ministry of Power moves quickly to approve and operationalise those two policies to facilitate the emergence of independent rural suppliers of electricity.

Spurred by unexpected massive power shortages in the western state of Maharashtra, efforts to settle an international dispute over the abandoned Dabhol power station intensified during the first half of 2005. The 2 184 MW power station was shut down owing to disputes over the cost of power produced by the plant. The settlement reached as a result of international arbitration paves the way for a quick restart of power operations and for completion of the construction of the LNG terminal that is to supply gas to the power plant.

## THE PETROLEUM AND NATURAL GAS SECTOR

Developments in the petroleum and natural gas sector kept up the fast pace which they gathered in 2004. The sector is seen as crucial to ensure India's energy security and the government initiated a flurry of activities over the last two years, the most visible of which was the surge in India's overseas oil and gas investments. In early 2005 the government revised upward the limit for investments by the Oil and Natural Gas Corporation without specific government approval, and is now thinking of according similar autonomous investment levels to other public oil and gas companies. India currently has 13 exploration and production interests in ten countries, of which two are producing. In addition, India is involved in three refining and pipeline projects and seven marketing projects, bringing its geographical presence to 14 countries. The most publicised new investment was the USD 30 billion 25-year deal with Iran, agreed in 2005, combining LNG purchases with upstream oil field investments. Importing LNG is seen as one way to address the growing demand for gas but India is also pursuing options for pipeline imports.

Since late 2004, discussions of different pipeline options to import gas have intensified. In early 2005 the Indian Cabinet agreed to hold talks with six of its regional neighbours, Afghanistan, Bangladesh, Iran, Myanmar, Pakistan, and Turkmenistan, with the aim of securing natural gas supplies by pipeline. The mandate for this "Pipeline Diplomacy" was awarded to the Ministry of Petroleum and Natural Gas. Most advanced among the pipeline options are the proposed Iran-Pakistan-India pipeline from the West and the Myanmar-Bangladesh-India pipeline from the East. Another sign of India's enhanced efforts at energy security through pipeline diplomacy came early in 2005 when the Minister of Petroleum and Natural Gas proposed the construction of a network of pan-Asian gas pipelines. The proposed grid would create a link between Iran and the Caspian in Western Asia, China and Myanmar in Eastern Asia, and Siberia in the North.

Given the importance of the petroleum and natural gas sector, its investment needs and readiness of businesses to invest, it is surprising that no substantial progress with sector restructuring has been made. A government-appointed committee that was tasked in early 2005 with analysing options for sector restructuring recommended against merging all public-sector oil and gas companies into one mega-company that could be competing effectively with international energy majors. Instead, it recommended transferring the government's shares in all public oil and gas companies into a trust to ensure that the companies are professionally managed, based on commercial considerations, and that they are given enhanced corporate autonomy. The government has not yet announced whether it will implement the committee's recommendation. The sector also still lacks a coherent petroleum and natural gas policy and regulatory framework. The draft Petroleum and Natural Gas Regulatory Bill is still pending, and the draft Policy for Development of Natural Gas Pipeline Networks is being discussed in its third draft without any target date for approval in sight. There is also a need to review and rationalise the tax structure and pricing mechanism for petroleum products, natural gas and pipeline transportation. The current pricing and tax structure is seen as opaque and resulting in hidden subsidies and irrational fuel choices, among other shortcomings.

## NON-CONVENTIONAL ENERGY SOURCES/BIOFUELS

India's potential and its commitment to develop its non-conventional energy sources are considerable. The country is pursuing a very active and extensive programme for non-conventional energy sources through its dedicated Ministry of Non-Conventional Energy Sources. The government's aim is to electrify 18 000 remote villages through non-conventional technologies by 2007.

A concept paper on "Decentralised Distributed Generation", based on local renewable sources (biomass, biodiesel, solar, wind, etc.), was issued for discussion in 2004. The potential for power production from these resources is assessed at 19 500 MW including 3 500 of exportable surplus power from bagasse-based co-generation in sugar mills and 16 000 grid quality power from other biomass resources. A number of technologies have been developed indigenously for gasification and briquetting of biomass materials.

India is also pursuing a widespread programme for alternative fuels/biofuel for transport through its Ministry of Petroleum and Natural Gas and the Ministry of Non-Conventional Energy Sources. The programme aims to gradually introduce ethanol-blended fuel based on sugarcane and biodiesel using jatropha nuts to produce oil. The government's long-term policy objective is to have a mandatory ethanol-blend of 20% by 2010. In early 2005, the western state of Gujarat introduced commercial bus services that run on a 5% jatropha nut oil-diesel mix. As with ethanol-blended petrol, the aim is to have a jatropha-diesel mix of 20% in the medium term. The objective of the government's policy is twofold: to reduce oil consumption while at the same time promoting agricultural production and rural employment opportunities. In particular, the jatropha-nut is seen as ideally suited for cultivation in arid conditions, as in Gujarat state, and the Indian government is hoping that the biofuels programme will stimulate farmers to cultivate on currently unproductive land. However, the current lack of co-ordinated marketing and transport facilities needs to be overcome to provide farmers with the required infrastructure to market their products and to make the biodiesel programme a success.

In addition, the Indian government has also been implementing a very successful compressed natural gas (CNG) programme for vehicles in New Delhi and Mumbai since 1998. Originally intended primarily to reduce air pollution, CNG for vehicles is increasingly also seen as an alternative to petroleum-based fuels. Plans for an expansion of CNG provision to mid-sized cities have been developed and are currently being implemented in several cities.

# SOUTH-EAST ASIA

With global growth reaching a 30-year high of 5.1%, strong growth in the US and Chinese economies, improved growth in Japan and the EU, and a recovery in the information technology (IT) sector, member countries of the Association of South East Asian Nations (ASEAN) were provided with a favourable external economic environment in 2004. Despite high oil prices, some localised security concerns, and sporadic outbreaks of avian flu, ASEAN countries experienced an average annual GDP growth of 6.3%.

However, ASEAN average growth for 2005 is set to slow to a still robust 5.5% and inflationary pressures will increase owing to the slowing in the globe's major economies this year, the risks from continuing high oil prices, and the USA current account deficit.

The impact of high oil prices is being largely felt by the major oil-importing economies of Singapore, Thailand and the Philippines, but regional trading relationships will spread the impact to all ASEAN countries.

While the smooth elections in Indonesia and leadership transition in Malaysia have encouraged greater investor confidence, there remains a strong imperative for some ASEAN economies to address outstanding financial and corporate sector issues of transparency, disclosure, governance and restructuring. Investment-to-GDP ratios have increased little from the lows of the post-1997 Asian financial crisis.

The high oil import dependence of the major ASEAN economies of Singapore, Thailand and the Philippines, the fast-increasing energy demand of all ASEAN economies, and the fast-increasing oil demand for ASEAN's burgeoning transport sectors mean that ASEAN economies are economically vulnerable to high oil prices in terms of direct costs, inflationary pressures, and rising interest rates.

In recent months, as global price increases have begun to flow more strongly through to ASEAN consumers, there appears to be some impact on consumption levels. This may be further affected by various governments' mooted conservation measures. Such measures are likely to have an impact on Asian demand growth levels in the latter half of the current year.

Additionally, the petroleum subsidies of various ASEAN economies are posing a heavy financial burden on national governments and are diverting public funds away from more targeted spending.

Governments throughout ASEAN have been urgently pursuing a range of national voluntary and compulsory energy-saving measures, but these are having minimal impact when compared with the vast amounts being spent on supporting domestic petroleum subsidies. While ASEAN governments with petroleum subsidy schemes now recognise the imperative for their removal, because of their political sensitivity, the ability of governments to wind them back varies greatly.

Thailand has spent up to USD 15 million each month subsidising domestic petroleum prices, and its current account deficit has ballooned. The Thai government was forced to float petrol prices in October 2004 and, in June 2005, "semi-floated" the more politically sensitive diesel prices.

In Indonesia, the impact of the fuel subsidies and their financial and political management is considerable. In 2005, the fuel subsidies were expected to cost the Indonesian government some USD 14 billion, one-third of forecast government expenditure for the year. The government had implemented a 29% price rise on petrol and diesel in March 2005. A subsequent 2-month mini–crisis forced the government to make another dramatic cut in the subsidies and on 1 October 2005, the government more than doubled the pump price of gasoline, diesel and kerosene.

Owing to increasing national demand and limited refining capacity, Indonesia is importing much of its petrol and diesel, and this has served to increase pressure on the government budget. Pertamina, the state-run oil company, pays the import costs and is reimbursed by the government. These high costs are proving difficult to meet, and Pertamina has struggled to secure credit lines to import the necessary fuel. In July, nationwide fuel shortages occurred and some hoarding has begun.

The Malaysian government has raised petrol and diesel prices three times since October 2004, but these increases have been small and prices remain low compared to its ASEAN neighbours. The government is now reconsidering its fuel subsidy programme from 2006 on.

To address region-wide energy issues, the ASEAN Senior Officials Meeting on Energy (SOME) and the ASEAN Ministers of Energy Meeting (AMEM) are held annually to review progress of policy and programmes in place and to provide direction for future regional policy and programmes.

## ASEAN OIL SECURITY

Recognising that ASEAN is becoming increasingly dependent on oil imports, the ASEAN countries have been developing a mechanism for regional consultation and co-ordination during a petroleum supply shortage and emergency. The new ASEAN Petroleum Security Agreement (APSA) and its annexed Co-ordinated Emergency Response Mechanism (CERM) have been under active revision since 2002 but remain to be agreed. Under the auspices of the ASEAN Secretariat, this agreement is scheduled for finalisation and signing at the 2006 ASEAN Energy Ministers Meeting.

The earlier proposed interim measure to address regional co-ordination and consultation procedures during a supply crisis, the "Standard Operating Procedures" (SOP), will no longer be pursued.

## TRANS-ASEAN ENERGY NETWORK

To address issues of longer-term security, energy mix and source diversification, sectoral efficiency, and environment sustainability, ASEAN policy-makers continue to work towards the Trans-ASEAN Energy Network, made up of the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline (TAGP).

The Trans-ASEAN Gas Pipeline (TAGP) project continues its development, and in early 2005 natural gas began flowing via two new projects from an offshore Malaysia-Thailand joint development area into Thailand and Malaysia. Three additional projects, in the Philippines and Indonesia, have also been identified.

The newly established ASCOPE Gas Centre (AGC), Kuala Lumpur, is implementing a number of regional initiatives and activities focusing on maritime pipeline transportation, technical standardisation, harmonisation, and cross-border and transit issues.

A memorandum-of-understanding (MOU) will be signed soon for the export of offshore Myanmar natural gas to India via Bangladesh.

The ASEAN Power Grid (APG) project continues the development of five cross-border electricity interconnection projects between ASEAN countries. The Council of the Heads of ASEAN Power Utilities and Authorities (HAPUA) has initiated the formulation of a common ASEAN policy and framework for cross-border electricity interconnection and trade.

## ASEAN COAL CO-OPERATION

An area that has attracted limited regional attention, the ASEAN Forum on Coal, is being strengthened with a major meeting in late 2005. Its theme will be "Coal, the Logical Alternative".

## ASEAN CO-OPERATION IN ENERGY EFFICIENCY AND CONSERVATION

While governments throughout ASEAN have been urgently pursuing a range of national voluntary and compulsory energy-saving measures, ASEAN regional co-operation continues to implement various projects, including the ASEAN energy benchmarking system for buildings, ASEAN Energy Management Accreditation System (AEMAS), and ASEAN Standards and Labelling System.

### ASEAN CO-OPERATION IN RENEWABLE ENERGY (RE)

ASEAN countries, as emerging economies with a high RE potential, continue to pursue a greater share of RE in the power generation mix. High oil prices, fast-growing oil import dependence, and strong impact on transport fuels are giving added impetus to RE substitution for stationary applications and the development of biofuel extenders and substitutes for the transport sector. Understandably, Thailand and the Philippines are taking the lead in biofuels with tax and financial incentives focusing on RE and rural development.

## LATIN AMERICA

Latin America still faces considerable challenges in ensuring access to secure, clean and affordable energy in the countries of the region. While creating stable investment environments to ensure the adequate expansion of energy sectors is of paramount importance, it is also necessary to have demand-side policy measures in order to promote the efficient use of energy.

Throughout the past year, regional energy co-operation and integration has been an important issue. Two regional organisations have already been established, PETROCARIBE and PETROSUR, and another, PETROANDINA, has been proposed and could be created soon – covering Bolivia, Colombia, Ecuador, Peru and Venezuela (Andean Community's member countries),. Some experts see these initiatives as part of President Chavez's "oil diplomacy" seeking to gain influence in the region. However, it cannot be denied that they have been welcomed by the countries involved. The members of these three organisations would in the future be part of another project named PETROAMERICA. Furthermore, there is also a plan to create an energy ring that will involve Peru, Chile, Brazil, Argentina and Uruguay in a first stage, and probably Bolivia at a later stage.

### VENEZUELA

Venezuela's vast indigenous reserves of oil and gas make it an important player in world energy markets. It is one of the world's largest producers and exporters of oil. As a founding member of OPEC and one of the United States key oil suppliers, its energy policies have a profound effect on world energy security.

Energy policies have changed dramatically since Chavez became President of Venezuela in 1998. Having set the priorities of Venezuela's energy policies, he aggressively and controversially embarked on this endeavour making several reforms: adhering to OPEC quotas (either through accident or design), and defending high oil prices and production cuts; regaining control of Petróleos de Venezuela (PDVSA); displaying its "oil diplomacy" to create new relations and to reinforce those already existing with several countries; and opening the natural gas and petrochemical sectors to private investment.

Venezuela has the world's sixth-largest proven oil reserves (78 billion barrels according to BP and the *Oil and Gas Journal*, end of 2003)[31]. It is the world's ninth-largest oil producer and the second-largest in Latin America behind Mexico (2.81 million barrels per day – mb/d – as of 2003)[32]. Moreover, Venezuela is the world's seventh-largest oil exporter and the second-largest in Latin America, again behind Mexico (1.80 mb/d as of 2003)[33]. However, current concerns over the reliability of Venezuelan oil have direct repercussions on world energy markets, and hence these are reflected on oil prices. The real situation of Venezuela's oil sector is uncertain. According to the IEA, at present Venezuela has a total crude output of 2.7 mb/d on average – including 2.12 mb/d of conventional crude and 588 000 b/d of synthetic crude from the Orinoco Belt (as of June 2005)[34]. This is 1.1 mb/d of conventional crude below its OPEC production target of 3.22 mb/d for July 2005. PDVSA figures show that Venezuela produced 3.3 mb/d in June 2005 – including 2.2 mb/d of conventional crude from PDVSA, 550 000 b/d of conventional crude produced by private companies under operating agreements (32 contracts) and 600 000 of synthetic crude[35]. Experts estimate that damaged reservoirs and equipment, as well as lack of investment in the sector and insufficient human capacity would make PDVSA's full production recovery difficult after the 2002/03 oil industry strike. Venezuela is also deemed to have lost influence in OPEC due to underproduction, hence is seeking to boost its proven oil reserves in order to regain negotiating powers within the cartel. The country would have no capacity to increase output, and it is uncertain whether and when Venezuela will be able to reach its OPEC quota.

A situation of uncertainty has been created as rules have been changing too often in recent months. Compulsory migration to a new joint-venture contracts scheme upstream that would favour PDVSA, which will hold a minimum stake of 51%, and an increase in royalties and taxes, all in line with the 2001

31. IEA, *World Energy Outlook 2004,* OECD/IEA, 2004, p. 91. According to the O&G J., excluding Canadian oil-sands.
32. *IEA Energy Statistics of Non-OECD Countries,* 2005. This figure includes crude, NGL, feedstock and non-crude.
33. *IEA Energy Statistics of Non-OECD Countries,* 2005. This figure includes crude, NGL, feedstock and non-crude.
34. *IEA Oil Market Report Data,* 2005.
35. BNamericas, IEA: *Crude Output Steady in June, Below OPEC Quota – Venezuela,* 13 July 2005, BNamericas news service website. (19 July 2005) <http://www.bnamericas.com/content_print.jsp?id+323709&idioma=I&sector=&type=NEWS>

Hydrocarbons Law, would make the country less attractive to private investment, especially if oil prices fall from current levels. SENIAT, the tax authority, is auditing and accusing foreign companies of not paying enough income tax. In spite of all this uncertainty, most foreign companies are in negotiations with Caracas and have decided to stay in the country and continue their operations, at least for now. Furthermore, a reform of the Central Bank Law has taken place recently in order to make possible the direct transfer of PDVSA's dollar income (without the need for previous approval of the Central Bank) into a special fund for social development programmes, which will be exclusively managed by President Chavez. Analysts consider that this reform would affect PDVSA's capability to invest in the sector and also the Venezuelan economy.

Venezuela also holds the largest proven gas reserves in Latin America and the eighth-largest reserves in the world (147.59 trillion cubic feet – tcf)[36]. Around 90% of Venezuela's gas is associated to oil production, and a large portion is reinjected to enhance oil recovery, making production dependent on OPEC quotas. Seeking to expand gas consumption, the Chavez Administration has taken steps towards developing non-associated gas reserves and promoting private investment. There is potential to increase the consumption of gas in every sector. Further, as Venezuela is highly dependent on hydropower, gas-fired generation would be desirable to enhance electricity supply security, particularly in periods of drought.

Venezuela is also seeking to diversify its economy from oil and refined products. The opening of the gas sector, through the 1999 Gas Law, to foreign participation in every activity of the chain (excluding associated gas) has created considerable interest among foreign companies. However, while, on the one hand, large reserves and proximity to the United States make Venezuela attractive for foreign investors, on the other hand, the conditions and protection of private investors, as well as the marketing perspective are not as attractive as those of other countries that are rich in gas. Pricing policy is a matter of concern, as the government wants to keep prices down in order to stimulate domestic demand. Finally, in order to become an LNG exporter, Venezuela would need at least two or three LNG trains in order to be able to compete with Trinidad & Tobago, as otherwise it would be too expensive.

Roughly 86% of Venezuela's installed generating capacity is operated and owned by public companies[37]. There has been little progress in the privatisation of the electricity sector since it was indefinitely postponed several years ago, and it is uncertain whether this situation will change. Moreover, in order to meet national demand growth and reduce dependence on hydropower,

36. World Energy Council, *2004 Survey of Energy Resources*, 20th Edition, 2004 (Elsevier Ltd.: London, England), pp. 129-130. This figure comprises natural gas proved recoverable reserves at end-2002.
37. EIA, *Country Analysis Brief: Venezuela,* EIA web site (6 July 2004) - <http://www.eia.doe.gov>

Venezuela must increase its generating capacity. President Chavez is encouraging private participation in thermal generation in the west part of the country. To date, owing to the government-fixed electricity tariffs and lack of clarity in the regulatory framework, little response has been shown by private investors. In the end, only state companies CADAFE and EDELCA are investing in the sector[38].

Claims have been made regarding the deteriorating diplomatic relations between Venezuela and the United States. Observers deem President Chavez's aggressive statements against the US Administration to be only rhetorical, and consider it improbable that President Chavez would stop commercial relations with the United States. This is simply because the United States is a natural market for Venezuelan crude and products, and the Venezuelan economy is highly dependent on crude and products exports to the United States. A cessation or restriction on oil exports would affect Venezuela to a much greater extent than it would the United States. Besides, much of Venezuela's crude production is heavy and sour, with currently only a limited number of refineries outside the US Gulf Coast region able to handle such crude. The US government no longer considers Venezuela to be a reliable oil supplier, and monitors Venezuela closely. Thus, in the first half of 2005, as a part of a contingency plan, the Government Accountability Office has been ordered to prepare a study on all aspects of the Venezuelan oil industry, the impact that it may have on any supply disruption, as well as on alternative suppliers of oil.

## BRAZIL

Brazil is the largest economy in Latin America and the ninth-largest in the world[39]. It is the tenth-largest power energy consumer in the world, the largest power energy consumer in Latin America, and the fourth-biggest power energy user among IEA non-member countries after China, India and Russia[40]. Brazil, therefore, is important in world energy and the success or failure of its energy sector reforms have an inevitable impact on its and the neighbouring region's economic growth and reform efforts. Brazil depends on hydropower to generate 84% of its electricity supply[41] and the government has plans to build more hydro plants, which means that hydroelectricity still plays the most important role in Brazil's energy policies, although it has tried to increase the

38. Global Insight, *Venezuela: Cadafe to Invest US$ 600 million in Power Plants in Venezuela*, World Market Research Centre website, 19 May 2005 (19 May 2005) - <http://www.worldmarketanalysis.com>
39. *IEA Energy Statistics of Non-OECD Countries*, 2005.
40. *IEA Energy Statistics of Non-OECD Countries*, 2005.
41. *IEA Energy Statistics of Non-OECD Countries*, 2005.

use of gas for power generation in recent years. Brazil has also instituted strong measures to promote renewable energy use.

In March 2004, Brazil's new Lula Administration approved the New Electricity Model which would aim to strengthen supply security, increase competition, and rationalise regulation in order to attract greater investment. The implementation of the New Electricity Model began in mid-2004. This New Model attempts to overcome the failures of the reforms to the electricity sector that President Cardoso's Administration introduced during 1995-2002.

In the hydrocarbons sector, new gas legislation is expected to be passed by Congress in 2005. The new legislation would aim to attract investment to the sector's exploration, production and transport in order to boost gas reserves and use in industry and for thermoelectric power generation, reducing dependence on Bolivian gas. It would attempt to achieve this by clarifying gas market rules as those regarding the creation of a secondary market where gas surpluses could be resold, as well as pipeline planning, construction, operation and access. Furthermore, Brazil's oil production has risen steadily in the past few years driven by the goal of achieving self-sufficiency by 2006 and net exporter status by 2010.

## BOLIVIA

Bolivia could become South America's natural gas hub and be a major exporter of LNG, although the country's situation has not changed in the past year. Political instability and social unrest are still prevalent in Bolivia. The country's proven natural gas reserves are the second-largest in Latin America after Venezuela's[42], but the largest in terms of non-associated gas. In September 2003, major protests erupted in opposition to the government's plan to export gas to the United States and Mexico through Chile due to a long-standing difference over territory which dates back to the 19th century. In addition, the fact that the Bolivian population believe that economic liberalisation has not helped to reduce poverty also contributed to the public revolt. As a result of the protests, President Sanchez de Lozada was forced from power in October 2003.

A new administration called for a referendum on the country's hydrocarbon policy in July 2004. The referendum results supported government proposals that included higher taxes and government control over hydrocarbons production. However, President Mesa also had to resign recently (for a second time in 2005) in the midst of new national social protests that demanded the complete nationalisation of the energy sector and other reforms. The New Hydrocarbons Law, passed last May 2005, increases taxes and royalties on oil

42. World Energy Council, *supra* note 36, pp. 129-130.

and gas production up to 50%. This new law also makes mandatory the migration of existing contracts to the terms comprised in it. The private sector considers that a 32% tax on output at the wellhead plus a royalty of 18%, in conjunction with a mandatory migration of existing contracts, jeopardise future investment in Bolivia's hydrocarbons sector, and hence, the development of the country. Protesters continue to demand the complete nationalisation of the energy sector, which leaves open the possibility of a further deterioration of the investment environment in the future. Negotiations on the migration of contracts will start in August 2005 between the companies concerned and the Bolivian Administration. However, according to the new law, after six months the companies would be able to file for international arbitration.

At present, Bolivia exports gas to Brazil and Argentina, and also has plans to export to Paraguay. The country's hydrocarbons sector and economy are suffering the consequences of political instability and social unrest. Bolivia's status as a reliable supplier of gas is in question. However, it has been invited to take part in a new Southern-Cone Energy Ring Project. The response of Bolivia is still awaited. Currently, President Rodriguez, caretaker and former President of the Supreme Court, has called for general elections which will be held in December 2005.

## ARGENTINA

Argentina is the largest gas producer in Latin America[43], and had a leading role in energy reforms in the region in the 1990s. In 2004, however, Argentina experienced an energy crisis that forced it to restrict gas exports to Chile and to suspend power exports to Uruguay temporarily in order to secure energy supply for its domestic market. Gas and electricity shortages were caused by a lack of investment in the gas sector as a result of low prices, and by a drought that resulted in lost hydroelectric output. In addition, the country's economic and financial crisis, which started in 2001, has critically affected the energy sector. Recession, devaluation of the peso, and massive foreign debt hampered the ability of energy companies to invest in exploration and development. In 2004, Argentina suffered power cuts and energy rationing for the first time in a decade. In the midst of the energy crisis, President Kirchner launched a plan that called for the implementation of an investment programme to fund the expansion of the country's gas and electricity infrastructure and the creation of a new state-owned energy company (ENARSA). It also included measures regarding energy imports from Bolivia, Brazil and Venezuela. The country currently imports gas from Bolivia, and can

43. *IEA Energy Statistics of Non-OECD Countries,* 2005.

sustain emergency power from Brazil and fuel oil from Venezuela, as happened in 2004.

This year, measures to restrain energy demand have also been launched, repeating last year's plan. In addition, the Kirchner Administration has introduced new tax incentives and other measures to encourage investment in the upstream sector and to increase activity in areas where there is little or no exploration. The objective of this plan is to raise the production of oil and gas in the medium term. In the gas sector, shortages of resources have also occurred this year for the same reason – lack of investment. Argentina's electricity sector also desperately needs investment in transmission and generation to cover demand. An improvement on regulatory certainty, the renegotiation of existing public service contracts between the government and providers (in progress), and higher prices will determine the future of further investment in the gas and electricity sectors.

## PERU

Peruvian hydrocarbons upstream sector is completely liberalised. However, PETROPERU, the state-owned company, still owns the only oil pipeline and main refineries. The main objectives of the current government's oil and gas policy are fourfold: to boost oil production, to develop the Camisea Project, to promote regional energy integration, and to improve transparency and relations between the Administration and the indigenous communities. The Toledo Administration has reviewed the hydrocarbons legislation, seeking ways to promote exploration and boost production. Tax incentives and more flexible oil royalty rates were introduced in 2003 to promote the conclusion of more contracts. Two new formulas to calculate oil royalties were established: *i)* fixed royalties at a rate between 5% and 20% according to production level, and *ii)* a fixed 5% for the productive stage of the field; and, in a later stage and based on economic success, another variable rate. Companies will decide which formula to use when signing new contracts. This way, the government expects to make the development of small fields less expensive, and the conclusion of contracts less difficult, as it will not be necessary to negotiate royalty rates. According to the Ministry of Energy and Mines, this new flexible policy has been fruitful. The hydrocarbons sector has received investments amounting to USD 70 million in 2004, compared to USD 12 million in 2003. The conclusion of more than eight new exploration contracts is expected in 2005, compared to five in 2004 and only two in 2003 and 2002[44].

44. World Markets Research Centre, *Country Report: Peru,* pp. 1-14, World Market Research Centre website. (19 July 2005) - <http://www.wmrc.com>
45. Proinversión, Agencia de Promoción de la Inversión Privada – Gobierno Peruano, *Camisea Project,* Proinversión website. (4 August 2005) - <http://www.proinversion.gob.pe/english/pqinvertir/ejemplos/cont_2.htm>

After a decade of declining oil reserves and production that transformed Peru into a net importer of oil, prospects for the country's energy sector and economy have changed with the development of the Camisea Project, which is considered one of the most important non-associated gas fields in Latin America (13 tcf of gas and 660 million barrels of liquids)[45]. The Camisea Project would give Peru the chance to become the first country to export LNG from the Pacific coast, as there are plans to export LNG to the United States and Mexico from Camisea by 2008. Camisea gas deliveries to the capital Lima started in August 2004. The Camisea Project plays a central role in the country's economic growth plan in the long term.

As Bolivia is currently considered an unreliable supplier of gas, Peru, Chile, Brazil, Argentina and Uruguay have initiated negotiations and planning for the creation of an energy ring that would be supplied with Peruvian gas from Camisea. Under this project, gas will be pumped through a new pipeline from Peru to Chile, and then from Chile through existent and new pipelines to Argentina, Uruguay and Brazil.

## RUSSIA

Over the last year, the Yukos situation has focused attention on troubling signs within the Russian government and troubling trends within its energy sector. At one point during the year, it looked as if Gazprom would be the final owner of Yukos production unit Yuganskneftegas, (through the acquisition of Rosneft – since nullified) expanding state control to a substantial part of the country's oil reserves and production. Under this scenario, Gazprom would not only have been the largest supplier of gas to Europe but it would also have provided 13% of European net imports of oil. The opacity of the long process has not encouraged investor confidence. Many point to this as a major factor in the slow-down in the growth of oil production as well as economic growth in Russia over the past year. From a peak of 12% year-on-year (y-o-y) growth in mid-2003, Russian oil production growth declined slightly until mid-2004 to levels of about 10% y-o-y and thereafter dropped precipitously to a low of about 4% y-o-y growth in mid-2005 to 9.45 million barrels a day. Deceleration in investment across all sectors is a concern for the economy more generally. There are, however, some signs that the tide may be turning after the "*lost economic year*" of 2004. The Russian government forecasts GDP growth of 5.5% for 2005, a disappointment in the face of the goal to double GDP by 2010.

This comes at a time when Russia is facing major decisions and requires major investment in its upstream oil and gas sector as well as in its electricity sector. Timely development of Eastern Siberia is increasingly a focus across all relevant ministries, Gazprom, Transneft and Russian and foreign investors. Yet given the events of the last year – with the Yukos case omnipresent and through it, the State's tightening grip on production and exports, after the *laissez-faire* privatisation of the early 1990s – there is reason for concern that investments will not keep pace with the exploration and production challenges ahead. The fiscal and regulatory systems are still unclear and can in no way attract or sustain the needed investment levels – especially in frontier areas with no infrastructure. Increases in 2005 oil production and export taxes, uncertainty over the soon-to-be enacted subsoil law, the recent clamp-down on transfer pricing and greater enforcement of compliance with existing production licences are all areas for concern. Until these measures are clarified, Russian producers may indeed curb investment with a consequent slow-down in production growth.

During 2004-2005, which saw the painful unfolding of Yukos' fate, major equity acquisitions were made by international oil companies. It is possible to speculate about the level of acquisitions and direct investments which might otherwise have been made – but this will never be known. Although such actions were part of longer-term initiatives begun over the last decade, these actions run counter to logic, as they would seem to fly in the face of several bad blows to the Russian investment climate. While we hear the foreign investment community welcoming the clarity emerging with each official announcement from Moscow and the denouement of the Yukos situation, their attitude is clearly driven by their interest to stay on good terms with the State and its monopolies in order to enhance their ability to gain access to the new licences to be tendered soon. There is a risk, however, that these positive signals from the private sector will undermine reform proponents' efforts to challenge the State in its apparent resolve to reassert itself in this sector through Gazprom and Transneft, at a time when major investments are needed in exploration and greenfield development and pipeline infrastructure.

Relatively new to the equation is the strong interest of Asian States' oil companies, such as India's Oil and Natural Gas Corporation (ONGC) and China National Petroleum Corporation (CNPC), to buy into equity positions in the Russian oil and gas sector. Clearly Russia has every reason to be receptive to these new players – given its geopolitical interests. It is also probably reasonable to speculate that this new interest by Asian States' companies could serve to erode or at least delay the incentive for market reform, competition and transparency in Russia being pressed by internal Russian reformers and Western interests. Western arguments that foreign direct investment will not flow without reform is put into question both by Western companies' expressions of optimism and by the arrival of new Asian suitors.

It is obvious that growing European imports of Russian oil and gas are counter-balanced by Russian reliance on oil and gas revenues. It is just as obvious that over time both sides of this delicate balance would be better served by market reforms within the Russian energy sector that would ensure timely investments and diversity of suppliers. The only way forward for an energy-secure future for both Russia and OECD Europe is through meaningful market reform and real competition across Eurasian markets. In the interim, public policy-makers need to be more alert to the market power of Russian state monopolies that have already demonstrated both commercial and sovereign risk.

## OIL SECTOR

After five years as the centrepiece of growth in non-OPEC oil, the outlook for Russian oil production growth is dimming, as investors become wary and as medium-term export capacity constraints loom. Transneft has effectively blocked any private effort since the Caspian Pipeline Consortium to add export capacity. Although it has been increasing export potential in line with production growth over the past five years, private oil companies complain that the new capacity is not in the right places – and because of their desire to diversify export markets. The increasing spread between Brent and Russian Urals blend reflects this growing concern by Russian majors. The final decisions to build a new export pipeline to the East (Taishet-Skovorodino with rail to Perevozhnaya) as well as a possible Northern line to Murmansk or Indiga, raise a subsequent question related to the need to increase production in the frontier territories of East Siberia.

In June 2004, the Russian Ministry of Economic Development and Trade forecast a sharp slow-down in Russia's oil output growth over 2003-2007, saying that the year-on-year increase could grind to an almost complete halt at 9.5 million barrels a day in 2007. This compares to the IEA's mid-term outlook for oil production to continue to grow at a slower pace than in the last five years, to 10.4 million barrels a day in 2010 (*World Energy Outlook,* 2004). The problems the MEDT points to reinforce the concerns IEA has raised over the last few years about the need for more exploration and new production (as opposed to enhancing existing production) and the need for regulatory and fiscal reform, including a more performance-based licensing regime and progressive taxation on resource production to enhance the investment environment.

In early February 2005, the Russian Ministry of Natural Resources (MNR) released its plans to auction 39 licences in East Siberia in 2005 including the Chayandinsky field, coveted by Gazprom. This field alone holds an estimated 360 million barrels of oil and 1.2 tcm of natural gas, out of the total proven reserves encompassed in the licences the MNR plans to issue in 2005 in the order of 128 million tonnes of oil and 1.7 tcm of natural gas. Yet licences planned for auction in 2006 are significantly smaller, while those planned for 2007 and beyond include areas where very little exploration has been undertaken to date. The MNR is proposing therefore to use federal government budget to support exploration work in these areas.

The MNR is linking these tenders to the construction of the Eastern pipeline – in an effort to increase their value and investor interest and given its view that major exploration investments are needed if the pipelines are to be filled. There are three scenarios for the Taishet-Nahodka pipeline with a possible spur line to

China (30, 50 and 80 Mt/year) as well as various proposals for its staged construction combined with expansion of rail lines for export. In a meeting between the Minister of MNR and President Putin at the beginning of February 2005, Minister Trutnev made it clear to the President that if the Taishet-Nahodka pipeline was to be rated at 80 million tonnes/year capacity, then there may not be enough oil to fill it and oil from neighbouring regions would be needed. The Minister estimated that a production level of 37 million tonnes/year would be possible by 2011 and that a level of 50 million tonnes/year was possible by 2016. Obviously this would demand substantially greater investment. To get to 80 million tonnes/year would not be possible in the medium term so the remaining 30 million tonnes/year would need to come from Yakutiya and Krasnoyarsk Krai, but as yet no licences for these two regions are included in the packet of licences to be auctioned off later this year or next.

Investment estimates by the MNR for exploration needs for East Siberia alone are on the order of USD 13 to 16 billion to 2020, or about USD 1 billion/year. This compares to current government-funded exploration investments for all oil, natural gas and precious metals of USD 28 million/year. Lukoil's 2003 exploration investments were on the order of USD 260 million[46], although no significant portion was directed to East Siberia. The *Journal of the Far East* estimates that only 4% of exploration investments are focused in East Siberia and the Far East[47].

Meanwhile, Lukoil is promoting construction of new export infrastructure in the north-west of Russia. The construction of the Vysotsk trans-shipment terminal by Lukoil is the only project envisaging oil deliveries to the US (with funding backed by the Overseas Private Investment Corporation). It will have a flow capacity of 240 000 barrels/day. It will not, however, solve the problem of large-scale oil deliveries. Last year, Lukoil and ConocoPhillips entered into a strategic alliance aimed, in particular, at organising a joint venture for developing the northern part of the Timan Pechora oil and gas province. The proven oil reserves in this region exceed 3 billion barrels. Although Transneft is firmly opposed to the Surgut-Murmansk project, it may support a truncated version, a 500 000 barrel/day pipeline running from Kharyaga to Indiga on the White Sea, which would help Lukoil ship new volumes out of Timan Pechora.

46. See Lukoil Annual Report 2003, page 16 at www.lukoil.com/materials/doc/2003/AR%202003%20ENG.pdf
47. See http://www.russiancouncil.org/reports/russian_far_east_federal_distric.htm

## NATURAL GAS SECTOR

Russia produced 633.5 bcm of natural gas in 2004, 85.7% of which by Gazprom. An estimated one-third of the world's natural gas reserves remain in Russia's super-giant fields and in smaller fields adjacent to the super-giants. In 2004, Gazprom, holding 60% of Russia's reserves, recognised that to maintain its position as a key gas supplier, it would need to focus increasingly on reserve replacement and exploration. The major problem Gazprom faces today is the decline of the three jewels in its current production portfolio – the Medvezhe, Urengoye and Yamburg – which together account for about three-quarters of Gazprom's production. Zapolyarnoye – which reached its peak plateau of 100 bcm/year in 2005 – is expected to match the decline at other fields for the next 3-4 years. It is considered the last relatively cheap gas in Russia. The Russian Energy Strategy presents estimates for development of the Yamal fields on the order of USD 30/thousand cubic metre which does not include investments needed for the related new transportation infrastructure this project will demand.

There is a tendency for Gazprom to focus attention on mega-projects with demanding engineering requirements and mega investment needs. In recent years Gazprom has undertaken large-scale infrastructure projects which do not seem to meet a commercial test for viability and which have required government support to be realised. The Blue Stream project under the Black Sea bypassing potentially difficult transit States is a case in point. This project needed major Russian government tax exemptions to make the project viable and gain support from suppliers. It is clear from its current utilisation that it was built virtually without firm demand for the gas.

Development of Yamal as well as the fields in East Siberia and the Far East will all require tens of billions of dollars in investments to develop the fields and more billions in new infrastructure to link these green fields to existing pipelines or consumers. It is widely expected that Gazprom will require substantial government support through various tax exemptions if Yamal is to be realised. It is not at all clear whether this is the best use of government funds, especially given the growing number of non-Gazprom gas producers and foreign investors who would be happy to bring in substantial capital if only there were more competition allowed in the upstream sector through reliable and more transparent access to the gas transportation network controlled by Gazprom. Third-party access has improved since 1998 when only six *independent* organisations (28.2 bcm) gained access. By 2000, 20 independent organisations with volumes of 106.2 bcm were allowed access and this number has grown slightly to reach 39 organisations and volumes of 112 bcm of natural gas in 2004. However, much of this gain in access over the past few years reflects the long-term contracts Gazprom has signed to buy associated gas production of Lukoil (in 2003) and to import natural gas from Turkmenistan. In mid-2005, Gazprom signed a long-term agreement of partnership with Novatek, the largest of the independent gas producers.

Given the growing number of non-Gazprom gas producers of both associated and non-associated gas and the efficiency gains possible from more competition in Russia's upstream sector, it is not clear that Gazprom's mega-project approach will produce the *most efficiently priced gas.* The Blue Stream project bypassing transit States is a case in point. The North European Gas Pipeline (NEGP) is yet another – an alternative pipeline – but one which would bring even more excess capacity than already provided by Blue Stream. Ultimately, consumers will pay the higher price for a pipeline built before its time – as will the shareholders of the companies involved.

By "energy security", the IEA Secretariat is not suggesting there is not enough gas or that the taps will be turned off any time soon. But the incident in Belarus in 2004 – where Gazprom shut off gas to force *negotiations* to increase Gazprom control in the transit joint venture – showed just how aggressive Gazprom can be and the extent of policy latitude conferred on it by the Russian government. Gazprom has taken similar actions in Georgia, Armenia and during the Balkan crises, sometimes reflecting Russian security interests as much or more than its commercial objectives. It has been demonstrated that doing business with Gazprom bears not only the commercial risk of an unregulated monopolist, but some degree of sovereign risk of an entity responsive to the State. These concerns are all the more relevant with the May 2004 EU enlargement, given in some cases the much less mature gas and electricity markets of accession countries. This is all the more disconcerting in view of the dominant position Gazprom holds in some of these countries, both in terms of a gas supplier and its increasing hold of the downstream (transmission and distribution) gas sectors of some of these economies.

This on its own is troubling enough. Add to this the concern that Gazprom and through it the Russian State may have bitten off more than it can chew – development of the oil and gas resources of East Siberia, catch-up in the LNG race through Shtokman, refurbishment of Central Asian pipeline systems and fields, expansion across energy sectors in Russia (including oil and electricity), expansion downstream in Eastern and Central Europe – not to mention the added weight on the State of its other monopoly, Transneft, and the building of oil pipelines East and/or North (at a time when increased state control has raised political risk and worsened the investment climate already reflected by lower oil production growth rates over 2005), one is left with an unsettled vision of the future, to say the least.

## ELECTRICITY SECTOR

The Russian government has embarked on a highly ambitious programme of electricity reform moving into its active phase in spring 2003. Although there have been certain set-backs since that time, the government's reaffirmed commitment to the electricity reform process in late 2004 reflected a recognition among Russian policy-makers that attracting timely and appropriate investment will remain a substantial and ongoing challenge, which can most effectively be addressed through the creation of efficient electricity markets operating in response to genuine price signals, within a robust and predictable legal and regulatory framework. Only such markets, in which competition is based on transparent prices that accurately reflect costs, can deliver the efficient, reliable and internationally competitive performance needed to meet the government's economic targets in the longer term. Such markets can attract the new investment that the industry will need, especially in order to ensure security of electricity supply beyond 2010.

Russia's costly experience in privatising its oil sector over the early 1990s should provide a sharp reminder of the potential dangers of this process. A key to the success of competitive markets in electricity and eventually other parts of Russia's energy sector will be strong, well-resourced, well-trained and independent regulators that can rise to the challenge of establishing access to network and other monopoly products and services on fair and reasonable terms for all market players. The IEA is concerned about the lack of resources and independence of Russian regulatory bodies, given the critical role they will need to play to ensure against market power abuses in the face of powerful vested interests and dominant players such as Gazprom.

The recognition by the Russian government that tariff rebalancing and especially the removal of cross-subsidies is a necessary precondition for the successful introduction of market reforms, is reassuring. Cost-reflectivity has been recognised as a principal objective of the reforms. The regime of vesting contracts now proposed for all users provides a means for dealing with this critical issue while at the same time allowing competitive wholesale and retail markets to be progressively introduced over the remainder of the decade. In its book *Russian Electricity Reform: Emerging Challenges and Opportunities* (IEA, 2005), the IEA commends the Russian government's plan to use this period to gradually raise regulated end-user tariffs to levels consistent with the delivered price of electricity sourced through the competitive wholesale and retail markets. Such rebalancing would allow customer choice to be extended progressively through the life of the vesting arrangements and ultimately to all users at the end of the vesting contract period if desired. The public backlash against monetisation of certain public services in early 2005 demonstrates the importance of getting this balance right. Although the proposal is likely to extend the transitional period, it has the potential to provide greater stability, certainty and public acceptance to the implementation process, which would help to enhance the likelihood of the reform being fully and successfully implemented.

## ENERGY EFFICIENCY AND THE ENVIRONMENT

Russia plays an important role in global greenhouse gas emissions as the third-largest contributor to global energy-related $CO_2$ emissions. With Russia's ratification of the Kyoto Protocol at the end of 2004 and the subsequent entry into force of the Protocol in February 2005, Russia has the potential to play a key role in global greenhouse gas (GHG) markets as well. Through the market mechanisms created under the Kyoto Protocol (*e.g.* emissions trading and Joint Implementation), Russia may be in a position to be able to attract greater foreign investments in its economy and to reduce GHG emissions at the same time. This is very much in the interest of the Russian government. In addition to working on meeting the institutional requirements to participate effectively in the Kyoto Protocol's flexible mechanisms, Russian officials are also developing their participation strategy. They are aware that the reluctance of many Parties to purchase Russia's "surplus" assigned amount units would be seen as not contributing to the global environment.

# UKRAINE

In the past year, because of the events surrounding the 2004 presidential elections, Ukraine has probably attracted the most attention from the rest of the world since the disaster at Chernobyl in April 1986. Ukraine has unique importance because of its role as a link between Russia and Europe, and its position as the world's largest gas transit nation.

Ukraine is highly dependent on energy and raw material imports. The vast majority of its energy comes from or through Russia, which has created significant security of supply concerns in Ukraine. In addition, Ukraine is one of the most energy-intensive industrialised countries in the world, with an energy intensity several times that of the OECD average.

In 2000, after almost a decade of decline, in which output dropped by almost 60%, GDP began to rise again and has increased by an impressive 48% in the past five years. GDP growth in 2004 was over 12% and in 2003 was 9.4%. Energy consumption has remained flat in recent years as the economy has grown more efficient.

The fuels used to produce energy in Ukraine have changed significantly since Ukraine's independence in 1991. The share of natural gas in Ukraine's TPES has increased from 36% to 47% from 1990 to 2002, and nuclear's share has doubled to 16% (and is set to increase still more), while coal and oil have decreased respectively from 32% to 25% and from 24% to 12%.

Ukraine's energy security depends to a large extent on its relationship with Russia. Ukraine is reliant on imports for more than 75% of its gas needs and almost 90% of its oil demand. Ukraine is also integral to Europe's energy security since approximately 84% of Russian gas exports to Europe are routed through Ukraine. The interdependence of Russia and Ukraine has brought about a certain stability in gas transit arrangements. However, it has also caused political discomfort and has pushed both Russia and Ukraine to try to diversify and reduce this dependence.

## RECENT POLITICAL DEVELOPMENTS

Politically, 2004 was a momentous year for Ukraine. Voting fraud brought millions of protesters to the streets. The so-called "Orange Revolution" culminated in a new round of presidential elections that brought reformist President Yushchenko to power. He appointed Yulia Tymoshenko, a former gas company CEO, as his Prime Minister. The new government's main goals include economic growth and reform, European integration and a reduction in corruption.

In the energy sector specifically, the government has made energy diversification and security its top priority. It is also considering wide reforms in many parts of the energy sector and energy prices have been rising, both at the border and at the consumer level. The government has been working actively to develop a new Energy Strategy. Early drafts of this strategy indicate that the government would like to find new sources of gas supply (the Ukrainian leadership has met with the governments of Iran and Turkmenistan, though the feasibility of building new pipelines from these countries remains limited in the medium term). The government would also like to increase production of coal and nuclear energy and build nuclear processing facilities in Ukraine. These ideas are preliminary, as the economics and mechanisms for implementing them have not yet been fully assessed.

Ukraine has seen many important developments this year in oil and gas. The government replaced the senior management of the state oil and gas company Naftohaz Ukrainy and most of its subsidiaries. It has decided to develop 90 days of strategic oil stocks, though it must still decide how to fund and organise the stocks. Yushchenko announced that Ukraine will re-reverse the Odesa-Brody pipeline to transport Caspian oil North instead of Russian oil South. However, filling Odesa-Brody in the northward direction requires many new transit contracts and will ultimately require substantial new investment to extend the pipeline to major markets. The country also experienced a major short-term disruption of oil products in May 2005. This was probably caused by price caps negotiated with the major Russian oil companies (which own most Ukrainian refineries). When the price of oil products was allowed to float again, the crisis subsided, though the higher prices are creating inflationary pressures and seem also to be having an impact on economic growth.

Ukraine has also experienced significant problems with gas supply in 2005. Turkmenistan demanded a 32% increase in the price of natural gas sold to

Ukraine's Naftohaz Ukrainy and temporarily halted supplies until Naftohaz Ukrainy agreed to the higher price. Then later in the year, Gazprom demanded an effective doubling of the price of gas it sells to Ukraine in exchange for transit services, despite an existing supply contract with Ukraine. Gazprom also complained that several billion cubic metres of gas had disappeared from Ukrainian gas storage, and though Naftohaz Ukrainy later proved this was not true, Gazprom is demanding that Ukraine now purchase the stored gas at a higher price than that in the current contract. Ukrainian officials are extremely worried about the economic impact of doubling the price of natural gas overnight. Naftohaz Ukrainy management has also struggled for much of 2005 to secure contracts for supply of gas to Ukraine this year, diverting attention from needed reforms. Moreover, the International Gas Consortium set-up with Gazprom to invest in Ukrainian gas transit assets seems to have virtually collapsed. President Yushchenko has spoken of the need to attract a broader spectrum of Western investment in the Ukrainian gas transit sector, without privatising it. The government has also devoted significant attention to the idea of finding new sources of gas.

Ukraine is considering several options for reforming the electricity sector. The sector is already unbundled and partially privatised, but non-payment problems have made the existing electricity market (Enerhorynok) inefficient and debt-laden. Reforms are likely to reduce the government's role in allocating fuel, dispatching power plants and setting prices, giving the regulator and grid operator more effective independence. Likewise, the market is likely to move towards bilateral contracts in place of a wholesale market, and the government plans to restart the privatisation of distribution companies. Ukraine's state nuclear power company, Enerhoatom, launched two new nuclear reactors in 2004 (Khmenitsky-2 and Rivne-4) to decrease Ukraine's reliance on thermal power plants. This also allowed Enerhoatom to temporarily increase power exports to Russia. The new reactors have been shut down numerous times because of operational and safety problems, and recently Russia stopped importing power when Ukraine raised the price. The government also decided in July 2005 to begin engineering work to build two additional reactors at Khmelnitsky.

The coal industry is probably the most economically troubled in Ukraine's energy sector: most of the mines are over 40 years old and are among the deepest, most dangerous and inefficient in the world. Ukraine is continuing its programme to shut down unprofitable mines, but the government still provides significant subsidies to the heavily-indebted sector, mainly in the form of capital investments and financing for mine closures. And although miner retraining and job placement programmes exist, they have not been as successful as hoped, in part due to lack of funding. The government plans to consolidate the remaining mines and continue to privatise them. Coal production has remained roughly stable in recent years, after several decades of decline, so the restructuring programme, while incurring a high social cost, does seem to be bearing some fruit.

District heating accounts for nearly 20% of total Ukrainian energy use and provides heat and hot water to over 65% of Ukrainians. In recent years, some progress has been made in improving efficiency in the sector and installing heat and water meters. However, the national programme aiming to install meters in the housing sector is not being fully implemented. Ukraine has recently adopted a number of laws that relate to district heating: the Law on Housing and Communal Services (June 2004), the Law on Combined Heat and Power and Waste Energy Potential (April 2005) and the Heat Supply Law (June 2005). The current legislation seeks to introduce market mechanisms to attract investment in the sector and to deal with non-payment.

The new government also plans to further improve energy efficiency; however, it recently abolished the State Committee on Energy Conservation as part of an effort to reduce the number of committees. At the same time, private investments in energy efficiency continue to grow, particularly in industry. Ukraine has several energy service companies which invest in energy efficiency at customer facilities. A more concerted effort to implement energy efficiency policies – such as standards and labelling, raising energy prices and reducing energy subsidies – could further benefit the country's efficiency and reduce reliance on energy imports.

## CENTRAL ASIA AND CASPIAN SEA

The production potential of the Newly Independent States of Central Asia and the Caspian Sea is of considerable importance to energy-consuming countries. The region itself depends on its mineral wealth to strengthen its newly found independence with foreign investment and economic growth. To the West, the region looks out to the energy-consuming markets of Europe and North America that face declining production in the Mexican Gulf and North Sea. The Caspian and Central Asian region allows these demand markets to diversify imports from dominant supply sources and market cartels. This safeguards a reliable and competitive functioning of world energy markets generally. To the East, the Chinese and Indian economies are rapidly becoming more import-dependent too. Their indigenous resource base is in decline while the growing momentum of industrial development makes consumption of hydrocarbons more welfare-driven. The demand for oil in the automotive sector and gas to produce electricity for expanding installation of energy-consuming goods is set to increase. The investment transferred from IEA member countries spearheaded by American, Anglo-Dutch, French and Japanese private-sector initiative, is followed upon its heels by that of National Oil and Gas Companies from China, India and other Eastern suitors that step in through state-driven initiatives in the hope of gaining further access to the Caspian and Central Asian region. This helps them to ease somewhat their dependence on sea-bound imports from the Middle East. International competition for access to the mineral wealth of Central Asia and the Caspian Sea region raises the potential for its economic recovery and growth. The significance of this landlocked region lies in its central location between energy demand centres in the East and West. Yet the upstream asset value still depends on how these resources are transported to international markets that largely depend on land-bound routes.

In 2005, Central Asia and the South Caucasus made significant progress in the realisation of west-bound oil exports through the Baku Tbilisi Ceyhan oil pipeline (BTC). Line fill from the Azeri Chirag Guneshli field commenced on 25 May this year. Some project partners in the consortium developing the Kashagan field in the Kazakh sector of the Caspian Sea have also taken a share in the BTC pipeline. This is to secure rights to capacity for the transport of their production from Kashagan. The Mediterranean port of Ceyhan already provides an important outlet for crude oil supplied from Kirkuk and other fields in the Middle East. The recent commitment given by President Nazarbayev at the line fill ceremony in Baku to allow production from the Kashagan field to be transported via BTC further interconnects rapidly emerging Caspian oil terminals in and around Atyrau, Aktau and Kurik in Kazakhstan, Machakala and along the Volga Don river in Russia, Baku in Azerbaijan, Turkmenbashi in Turkmenistan and Neka in Iran. Tanker traffic, port depth and loading and unloading facilities as well as storage are being rationalised and upgraded, including offshore pipelines. Together with oil production from the major Azeri Chirag Gunashli field and ultimately Kashagan, the BTC opens an important new market window on the East Mediterranean for Caspian producers to supply world markets with an additional 1 to 1.2 million barrels a day of light sweet crude by 2010. Apart from bringing relief to tight oil markets, the BTC assists Caspian producers to diversify export options and counterbalance the market dominance of regional export

Table 16

**The Central Asian and Caspian Sea Production Potential: Proven and Probable Estimates**

(Oil and gas expressed in thousand barrels and billion cubic metres per year compiled from various sources)

| | *2001* | | *2005* | | *2010* | |
|---|---|---|---|---|---|---|
| | *Oil* | *Gas* | *Oil* | *Gas* | *Oil* | *Gas* |
| Azerbaijan | 309 | 5.6 | 628 | 9 | 1 200 | 60 |
| Iran | 0 | 0 | 0 | 0 | - | - |
| Kazakhstan | 798 | 9 | 1 200 | 14.6 | 2 200 | 28.1 |
| Russia | 100 | 0 | 140 | - | 320 | - |
| Turkmenistan | 164 | 51 | 200 | 60 | 120 | 120 |
| Uzbekistan | 140 | 28 | 117 | 30.1 | 125- | 50 |
| **Total** | **1511** | **93.6** | **2285** | **113.7** | **3965** | **258.1** |

monopolies while alleviating congested and environmentally sensitive areas such as the Bosporus and Dardanelle straits or the Aegean, Black and Baltic Seas.

The Baku Supsa oil pipeline and the Caspian Pipeline Consortium (CPC) already operate outlets on the eastern Black Sea coast in Supsa, Georgia, since 1999 and via terminals near Novorossisk in Russia since 2001. These outlets were financed and constructed through strategic public-private partnerships between host governments and international oil and gas companies. They replace transport of early oil by rail car from major new oil deposits such as the Tengiz field in north-west Kazakhstan with dedicated cross-border infrastructure to accommodate increasing volumes from full field development. As new pipelines come on line, they will free up capacity in earlier built infrastructure and provide additional market flexibility for oil supplied from other new and existing Caspian fields to reach world markets on competitive terms. With BTC on schedule to load its first tanker at the Turkish port of Ceyhan by the end of 2005, this first generation of independent oil pipelines has aligned Caspian oil exports more efficiently with the new open market realities that emerged after the collapse of the Soviet Union. Market competition between pipelines and other export options is beginning to take effect. How much of the volume of Kashagan and other North Caspian fields will be captured by BTC, how much by CPC or Transneft? This puts downward pressure on the cost of transporting Caspian oil to international markets. In this west-bound perspective the Caspian region is establishing itself in a transparent and stable international environment for energy investment and trade. More remains to be done, notably to integrate the South Caspian trade and to mobilise investment in the newly independent States of the wider Caspian Sea region.

Further downstream, a next generation of infrastructure is being considered to deal with increasing Caspian and Russian oil flows shipped from new terminals and upgraded terminals on the north-eastern Black Sea west across the Black Sea. These volumes compete for access to European markets through increasingly congested and environmentally sensitive routes to the East Mediterranean and North Sea from where world markets can be reached. New plans for a Samsun-Ceyhan bypass across Turkey, a revitalisation of the Burgos-Alexandropolis bypass from Bulgaria to Greece, the Burgos-Durres bypass from Bulgaria through Macedonia to the Albanian coast (AMBO), and finally the Constanta-Trieste bypass from the Black Sea coast of Romania through Hungary and Slovenia to the Aegean Sea coast of Italy are indicators that Caspian oil is successfully making its way to tightly supplied world markets. Kazakhstan's oil output will increase threefold over the coming decades much faster then overall GDP. Though oil output from Azerbaijan will not be of the same magnitude, full-field development from the Azeri Chirag Gunashli field further exposes fragile economic stability to already volatile oil markets enduring upward oil price pressure. This risks a loss of competitiveness in non-oil-manufacturing and service sectors due to appreciation of the local currency: "Dutch Disease". Robust and fairly successful fiscal policies and monetary discipline will continue to insulate Azerbaijan and Kazakhstan from this and other manifestations of the "resource" curse. This includes national development funds (Oil Funds) into which excess tax revenue is transferred for use in times of budget shortfalls or for long-term investment programmes for the public benefit. As recently as June 2005, Kazakhstan signalled its political commitment to transparent and accountable revenue management by joining the Extractive Industries Transparency Initiative (EITI). Azerbaijan and Kyrgyzstan are among the other countries from Central Asia and the South Caucasus that have joined this important initiative. This strengthens public and private sector accountability in the interest of sustainable macroeconomic development of resource-rich developing economies.

Ongoing efforts continue to expand the complementary capacity and competitive market options that independent pipelines provide to existing oil and gas export routes. This is to ensure that the rising export potential of Azerbaijan, Kazakhstan, Turkmenistan and the Russian sector of the Caspian Sea can find its way to world markets along transparent, equitable and reliably functioning export routes. Major new field discoveries such as the Azeri Chirag Gunashli, Shakh Daniz, Tengiz, Karachaganak, Kashagan, and other likely hydrocarbon deposits of the Caspian Sea basin contrast with the Soviet past when the Caspian offshore was left largely undeveloped in favour of onshore exploration and development in Russia. The "Kurmangazi" block, for which a licence was recently awarded under a Russian Kazakh joint development agreement, may prove to hold considerable volumes. Still, after one-and-a-half decades of development, the difficulty with which capacity expansion plans for the Caspian Pipeline Consortium are agreed and a controversial reversal of the initially idle Odessa Brodi crude oil pipeline in Ukraine indicate some loss in momentum for the further development of west-bound export routes.

The considerable gas export potential from the Caspian region of which Turkmenistan holds the world's fourth-largest natural reserves remains captive to the expanding market dominance of Gazprom. Nebulous trade and investment practices obscure, if not deter, rational investment and trade policies for gas sector development in the wider Caspian area. This places obstacles in the way of sustainable market integration in Eurasian gas markets generally. Uncertainty created by asymmetric policies for Eurasian gas market design have a chilling effect on mobilising capital and technology for both resource and infrastructure development. Liberal West European gas markets geared towards opening of gas markets to competition collide with dynamics in East European gas markets created by monopolist preferences for market dominance and closure to new market entrants. This poses growing risks to security of gas supply for both gas producer and consumer markets. Increasing geological risks to effective investment in reserve replacement and infrastructure, as well as the need for more transparent and reliable reserve accounting standards, sharpen commercial risks in terms of price exposure for consumers and more onerous market entry conditions for companies.

Policy shifts in fiscal and legal terms and energy sector regulation by Caspian host States are symptomatic of changing attitudes towards international oil and gas companies from OECD countries and are indicative of newly emerging macroeconomic challenges. As a consequence, Russia is reasserting itself both in terms of its hydrocarbon production potential and in terms of the oil and gas that is shipped through its network monopolies. Production schedules from Tengiz and other fields in Kazakhstan have suffered delays over debates on transport tariffs and other terms for capacity expansion, investment and trade on crude quality differentials. The Odessa Brodi pipeline exports Russian crude to a terminal near Odessa on the Black Sea coast instead of providing the market entry point for Caspian crude shipments to Central European refinery centres and terminals in accordance with its original design.

With the turn of the millennium, state-driven companies seem to have taken the lead in securing new exploration and production rights from the publicly listed international oil and gas companies and independents that fuelled economic development in the Caspian Sea region from the early 1990s. National oil and gas companies and other state enterprises that are venturing outside their national domains have more flexibility to compensate for terms that OECD incorporated companies find commercially prohibitive or in conflict with the business standards and practices that shareholders and oversight agencies require them to abide by when investing overseas. This trend is amplified by market volatility on global oil and other commodity markets and has prompted a revival of state interventionist and protectionist policies in most energy markets to which the Caspian forms no exception. This global trend risks disrupting the level playing field between IEA member and non-member companies. It exposes Caspian host governments to risks of inefficient allocation of capital that is based on political convenience rather then rational energy policies, or inducing investors to react to price signals – that are not in short supply – on the basis of tested market disciplines.

Central Asian States have launched important new initiatives for the development of an east-bound perspective to further establish themselves in international energy investment and trade flows. To balance the market dominance of transport monopolies and diversify foreign investment, Central Asian host governments have concluded significant inter-state investment, and trade agreements with China and launched diplomatic initiatives with India that no doubt will be reflected in forthcoming agreements. Construction of a new oil export route from Atasu in Kazakhstan to Alashankou in north-west China links Kazakhstan, and potentially Russia through Pavlodar, with refinery centres in Urumqi, China. This pipeline will transport about 600 thousand barrels per day and is due to be completed by the end of the year. It will be the first export pipeline to feed directly into rapidly rising Chinese oil demand. Like the Baku-Supsa pipeline it will help to replace inefficient and costly oil transport by rail car to Chinese markets from Kazakhstan as well as Russia. A study was recently launched for a northern as well as a southern variant for east-bound gas shipments from north Caspian production centres in Kazakhstan to Astana and Almaty, that still depend on gas imports from Russia, onwards to Lunnan in China. China recently signed contracts with Uzbekistan for Sinopec to develop oilfields in the Andijon and Namagan provinces in eastern Uzbekistan and provides soft loans for Uzbekistan to upgrade its Soviet-built gas network.

## CENTRAL AND SOUTH-EASTERN EUROPE

Membership in the European Union (EU) has dominated the energy scene of the eight new member countries[48] (EU-8) since May 2004. Existing directives, for example on energy security, nuclear safety, Internal Energy Market (IEM) and the recent Emissions Trading Scheme (ETS), now apply. EU-8 also takes part in the elaboration process of EU energy policy and legislation.

EU-8 plays an important transit role, as 27% of EU-15 natural gas supply and about 10% of its crude oil supply transit this area from the Commonwealth of Independent States (CIS). The area depends much more on Russian oil, gas and nuclear supplies but some of the eight countries have diversified their import sources and routes as well as their fuel mix, and reduced their energy intensity. Nevertheless, except for the Czech Republic and Hungary, the EU-8 countries' oil security systems (stockpiling and emergency plans) do not yet comply with EU and IEA standards[49]. Poland and the Slovak Republic, however, have stepped up their efforts in this respect.

Increasing hydrocarbon prices, combined with an energy intensity twice the OECD Europe average, inflates energy expenses for households (10-20% of incomes) and businesses. But EU-8 governmental policies for energy efficiency have not yet sufficiently developed to tap into the abundant energy efficiency potential.

Market reforms have continued both domestically and regionally with the new objective to develop regional electricity and gas markets in Central Europe and the Baltic as they increasingly conform to the IEM. Harmonisation and convergence of regulation, notably fair cross-border access to networks and customers, are crucial to overcoming the constraints of traditional dominant vertically integrated companies, overly rigid long-term contracts, baseload overcapacity and persistent price distortions.

In addition, the rapid extension since 2003 of offshore energy trading companies in Central and South Europe have raised the issues of transparency and fair competition. For example, Eural Trans Gas (ETG), and, since 2005, RosUkrEnergo (RUE) have re-exported to the EU gas volumes supposedly

48. The Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia.
49. IEA Emergency Preparedness web page (www.iea.org) and EU DG TREN security stocks (www.europa.eu.int/comm/energy/oil/stocks/index_en.htm)

derived from their management of Turkmen gas transit to Ukraine. Energy Financing Team Ltd (EFT) has continued to export electricity from the Balkans to Central and South Europe.

In 2005, the Polish government offered financial incentives to electricity generators to abandon their long-term purchase agreements (70% of sales) which are, together with insufficient unbundling of the power grid company, obstacles to an effective electricity market opening. Stock floatations have been chosen to privatise the oil company Lotos Group and the gas monopoly POGC (Polish Oil and Gas Company) Group. The completion of the gas pipeline Yamal 1 transiting Russian gas through Belarus and Poland to its planned capacity of 32 bcm should be effective in 2006. At the same time, Gazprom, with the support of German gas companies, announced its decision to build a bypass pipeline under the Baltic Sea despite its high costs (EUR 8-10 billion), non-confirmed sales, and available spare capacities in existing lines. Similarly, the Blue Stream gas pipeline that has linked Russia and Turkey since 2003, at a construction cost of EUR 3 billion, has remained little used.

In Slovakia[50], ambitious energy reforms have focused on the unbundling of monopoly activities in the gas sector and consolidation of the competitive structure of the electricity sector. In parallel, the privatisation programme has been pursued with the sale of 66% of Slovenské Elektrárne (SE), the main electricity generation company, for an amount of around EUR 2 billion to the Italian power company Enel. It is the first privatisation of nuclear assets in Continental Europe. Majority ownership in the three distribution companies will be transferred to existing owners (EON, EDF, RWE). Also, the government continues to prepare the decommissioning of nuclear and thermal electricity generating capacities (1.6 GW, or 20% of total or 40% of apparent surplus capacities) between 2005 and 2010.

Further to its major role in gas transit (83 bcm in 2004 or 18% of EU-15 gas supply), Slovakia operates the Druzbha oil pipeline and is involved in developing new Russian oil transit projects, including the DruzhbAdria to the port of Omisej in Croatia and the Bratislava-Vienna. However, the dismantling of Yukos in Russia, which is the reference shareholder of Transpetrol and initial crude supplier, as well as the non-compliance to Croat and Slovak environmental regulation have delayed investment decisions for these pipelines.

In South-East Europe, Bulgaria and Romania are preparing their EU membership, planned for 2007. The Bulgarian government has continued its ambitious energy reforms in line with its 2002 energy strategy. The sale of the three regional electricity distributors to strategic investors (EVN, EON, CEZ) for EUR 0.7 billion was finalised and important generation plants have been

50. The 2005 IEA Energy Policy Review of the Slovak Republic will be published at the end of 2005 or early 2006.

tendered. The government agreed with the EU to shut down two nuclear blocks at Kozloduy (880 MW) and plans to complete the nuclear plant of Belene (1 000 MW) for an estimated cost of EUR 2 billion. In Romania, the two gas distribution companies have been privatised to EON and GDF. Tenders have been launched for the sale of electricity distribution companies.

Croatia has continued its regulatory reforms and restructuring of the vertically integrated electricity and gas companies. A decision has been taken on the second phase of the privatisation of INA, the national oil company, which is already 25% owned by MOL of Hungary.

In contrast, in the Western Balkans, progress is still much slower in developing robust energy strategies, setting up reliable energy data systems and reinforcing institutional structures. Countries' and donors' efforts to create a "Regional Energy Market" have continued, taking the form of a draft treaty for the "Energy Community of South Eastern Europe" (ECSEE). This treaty provides the opportunity to foster crucial reforms in order to reach the market conditions required to effectively and transparently open the electricity markets at the domestic and then at the regional level.

The development of gas export routes from the Caspian and the Middle East through South-East Europe has made good progress. Parallel to the Baku-Tbilisi-Ceyhan (BTC) oil pipeline, which was inaugurated in June 2005, the South Caucasus Pipeline (SCP) will deliver gas to Turkey by the end of 2006. The Turkey-Greece interconnector should be operational by the end of 2006 and its extension to Italy is being studied. The second commercially supported project is the Nabucco Gas Pipeline between Turkey and Austria via Bulgaria, Romania and Hungary which targets South-Eastern, Central and Western European gas markets. Such diversification of European gas supply should increase security of supply, market efficiency and transparency.

## MIDDLE EAST AND NORTH AFRICA

The oil and gas resources of the Middle East and North Africa (MENA) will be critical to meeting the world's growing appetite for energy. The greater part of the world's remaining reserves lie in that region. They are relatively under-exploited and are sufficient to meet rising global demand for the next quarter century and beyond. The export revenues they would generate would help sustain the region's economic development. But there is considerable uncertainty about the pace at which investment in the region's upstream industry will occur, how quickly production capacity will expand and, given rising domestic energy needs, how much of the expected increase in supply will be available for export. The implications for both MENA producer and consuming countries are profound. The *World Energy Outlook 2005 – Middle East and North Africa Insight*s (WEO-2005) seeks to shed light on these very complex issues.

## World Energy Outlook 2005 – Middle East and North Africa Insights: Key Findings

**In the absence of new government policies, the world's energy needs will rise inexorably.** In the Reference Scenario, world primary energy demand is projected to expand by more than half between now and 2030, an average annual growth rate of 1.6%. By 2030, the world will be consuming 16.3 billion tonnes of oil equivalent – 5.5 billion toe more than today. More than two-thirds of the growth in world energy use will be in the developing countries, where economic and population growth are highest. The international energy prices that underpin these projections have been revised upwards from last year's *Outlook.* The average IEA crude oil import price is now assumed to ease to around USD 35 per barrel in 2010 (in year-2004 dollars) as new crude oil production and refining capacity come on stream. It is then assumed to rise slowly to USD 37 in 2020 and USD 39 in 2030. In nominal terms, the price will reach USD 65 in 2030.

**Fossil fuels will continue to dominate energy supplies, meeting more than 80% of the projected *increase* in primary energy demand.** Oil remains the single most important fuel, with two-thirds of the increase in oil use coming from the transport sector. Demand reaches 92 mb/d in 2010 and 115 mb/d in 2030. The lack of cost-effective substitutes for oil-based automotive fuels will make oil demand more rigid. Natural gas demand grows faster, driven mainly by power generation. It overtakes coal as the world's second-largest primary energy source around 2015. The share of coal in world primary demand falls a little, with demand growth concentrated in China and India. The share of nuclear power declines marginally, while that of hydropower remains broadly constant. The share of biomass declines slightly, as it is replaced with modern commercial fuels in developing countries. Other renewables, including geothermal, solar and wind energy, grow faster than any other energy source, but still account for only 2% of primary energy demand in 2030.

**The world's energy resources are adequate to meet the projected growth in energy demand in the Reference Scenario.** Global oil reserves today exceed the cumulative projected production between now and 2030, but reserves will need to be "proved up" in order to avoid a peak in production before the end of the projection period. Exploration will undoubtedly be stepped up to ensure this happens. The exact cost of finding and exploiting those resources over the coming decades is uncertain, but will certainly be substantial. Cumulative energy-sector investment needs are estimated at about USD 17 trillion (in year-2004 dollars) over 2004-2030, about half in developing countries. Financing the required investments in non-OECD countries is one of the biggest challenges posed by our energy-supply projections.

**The global oil-refining industry has an urgent need for more distillation and upgrading capacity.** As a result of strong growth in demand for refined products in recent years, spare capacity has been rapidly diminishing and flexibility has fallen even faster. Effective capacity today is almost fully utilised, so growing demand for refined products can only be met with additional capacity. Upgrading capacity will be needed even more than distillation capacity, since demand will continue to shift to lighter products, while crude oil production is becoming heavier, with a higher sulphur content.

**Rapidly expanding populations, steady economic growth and heavy subsidies will continue to drive up MENA energy demand.** In the Reference Scenario, demand is projected to grow on average by 2.9% per year between now and 2030. As a result, demand more than doubles. By 2030 the MENA region will account for 7.5% of global primary energy demand, two percentage points more than today. The biggest contributors to demand growth will be Saudi Arabia and Iran. These two countries will account for some 45% of MENA energy demand in 2030, about the same as today. The fastest *rate* of energy-demand growth will occur in Qatar.

**Most MENA countries will continue to rely almost exclusively on oil and natural gas to meet their energy needs.** Gas will overtake oil after 2020 as the region's main energy source for domestic use, thanks to policies aimed at freeing up oil for export. The use of other fuels increases, but together they account for less than 4% of primary energy demand in 2030 – hardly more than at present.

**Despite rapid growth in MENA energy use, per capita consumption projected for 2030 will still be barely half the current level in OECD countries.** Large discrepancies in per capita energy use among MENA countries will remain. In most of the Gulf countries, per capita *electricity* consumption will remain among the highest in the world – mainly the consequence of heavy price subsidies which lead to inefficient energy use and of the hot climate which necessitates considerable air-conditioning.

**The power and water sectors will absorb a growing share of the region's total primary energy use as electricity and desalinated water needs expand rapidly.** Heavy subsidies to both services are accentuating this trend. Gas-fired power plants, mostly using combined-cycle gas-turbine technology, will meet 71% of new generating-capacity needs. Water desalination, an energy-intensive process usually integrated with power production, will account for more than one-quarter of the increase in total fuel use in the power and water sector in Saudi Arabia, the United Arab Emirates, Kuwait, Qatar, Algeria and Libya combined.

**Output of oil and natural gas in the MENA region is poised for rapid expansion.** In the Reference Scenario, oil production (including natural gas liquids) is projected to rise from 29 mb/d in 2004 to 33 mb/d in 2010 and to 50 mb/d by 2030. In some countries, this may require opening up the upstream sector to foreign investment. The contribution of giant oilfields to total production will drop sharply, from 75% today to 40% in 2030, as mature giant fields decline and new developments focus more on smaller fields. Production in MENA countries, especially in the Middle East, increases more rapidly than elsewhere because their resources are greater and their production costs lower. Growth in aggregate production outside MENA is expected to slow over the *Outlook* period. Saudi Arabia, which has the largest proven reserves of oil in the world, will remain by far the largest supplier. Its output will rise from 10.4 mb/d in 2004 to 11.9 mb/d in 2010 and just over 18 mb/d in 2030. Iraq is expected to see the fastest rate of production growth, and the biggest increase in volume terms after Saudi Arabia. In some countries, including Iraq, increased production will hinge on large-scale foreign investment.

**On this basis, MENA's share of world oil production would jump from 35% in 2004 to 44% in 2030.** Almost all the increase comes from the Middle East. Saudi Arabia's share of total MENA oil output in 2030 will be much the same as today, at about 36%. Four countries will see their share in MENA output increase: Iraq, Kuwait, the UAE and Libya.

**MENA production outpaces growth in domestic demand, allowing the region's net oil exports to rise by three-quarters over the *Outlook* period, from 22 mb/d in 2004 to 25 mb/d in 2010 and to 39 mb/d by 2030.** Most exports will still be as crude oil in 2030, but refined products will account for a growing share. Exports to developing Asian countries will increase most, but will grow to all the major consuming regions.

**MENA gas production is projected to grow even more rapidly than oil, trebling over the projection period to 1 210 billion cubic metres in 2030.** This is faster than almost any other major world region. The biggest volume increases in the region occur in Qatar, Iran, Algeria and Saudi Arabia. A third of MENA gas output comes from North Field/South Pars, a field shared by Qatar and Iran, and Hassi R'Mel in Algeria. This share will increase as they are further developed. Demand for MENA gas will be driven by strong global demand and dwindling output in many other gas-producing regions. The bulk of the increase in output will be exported, mostly as liquefied natural gas. Net exports from MENA countries to other regions are projected to more than quadruple to 440 bcm in 2030, with a marked shift in sales to Western markets. Europe will remain the primary destination for North African gas exports. Major gas importers, including most OECD countries and developing Asia, will become ever more dependent on imports from MENA countries.

**MENA oil- and gas-export revenues, which have surged in the last few years, will remain high.** Aggregate MENA oil and gas revenues are projected to rise from about USD 310 billion in 2004 to USD 360 billion in 2010 and USD 635 billion in 2030. Natural gas will make a growing contribution. Cumulative revenues will far exceed the investment needed to make them possible. Total oil and gas investment is projected to amount to about USD 1 trillion over the period 2004-2030 (in year-2004 dollars), or USD 39 billion per year.

**The need for more comprehensive and transparent data on oil and gas reserves in all regions is a pressing concern.** The preparation of this *Outlook* involved an extensive effort to collect the best available data on reserves from official and informal sources. But there are inconsistencies in the way reserves are defined and measured, and a lack of verifiable data on reserves and of a universally recognised reporting system makes it difficult to assess the quality of data on reported proven reserves in many regions, including MENA. Uncertainties about just how big reserves are and the true costs of developing them are casting shadows over the oil market outlook and heightening fears of higher costs and prices in future.

**A major shortfall in MENA investment in upstream oil would radically alter the global energy balance.** In recent years, global investment, crude oil production capacity and refining capacity have lagged the rise in demand, driving up oil prices. Our projections in the Reference Scenario involve a doubling of the level of annual upstream investment in MENA countries. It is far from certain that all that investment will be forthcoming: MENA governments could choose *deliberately* to develop production capacity more slowly than we project in our Reference Scenario. Or external factors such as capital shortages could *prevent* producers from investing as much in expanding capacity as they would like. The Deferred Investment Scenario analyses how energy markets might evolve if upstream investment in each MENA country were to remain constant as a share of GDP at the average level of the past decade. This would result in a USD 110 billion, or 23%, drop in cumulative upstream MENA oil investment over 2004-2030.

**Lower investment on this scale causes MENA oil production to drop by almost a third by 2030 compared with the Reference Scenario.** Production falls further than investment by the end of the projection period because of the *cumulative* effect over the projection period. In 2030, total MENA output reaches 35 mb/d, compared with 50 mb/d in the Reference Scenario. Saudi Arabia's production, at 14 mb/d in 2030, is more than 4 mb/d lower than in the Reference Scenario. MENA's share of world oil production drops from 35% in 2004 to 33% in 2030 (against a rise to 44% in the Reference Scenario). As a result, MENA oil exports are almost 40% lower in 2030. By contrast, higher prices stimulate an 8% increase in non-MENA oil production compared to the Reference Scenario. Natural gas production in MENA countries also falls significantly, due to lower global demand and lower output of associated gas. Gas exports fall by 46% in 2030, with Qatar's falling furthest in absolute terms.

**In the Deferred Investment Scenario, the international crude oil price is significantly higher than in the Reference Scenario over the projection period.** In the Reference Scenario, the average IEA import price is assumed to fall back from recent highs to around USD 35 (in year-2004 dollars) in 2010, and then to rise slowly to USD 39 in 2030. In the Deferred Investment Scenario, the price increases gradually over time, relative to the Reference Scenario. It is about USD 13 higher in 2030, or USD 21 in nominal terms – an increase of almost one-third. Natural gas prices rise broadly in line with oil prices. The coal price also increases slightly. Energy prices would become more volatile.

**As a result of higher prices and lower world GDP, global energy demand is reduced by about 6% in 2030, compared with the Reference Scenario.** World GDP growth, the main driver of energy demand, is on average 0.23 percentage points per year lower. Lower oil and gas revenues and higher prices cause primary energy-demand growth in MENA countries to slow, but less markedly than in non-MENA regions. Among the primary fuels, global demand for oil falls most. Global oil demand, at 105 mb/d in 2030, is 10 mb/d lower than in the Reference Scenario. Demand for both gas and coal also falls, mainly as a result of lower demand for fuel inputs to power generation.

**Our analysis suggests that MENA producers would lose out financially were investment to be deferred in the way assumed in the Deferred Investment Scenario.** The increase in prices fails to compensate for lower export volumes. Over 2004-2030, the cumulative value of aggregate MENA oil and gas export revenues would be more than a trillion dollars lower (in year-2004 prices) than in the Reference Scenario. The loss of revenues is almost five times more than the reduction in oil and gas investment. Revenues also fall in terms of net present value. Oil accounts for about 70% of the fall in revenues.

**The World Alternative Policy Scenario depicts the energy future that might emerge if consuming-country governments press ahead with the vigorous new policy measures already being contemplated.** They involve promoting more efficient energy use and switching away from fossil fuels, for environmental or energy-security reasons. The basic assumptions about macroeconomic conditions and population are the same as in the Reference Scenario. But energy prices change, because of the new level at which an equilibrium between supply and demand is established.

**In the World Alternative Policy Scenario, global primary energy demand is about 10% lower in 2030 than in the Reference Scenario.** Primary energy demand grows by 1.2% per year, 0.4 percentage points less than in the Reference Scenario. Nonetheless, demand in 2030 is still 37% above the current level. Oil remains the leading energy source. Its share of global primary energy demand – just over one-third – is only slightly lower than in the Reference Scenario in 2030. By contrast, the share of coal in primary energy demand falls sharply in all regions. On the other hand, the use of non-hydro renewables, excluding biomass, is almost 30% higher in 2030 than in the Reference Scenario. Biomass and nuclear energy also grow. The effect of energy-efficiency and fuel-diversification policies on energy demand grows over the projection period, as the stock of energy capital goods is gradually replaced and new measures are introduced.

**The fall in oil and gas demand in the main consuming regions leads to a reduction in MENA production and exports, and drives down prices.** By 2030, MENA oil production reaches 45 mb/d – almost 6 mb/d less than in the Reference Scenario. But it is still more than 50% higher than in 2004. The oil price is on average about 15% lower compared with the Reference Scenario. Lower demand and prices cut cumulative MENA oil and gas export revenues by 21% over the projection period compared with the Reference Scenario. Revenues also fall in terms of net present value. Nonetheless, revenues in 2030 are USD 160 billion, or just over 50%, higher than in 2004.

**Lower overall energy consumption and a larger share of less carbon-intensive fuels in the primary energy mix yield a 5.8 gigatonne, or 16%, reduction in global carbon-dioxide emissions in 2030 compared to the Reference Scenario.** This is comparable to the current combined emissions of the United States and Canada. The bulk of the reduction comes from lower coal use, especially in power generation in non-OECD countries. This results mainly from the reduction in electricity demand brought about by new end-use efficiency policies. Emissions, nonetheless, still rise 28% over current levels.

**The policies of producing and consuming countries will change over time in response to each other, to market developments and to shifts in market power.** If MENA upstream investment falters and prices rise, the more likely it becomes that consuming countries will adopt additional policies to curb demand growth and reliance on MENA. This would have the effect of tempering the long-term impact on prices of lower MENA investment. It would also amplify the depressive effect of higher prices on oil and gas demand. The more successful the importing countries' policies are, the more likely it is that the producing countries will adopt policies to sustain their production and their global market share. Lower prices would result.

**These interactions illustrate the case for improving market transparency, for more effective mechanisms for exchanging information between oil producers and consumers, and for a more profound dialogue between them.** Concerns among consuming countries about security of supply are matched by those among producing countries about security of demand. Consuming countries will continue to seek to diversify their energy mix, while producing countries will continue to seek to diversify their economies. Together, consumer and producer governments can improve the mechanisms by which they seek to reconcile their interests and achieve mutually beneficial outcomes.

# PART 2

# THE COUNTRY REPORTS

# IN-DEPTH REVIEWS: SUMMARIES

This part contains summaries of the findings and full list of recommendations of the 2004/2005 in-depth reviews for the following countries. The summary of **Belgium is not included here as the report will only be released in early 2006.** The findings and recommendations reflect the situation when the report was drafted and finalised. The full reviews have been published separately.

## AUSTRALIA

Team visit: February-March 2005; approved at the Standing Group on Long-Term Co-operation (SLT): February 2005.

## BELGIUM

Team visit: April 2005; approved at the SLT: October 2005.

## CZECH REPUBLIC

Team visit: October 2004; approved at the SLT: February 2005.

## LUXEMBOURG

Team visit: April 2004; approved at the SLT: October 2004.

## NORWAY

Team visit: April 2005; approved at the SLT: October 2005.

## SPAIN

Team visit: January 2005; approved at the SLT: June 2005.

## TURKEY

Team visit: September-October 2004; approved at the SLT: February 2005.

# AUSTRALIA

The Australian energy sector and energy policy are heavily influenced by the country's natural circumstances and general market approach to economic issues. Australia is the world's sixth-largest country, roughly 80% larger in land mass than the EU-25 countries together. With a population of 20 million people, it has the lowest population density in the OECD. The country is rich in mineral resources, including coal, oil and natural gas. As an island nation, it has no land boundaries and is a substantial distance from most of its major trading partners. From 1993 through 2003, Australian GDP grew at an average annual rate of 3.9%. while unemployment fell to a 27-year low in November 2004 with a rate of 5.2%. The generally light-handed government approach to the economy is reflected in the energy sector. Energy policy is also influenced by Australia's federal structure with six states and two territories[1].

Like all IEA countries, Australia strives to achieve the three E's of energy policy: Economic efficiency, Energy security and Environmental sustainability. The federal government's June 2004 energy White Paper explains the strategy to meet these objectives and is a commendable document developed in a transparent manner that gives predictability to all stakeholders. Regarding economic efficiency, Australia fares well. It has some of the lowest prices in the IEA for electricity, coal and gas. For example, industrial electricity prices are 38% below the IEA average and household prices are 31% below the average. There is a great deal of choice at the retail level, allowing many customers to select their preferred supplier. In addition, Australia successfully exploits its domestic fuel resources in the international market. The coal, oil and gas industries employ 120 000 people and provide more than AUD 24 billion[2] annually in export revenue, equal to about one-fifth of the country's total export revenue.

Australian energy security is sound. Security is enhanced substantially by the endowment of domestic fuels (albeit with declining oil production), extensive energy delivery infrastructure and good access to world markets. In 2003, net oil import dependence reached 14% and government forecasts project this figure will rise to 37% in 2010 and 46% by 2020. However, the fluid market in crudes and products means this should not pose an undue threat. The government's energy White Paper rates energy security as "high." Nevertheless, recognising the importance of this issue, the government has called for a biennial review of Australia's energy security outlook. Significant indigenous coal and natural gas resources also play an important part in enhancing Australia's energy security.

1. Throughout this report, the terms "government", "federal government" or "commonwealth government" will refer to the national government based in Canberra. Governments at the sate or territory level will be explicitly denoted.
2. On average in 2004, one Australian dollar (AUD) = USD 0.734. As of 6 June 2005, AUD 1 = USD 0.765.

It is with the third E of energy policy, environmental sustainability, that Australia faces its greatest challenge. Regarding the issue of climate change, Australia's emission intensity is very high. Australian emissions of $CO_2$ from fuel combustion per unit of GDP are the second-highest in the IEA, behind the Czech Republic, and 43% above the IEA average. This is due to the widespread use of coal and the country's generally high energy intensity which results in part from the presence of numerous energy-intensive industries. Under the Kyoto Protocol, Australia's target was to limit greenhouse gas (GHG) emissions to 108% of 1990 levels by 2008 to 2012. While a signatory to the Protocol, the government has decided not to submit it for ratification. The government recognises the importance of reducing GHG emissions but does not believe Kyoto is an effective international instrument, specifically because many large emitters will not be obliged to reduce their emissions. However, the government has committed to continued engagement and participation in international post-Kyoto efforts to curb global emissions.

Despite not ratifying the Protocol, the government has stated its intention to meet its Kyoto target. According to government projections released in December 2004, the country is on schedule to do so. Australia will be able to meet its target largely as a result of reductions realised in the land use and forestry sectors where emissions are projected to be cut by 85%. By contrast, emissions from other sectors have grown by 30% from 1990 to 2002. From 1990 to 2008-2012, emissions from the energy sector are expected to grow by 43%. Further emissions reduction from land use changes will not be possible and energy emissions will come to increasingly dominate the mix. As a result, the country will have to substantially change future energy supply and/or demand behaviour if it wants to keep overall emissions at moderate levels that are likely to be consistent with a future global climate change mitigation programme.

Australia is taking a technological approach to curbing climate change and is seeking to develop new technologies to provide economic energy with reduced emissions. The government has recently announced a number of new substantial energy research and development (R&D) and technology commercialisation programmes which focus on developing partnerships with industry and the research community. It has also decided not to develop an emissions trading programme at this time. This decision was driven largely by the fact that the country is already on track to meet its Kyoto target and the concern that Australia's international competitiveness would be adversely affected, given that most of its competitors in the Asia-Pacific region have no obligations to limit their emissions. At the same time, a number of States are considerably more enthusiastic about trading and developing plans of their own.

Australia's focus on technological solutions to climate change has certain advantages. Although it carries the risk that technological solutions will not be forthcoming, it also recognises the long-term nature of this issue and the need for massive changes in energy patterns that new technologies can achieve.

However, even if such technologies are found – and in the Australian context, this would likely be carbon capture and storage as well as other clean coal and hydrogen-based technologies – a carbon price signal will probably still be needed to facilitate their implementation. A trading system is an effective means of introducing a price signal and fits in well with the country's overall market approach. The state and territory governments have established a working group to develop the parameters of a multi-jurisdictional emissions trading scheme to be considered. The government is encouraged to periodically appraise the costs and benefits of a national emissions trading scheme in light of international developments of further global and domestic climate change frameworks.

Improved energy efficiency offers an important, immediately available tool for cutting GHG emissions. Australian energy intensity is quite high with primary energy per unit of gross domestic product (GDP) 35% above the IEA average. This is largely due to the country's vast spaces, large reserves of low-cost black and brown coal, predominance of energy-intensive industries and low energy prices. Traditionally, energy policy has focused on the supply side but greater attention is now being paid to the benefits of demand restraint. The June 2004 energy White Paper states that energy efficiency can increase both GDP and employment. The National Framework for Energy Efficiency (NFEE) has been established and the Productivity Commission (PC) will complete a year-long inquiry into the benefits of energy efficiency in August 2005. The Australian energy sector stands to benefit from greater government efforts to improve energy efficiency throughout the economy.

The transport sector could particularly benefit from efficiency efforts. Transport energy use accounts for 40% of final consumption and is projected to grow by 2.0% annually over the period 2001/02 to 2019/20. Despite this, transport appears to be receiving less attention than other sectors. The current fuel efficiency standards are at the lower end of IEA countries and are voluntary without any penalties. Vehicle taxation does not favour more efficient vehicles. The White Paper reform of the excise tax for fuels will substantially lower the overall tax burden, decreasing government revenue in this area by up to AUD 1.5 billion over ten years and could lead to an increase in transport consumption. If the Australian government wants to deal with the overall energy efficiency of the economy, it should address transport energy use more forcefully.

Although the use of renewable energy in Australia is relatively modest, the country has a successful renewable support scheme and some of the lowest prices for renewables in the IEA. Renewable energy development is influenced by the predominance of accessible, well-located, inexpensive fossil fuels and an approach to climate change that is based on securing least-cost abatement opportunities. Nevertheless, government activity supporting renewable energy has risen in recent years. The Mandatory Renewable Energy Target (MRET) system mandates that electricity retailers and wholesale buyers acquire renewables certificates equal to a certain percentage of their electricity sales, likely to be around 3.5% in 2010. MRET has resulted in substantial new capacity in a wide range of different technologies, particularly wind, solar and hydro. Costs for the certificates are below what other IEA countries are paying as part of a renewables "premium" over conventional fuels. While the government has chosen not to expand the MRET target at this time, additional policies could be considered to support the further development of the country's world class renewable energy resources and technologies. In addition, the benefits of renewables use in areas that may be profitable in an Australian context, such as off-grid power and summer electricity peaks, should be further explored. The Solar Cities initiative is likely to advance this possibility.

Electricity plays a pivotal role in Australia and is important for international competitiveness, industrial employment and economic development. It also has great a consequence on the environment as 50% of Australian energy-based GHGs come from power generation. Australia was one of the pioneers in energy sector microeconomic reform and should be commended for its vision and implementation of a liberalised market. The country now has one of the most transparent and competitive electricity markets in the world and could serve as a model for other countries. Electricity prices are low by international standards on both retail and the wholesale levels with some of the lowest electricity prices in the IEA and the world. Although electricity security is sound, it will continue to be monitored as in all IEA countries.

Current reforms are moving the electricity sector towards more of a national rather than state-level governance. These reforms include the creation of the Australian Energy Market Commission (AEMC, the national rule-making body) and the Australian Energy Regulator (AER, the national rule-enforcing body) as well as the improvement of the decision-making for investments in inter-state transmission infrastructure. These moves are welcomed and encouraged. Greater inter-state trade enhances security and diminishes market power. Growing constraints on interconnections and greater divergence of prices between regions indicate that the existing infrastructure is becoming constrained. The proposed new rules on the methodology for assessing the cost-effectiveness of inter-state transmission upgrades are welcomed but will need to be further fleshed out. Other areas for improvement include encouraging greater demand-side response and elimination of all appearances of conflict of interest where there is state ownership of electricity assets.

Coal plays a major role in providing Australia with low energy prices and sound energy security. In 2003, it accounted for 43% of TPES and 77% of all electricity generation. The most pressing short-term concern for the industry is a constrained export infrastructure in these times of high prices and demand; however, several major expansions are planned. While infrastructure expansion is largely the responsibility of industry, the federal government can nevertheless work with the states to help in a number of important ways, including the review of Environmental Impact Statements (EIS) in a timely manner, providing leasing for rail tracks, making any state-owned land available for appropriate development and facilitating a dialogue with the governments of purchasing countries to co-ordinate their offtake with the domestic supply chain.

In large part because of coal's high carbon content, Australia's GHG emissions intensity is one of the highest in the world. Electricity from coal-fired plants has more than twice the $CO_2$ emissions per unit than electricity from gas-fired combined-cycle plants. A number of collaborative efforts between private and government stakeholders have formed to develop technologies that can curb coal emissions, primarily carbon capture and storage. These initiatives, such as COAL21 and the AUD 500 million Low Emissions Technology Demonstration Fund (LETDF), are commendable and will provide the best opportunities for coal's future. However, any co-operative efforts will need to be reinforced with additional funds from the interested parties to expedite the technology development. It is notable that a number of these programmes, such as the LETDF, leverage significant industry funding (at least an additional AUD 1 billion), are based on co-operative industry-government-researcher partnerships. Without the development of a suitable technology to curb high emissions from coal combustion, Australia will only be able to embrace serious climate change mitigation plans with substantial economic costs.

The Australian natural gas sector has experienced major reforms and structural change since the mid-1990s with the separation of formerly integrated companies and the introduction of third party access (TPA) to transmission and distribution pipelines. There has been significant investment for expansion and integration of the gas transmission network, which has enhanced competition and security of supply. In 2003, natural gas accounted for 20% of primary supply although its production and use are expected to expand dramatically with a 184% growth in production between 2003 and 2020 and a 97% growth in domestic use. Most of the gas reserves are located in the north-west of the country, far from demand centres and are most likely to be exploited as liquefied natural gas (LNG) projects. Although competition in the global LNG market is fierce, Australia offers several advantages compared with other LNG suppliers, mainly political and economic stability and proximity to Asian demand centres. Upstream competition has started to emerge, mainly in the south-eastern part of the country.

Despite a progressive move towards more competition, the market is still immature and highly concentrated. A limited number of producers and customers dominate the market. The government has started a major reform to improve consistency of regulation and efficiency of the rules, and to create a national gas market. The most pressing regulatory and policy issues in the gas sector are to proceed with the review of the gas access regime, to facilitate upstream competition and to promote the development of gas hubs. The impact of differing federal and state taxes, charges and royalties may affect the competitive position of gas versus coal and could warrant further study.

Oil accounts for about one-third of Australian primary energy supply. The country has substantial domestic production, which has stayed at a relatively constant level since 1990. The government, through the Australian Bureau of Agricultural and Resource Economics, projects that domestic oil production will remain flat in the coming years and that increasing oil demand will cause import reliance to rise, reaching 37% in 2010 and 46% in 2020. More conservative forecasts from Geoscience Australia predict a steady downturn in Australian oil production over the next two decades as existing fields mature and new discoveries are limited. Given the liquidity of global and regional crude and products markets this does not necessarily pose a security of supply problem. The government is interested in keeping Australia an attractive investment destination for oil exploration and production. It considers the country's oil resources to be under-explored and would like to see greater activity to exploit domestic oil. The efforts being made to encourage more activity such as a tax uplift and government geoscience pre-competitive surveys appear to be sound, particularly given that these actions are targeted on the so-called "frontier areas", which remain largely unexplored. The success of these measures in attracting investment will only be seen in some years and thus, against the background of high oil prices, it seems prudent for the government to take a step-wise approach towards any further tax or other concessions.

While Australia does not generate electricity from nuclear power, it does have substantial uranium reserves and is a major global uranium exporter. In 2002, total Australian economically demonstrated uranium resources were estimated at 702 000 tonnes, with the majority of the resources located in South Australia, the Northern Territory and Western Australia. Continuing stable uranium exports from Australia contribute to global security of supply.

Australian energy policy has placed a great deal of emphasis on the promises of further energy technology developments, particularly in their treatment of climate change mitigation. As such, energy R&D will be particularly important for the country. The White Paper takes a commendable approach to R&D by looking at the overall innovation process, including not only R&D but also concept identification, commercialisation/demonstration and uptake. There is also effective collaboration among the many stakeholders, including public-private partnerships such as Cooperative Research Centres (CRCs). In general, the R&D targets and objectives are consistent with overall energy policy. In the past there have been difficulties gathering adequate information on government energy R&D spending. Recent efforts to develop statistics or data in the energy sector, including profiles of various technologies, will help Australia to develop a clearer picture of energy R&D innovation, to realize trends of energy R&D funding since the mid-1990s by sector and to compare Australia's funding with other IEA countries. These efforts are encouraging and should be strengthened. Assessing the performance by a set of indicators or benchmarks is important to maximise the cost-effectiveness of energy R&D programmes. In particular, care should be taken that the energy R&D programme and its product technology are designed specifically to meet the country's overall energy policy goals.

## RECOMMENDATIONS

*The government of Australia should:*

### General Energy Policy

- *Maintain the momentum of the collective government effort demonstrated in producing the White Paper in order to ensure a timely implementation on all levels of the measures and initiatives announced in the White Paper.*
- *Strengthen the efforts towards creating a National Energy Market, particularly in the gas sector, with the establishment of a national energy regulator (AER). This becomes more important if a carbon price signal is created that will enhance the demand for gas.*
- *Implement the plan to undertake biennial energy security reviews and continue the work of the Energy Group to maintain energy security; ensure that this work is widely discussed by all the relevant players of government and industry, particularly in light of guaranteeing security in the reformed market sectors.*
- *Consider stepping up demand-side energy policies to curb growth in energy demand by outlining an ambitious national energy efficiency strategy in order to approach best practices in other IEA countries.*
- *Look for new opportunities in climate change mitigation policy responding to evolving international and domestic circumstances through further development of the national climate change strategy engaging key stakeholders, in particular industry and state/territorial governments.*

### Energy and the Environment

- *Reappraise as required the costs and benefits of a national emissions trading scheme, particularly in light of developments regarding further international and domestic climate change frameworks and technology advancements. Ensure that all stakeholders are kept abreast of these developments in order to keep supply and consumer decision-makers fully informed.*
- *Ensure consideration of the environmental consequences in future decisions on energy tax reform.*

## Energy Efficiency

- *Develop a co-ordinated energy efficiency strategy that aims to realise all the benefits of improved efficiency such as emissions mitigation, increased productivity and hence competitiveness, the advantages of delaying infrastructure investments to gain technology advancements, and enhanced energy security.*
- *Consider targets for improved energy efficiency on a national or sector-specific basis and the appropriate means of achieving them.*
- *Address means of curbing peak electricity demand, for example through more cost-reflective pricing in meeting summer peaks and/or more stringent efficiency standards for peak energy consumers such as air-conditioning.*
- *Develop stronger means of improving energy efficiency in the transport sector, in particular through vehicle taxation and fuel efficiency standards.*
- *Consolidate the different levels of energy efficiency programmes to simplify them for users and/or improve their effectiveness.*

## Renewable Energy

- *Maintain an efficient market-oriented approach to renewables development such as the Mandatory Renewable Energy Target (MRET), while also supporting the most promising renewable energies that still need additional assistance.*
- *Exploit those renewable energies where Australia enjoys a relative cost advantage over other countries.*
- *Continue to give a long-term perspective to the renewable industry, by assessing the effect of government support programmes (and their expiration schedules) and responding if renewables development is not consistent with the goal of making renewable energy an important part of the long-term strategy.*
- *Maintain focus on cost reduction of renewables technologies and on energy needs where renewables may be more cost-effective, such as remote area power generation and summer electricity peaks.*

## Electricity

- *Continue taking measures of transparency, openness and competition as tools for creating a low-priced reliable electricity sector.*
- *Encourage the process of integrating the markets, with the view to strengthening a fully competitive market with full contestability for all consumers.*

- *Implement plans for improved decision-making on new interregional transmission investment to enhance reliability, check market power and improve system-wide economic efficiency.*
- *Accelerate the process of further streamlining and simplifying the regulatory framework with the aim of a more nationally focused regulatory regime.*
- *Monitor closely the market response to growing generation needs and be prepared to take appropriate action to achieve security of supply; further incorporate the Annual National Transmission Statement (ANTS) into the Statement of Opportunities (SOO) with more concrete suggestions in recognition of transmission's ability to address regional needs.*
- *Consider the effects of mixed ownership in the generation sector between state and private actors; ensure there is a level playing field between all participants.*
- *Address the issue of how the market could more efficiently and reliably meet peak demand. Encourage market actors to increase demand-side participation, in order to make electricity demand more responsive to price signals.*

## Coal

- *Work in close co-operation with states and industry to alleviate the bottlenecks in the coal supply value chain, particularly those associated with transportation needs in the immediate and longer term.*
- *Support the development of the necessary technologies for the next generation of coal use as part of a larger effort to consider how the expanding future use of coal in domestic and international environments can accommodate future carbon constraints.*
- *Co-ordinate activities between coal producers, electricity companies, government and researchers to address the challenges facing coal's future given its high carbon content, particularly in garnering sufficient funds to develop emission-cutting technology.*
- *Anticipate the effects of higher energy prices owing to coal's high carbon content.*

## Natural Gas

- *Strengthen the development of a national energy/gas market with better interconnectivity of the grid and more consistency of rules across jurisdictions; complete the gas market development plan jointly developed with the industry; actively promote the development of hubs/spot markets; and increase transparency in the market (*e.g.* market share information and prices).*

- *Complete the Gas Emergency Response Protocol as soon as possible, making clear the roles and responsibilities of governments, market participants and customers.*

- *Establish a clear, transparent and stable framework for a gas access regime that enables cost-effective access at the transmission level, gives enough incentives for new greenfield pipelines and ensures uniformity of approach nationally; quickly respond to the Productivity Commission Review on the Gas Access Regime.*

- *Promote further upstream competition, for example by reviewing the upstream fiscal regime for onshore and offshore fields in order to incentivise exploration and production offshore and create internationally, as well as across jurisdictions, competitive conditions; by reviewing joint marketing policy and facilitating separate marketing where feasible; and by reviewing/monitoring conditions for access to upstream facilities.*

- *Continue to encourage the development of LNG exports in the face of global competition, with particular attention to resolving boundaries and royalty issues with East Timor.*

- *Review the effects of differing taxes, regulations and changes on the competitive position of gas versus coal in energy markets.*

### Oil

- *Continue to review and adapt the upstream regulatory regime in close co-operation with the oil industry.*

- *Assess whether the announced fiscal measures and the upstream taxation provisions have the intended impact of increasing exploration and production activities and, if necessary, propose new measures.*

- *Continue to work with industry and other stakeholders to reform legislation governing retail activity in light of the substantial changes that have taken place in the motor fuels market.*

- *Monitor closely its emergency stockholding position to ensure it continues to comply with IEA obligations, especially in light of the changing domestic refinery industry and the expected growth of oil imports.*

### Energy Research and Development Innovation

- *Maintain and refine the approach taken in the White Paper to look at the innovation process overall.*

- *Maintain and further develop effective collaboration among stakeholders, including public-private partnerships.*

- *Ensure regular reviews of the technology assessments and consistency between government support for energy R&D innovation, the technology assessments and the goals of general energy policy.*
- *Develop improved mechanisms for data collection of overall energy R&D funding, the allocation of that funding and communication of this information to international partners.*
- *Continue to provide energy R&D innovation support which is both substantial and responsive at different stages of the projects, and which is consistent with the goals of the White Paper in particular and other national research priorities.*
- *Develop improved mechanisms for assessing the performance of R&D projects conducted by the government and public-private partnership.*
- *Ensure actions or measures under international technology agreements to help Australia achieve its aspirations as a leader and "fast follower" in technology development.*

# THE CZECH REPUBLIC

The Czech Republic has undergone a major transformation in the last fifteen years. The country has changed from an economy guided by central planning and intensive government involvement to one driven by market forces and the individual choices made by producers and consumers. This transformation has proceeded smoothly during the break from the previous regime in the "Velvet Revolution" and the separation with what is now the Slovak Republic in the "Velvet Divorce". Despite large budget deficits, the country has seen strong economic growth in recent years and most forecasts project that this expansion will continue. On 1 May 2004, the Czech Republic, along with nine other countries, joined the European Union (EU).

The energy sector has also changed substantially over this period. Energy efficiency for supply and consumption has improved with the national energy intensity (unit of primary energy supply per unit of GDP) decreasing by 17% from 1990 to 2002. Emissions have also fallen, with $CO_2$ emissions from fuel combustion decreasing 24% from 1990 to 2003. The government has privatised almost the entire natural gas sector and market reforms in the gas and electricity sectors have introduced competition and compliance with the relevant EU directives. The framework for reform is sound and includes a timetable for gradual market opening with fixed dates for complete opening, non-discriminatory open access to all networks, elimination of subsidies for different customer classes and the establishment of an energy regulator. The Energy Regulatory Office (ERO) was established in January 2001. The government is to be commended for this work and is encouraged to continue with the process. New entrants to the electricity sector now capture 30% of the wholesale market in competition with the incumbent. In 2003, a new nuclear power plant was brought on line (Temelín) allowing the country to become a major electricity exporter. In March 2004, the government released its new State Energy Policy (SEP) with long-term targets and strategies through 2030. The aim of the SEP is consistent with the IEA *Shared Goals*, seeking to achieve the three Es of energy policy: Energy security, Economic growth and Environmental Sustainability.

Despite these many positive developments, substantial challenges remain for the Czech Republic. One such challenge involves the implementation and practice of market reform in the gas and electricity sectors. The largest impediment the country is facing in transitioning to competition may be the market power of the incumbent utilities. On the gas side, one company (RWE), the near-exclusive gas importer, owns and operates the transportation pipeline network and controls distribution companies which together have 83% of the retail market share. On the electricity side, one company (ČEZ) has a 70% wholesale market share and controls companies which themselves have a 66%

share of the retail market. While maintaining powerful national companies may be attractive in certain respects, the government is encouraged to envision how such market concentration will impede competition (and its benefits) and which tools can be used to overcome this obstacle. One means of addressing market concentration is through imports (or the threat of imports) into the Czech market. The government should take all steps to ensure that any restrictions (*e.g.* with the infrastructure or regulations) are removed and that such cross-border trade is encouraged.

Another related challenge for the government is to strengthen the institutions that will be required in a competitive market. These are primarily the regulator, the ERO, and the competition authority, the Office for the Protection of Competition. There have been questions raised about the independence and strength of the ERO, particularly following the dismissal of its chairman in August 2004. The Office for the Protection of Competition has ruled on a number of important cases regarding market power concentration in the energy sector but the power of its edicts has not been thoroughly established. While it would appear that the expertise and intentions of these two groups are sufficient for their important role in the reformed markets, their independence and authority need to be more explicitly established.

As customers are given the right of supplier choice in the gas and electricity markets, they will no longer have recourse to a regulated tariff and must take gas and electricity at prices and terms offered by market players. While this may not be a problem for larger industrial customers who have the resources and motivation to pursue alternative suppliers, the smaller customers will generally not be so motivated and thus accept the terms that the incumbent offers. Given the initial state of concentration in the Czech gas and electricity markets, the government should take steps to ensure that newly contestable customers are able to access a regulated transitional tariff until such time as a mature competitive market develops.

Given the Czech Republic's central position in Eastern Europe, its relatively small size and its lack of oil and gas deposits, it is not surprising that the country has many different types of international energy connections. It is the second-largest electricity exporter in Europe (after France) and displays a commendable gas supply diversity with more than 25% of imports coming from non-Russian sources. This international scope should be maintained and even expanded further as appropriate. This would include: removal of any constraints on international electricity trade in order to mitigate domestic market power and boost security of supply and consideration of a regional power pool as a longer-term project; maintained gas import supply diversity; use of international flexible mechanisms to benefit from the comparatively low GHG emissions; and international co-operation with energy research and development such as through the IEA's Implementing Agreements (IA).

As mentioned above, the SEP contains generally prudent strategies and objectives that move the country in the right direction. However, the review team felt that some of the targets were overly ambitious and would thus be very difficult to achieve. For example, the SEP called for a decrease in liquid fuel use with consumption in 2030 below current levels. Since liquid fuel use includes the transport sector, and transport demand has risen strongly in countries that improve their per capita income, this objective may be too ambitious. The energy target of 8% of electricity coming from renewables by 2010 is also ambitious. Given the reach of some of these targets, cost-benefit analyses of the plans could be highly useful. The SEP also includes target ranges for the shares of fuel for primary energy supplies through 2030. Given the trends observed in most other European countries, it seems unlikely that the share of gas consumption out of total primary energy supply would stagnate at around 20%. While such an energy portfolio can provide guidance to sector participants, the government should refrain from direct interventions with the goal of meeting the fuel supply targets. Such a supply mix should be achieved by market instruments and the decisions of individual producers and consumers. Excessive government intervention could deter efficient private-sector investment in energy infrastructure and services

The SEP rightly makes energy efficiency the primary focus of the new energy strategy. Even though progress has been made in this area over the last fifteen years, this improvement lags behind that of neighbouring countries. While energy intensity has fallen by more than 17% in the Czech Republic from 1990 to 2002, it has fallen by 23% in Hungary, 27% in Slovakia and 39% in Poland. This suggests that substantial energy efficiency potential remains in the Czech Republic. The government is encouraged to follow up its work in the SEP with concrete policies and measures to improve efficiency which the review team felt was lacking in the new plan. Improving the efficiency of the transport sector and the building sector should be the government's highest priority.

Currently, renewable energy does not play a major role in the Czech Republic, accounting in 2002 for 2.5% of primary energy supply and 4.2% of electricity generation. As noted above, the SEP calls for a substantial increase in renewable energy, with its share in electricity generation rising to 8% by 2010 and that of primary energy supply rising to 16.8% in 2030. While renewable energy is one important means to achieve multiple energy policy objectives, it is not an objective in itself and care should be taken that overly ambitious targets do not put an excessive burden on the economy. The government is currently revamping its renewable energy support scheme. This is a prudent undertaking since the previous scheme was a complicated two-tiered approach of investment subsidies and feed-in tariffs. The proposed new scheme will constitute either a continuation of the feed-in tariff (with discontinuation of the investment subsidies) or a green certificate programme with quotas. While feed-in tariffs have proven effective in delivering installed capacity, the tariffs should be regularly reduced to motivate greater efficiency and thus reduce costs to the consumer. If green certificates are chosen, the government may draw on the experiences of other countries in designing an effective trading system that could also accommodate regional certificate trading. Regardless of the renewable support scheme ultimately chosen, care should be taken to avoid overlap with any other support schemes, whether they be domestic or international (*e.g.* the EU-ETS).

The Czech government often groups energy efficiency and environmental policy together. These two topic areas are often discussed together in policy papers, pursued by the same organisations and have budgets that are difficult to separate. Even though both efficiency and renewables can deliver decreased emissions and reduced reliance on imported fuels, their application and implementation are substantially different from one another. While it is commendable that the energy policy implementation reflects environmental realities, the government may consider taking a more distinct and separate approach to efficiency and renewables from an organisational point of view. It appears that government funding for energy efficiency has fallen in recent years while funding for renewable energy has risen. This is not consistent with the ambitious targets for energy efficiency improvement in the SEP. If energy demand can be reduced at a lower cost than production of useful energy through renewable means, more attention and resources should be directed towards energy efficiency, and vice versa. Historical and geographical factors indicate that the potential for energy efficiency in the Czech Republic is greater than that for renewable energy. The finite budget resources of the government should be allocated accordingly.

Regarding Czech environmental performance, emissions from fuel combustion have fallen substantially in the last ten or so years. As noted, $CO_2$ emissions from fuel combustion have fallen by 24% from 1990 to 2003 and other energy-related emissions (*e.g.* $SO_2$ and $NO_x$) have declined even further. These reductions have proceeded from economic developments and, in the case of $SO_2$, from specific government policies. Nevertheless, almost all energy-related emissions (per unit of GDP) remain well above the average for the EU. The country is expected to easily meet both its commitment under the Kyoto Protocol to reduce greenhouse gas (GHG) emissions by 8% below 1990 levels by 2008-2012 and a more stringent internal target of 20% below 1990 levels by 2005. As a result, the government has not actively designed or executed an emissions control strategy despite the potential to achieve further reductions from current high levels at relatively low cost. This lack of a comprehensive GHG strategy is unfortunate because the country can benefit substantially by selling or otherwise transferring its emission rights to other countries, primarily through the EU Emissions Trading Scheme. It should be borne in mind that the country could face more demanding targets in the future. The Czech Republic is encouraged to introduce and implement a strengthened climate change strategy with plans to benefit the country by transferring emission rights abroad.

Coal is the most important energy supply for the Czech Republic accounting in 2003 for 47% of total primary energy supply (TPES). While coal's share of TPES has been falling steadily – it was more than 63% in 1991 – and is expected to fall further according to most forecasts, it will remain a crucial part of the Czech energy sector in the foreseeable future. Coal is a relatively low and stable priced fuel from domestic sources. The government makes payments to defunct coal mines to restore mine sites and pay for former miners. The mines receiving these payments had been producing uneconomic coal under the previous regime. Such payments are appropriate given the historical legacy and responsibility. Nevertheless, efforts should be made to reduce these payments as much as possible and ensure they do not become a *de facto* subsidy to operating mines which might discourage them from making sufficient financial provisions for their future closure expenses. In particular, the government should set transparent criteria for future payments, payments to mines currently under operation and a fixed date by which all such payments are terminated. At present, the mining industry does not appear overly concentrated, but the government is advised to monitor the situation closely because of the substantial merger and acquisition activity in the sector.

The Czech Republic has two nuclear power plants which in 2003 provided 15% of TPES and 31% of total electricity generation. According to international organisations, the safety and technical performance of both operating nuclear power plants have been satisfactory. The government has established funds to handle waste disposal. While the levels in these funds and provisions for future funding appear sufficient for their purposes, the government is encouraged to monitor this situation and regularly review the adequacy of these provisions, especially given the uncertain nature of post-operation liabilities. Attempts to create a domestic final waste disposal site have been thus far unsuccessful, primarily because of local opposition to those sites deemed geologically suitable. The government is urged to develop a framework for expanded and more consultative dialogue with local groups to see if a solution is not ultimately possible. In 2004, the Czech Republic continued to produce uranium from its Dolní Rožínka mine although the cost of ore from this site is substantially above market rates. The Czech government decided to close the Dolní Rožínka mine in 2005. The government is urged to shut down this mine, as it has said it would on previous occasions.

# RECOMMENDATIONS

*The government of the Czech Republic should:*

## General Energy Policy

- *Examine the feasibility and cost of achieving the national targets such as energy efficiency, renewable and fuel mix goals.*
- *Supplement work in strategy with detailed action plans and with sub-targets to ensure progress across all areas.*
- *Follow through on the intention to conduct a three-year review of strategy by developing an analytical framework to assess progress.*
- *Develop a regulatory, fiscal and market structure that seeks to reflect environmental externalities in energy prices.*
- *Enhance involvement of all stakeholders, including consumers, when developing energy policies and disseminate information widely.*
- *Ensure the independence of the Energy Regulatory Office from political and industry influence.*
- *Enable the anti-monopoly authority to monitor energy markets in depth, promote a competitive environment and prevent possible abuse of market power, and act where appropriate.*
- *Consider means of improving the efficiencies of the still-regulated components of the liberalising energy sector, including domestic and international benchmarking and regulatory incentives.*

## Energy and the Environment

- *Consider developing a plan for reducing GHG emissions with targets on overall and sectoral level; regularly update GHG projections and take measures if necessary.*
- *Monitor and evaluate the cost-effectiveness of the policies and measures in the State Environmental Policy and the National Plan to Mitigate Climate Change.*
- *Define clear responsibilities of relevant ministries and strengthen co-ordination among different ministries.*
- *Examine and institute means of profiting from continued emissions reduction through the use of flexible mechanisms such as emissions trading and/or Joint Implementation.*
- *Continue to reduce the level of emissions of local pollution.*

## Energy Efficiency and Renewable Energy

- *Develop sectoral targets supported by concrete measures to achieve the national target of improving energy efficiency, and closely monitor progress.*
- *Define clear responsibilities of relevant ministries and strengthen co-ordination among different ministries to improve energy efficiency in each sector.*
- *Consider expanding efforts to capture the energy-saving potential of medium- and small-size energy users.*
- *Address energy demand growth in the transport sector by:*
  - *Further fostering more energy-efficient modes such as public transport.*
  - *Providing economic and regulatory incentives (*e.g. *fuel taxation, vehicle taxation, car inspection system) for the choice of more fuel-efficient vehicles and for the accelerated retirement of old and inefficient vehicles (vehicle taxation, car inspection system, etc.).*
  - *Enhancing measures to control the volume of road traffic such as park and ride and road pricing.*
- *Enhance policies to encourage renovation of existing energy-inefficient buildings.*
- *Define the role of combined heat and power (CHP) in achieving national energy policy objectives and target the support scheme for CHP plants with higher efficiency.*
- *Pursue renewable energy policy that is cost-effective with elements of incentives for cost reduction. Consider a market-oriented approach such as green certificates.*
- *Enhance measures to promote renewable energy use in the heat and transport sectors.*
- *Review prioritisation of state budget allocation between energy efficiency improvement and renewable energy promotion based on its cost-effectiveness.*

## Fossil Fuels

### Natural Gas

- *Continue to monitor overall supply source decisions made by private gas importers to ensure a continued sufficiency of supply diversity and continued adequacy of plans to deal with emergency situations.*
- *Review the static demand projection of gas use presented in the SEP.*

- *Refrain from any policy intervention to discourage gas growth to meet the static demand projections used as the basis for the SEP.*
- *Remove barriers to entry for new competitors in the supply, distribution and retail aspects of the liberalised gas market.*
- *Closely monitor the gas market and prevent possible abuses of dominant position.*
- *Ensure that consumers given supplier choice are provided protection from excessive prices in the transitional phase towards a competitive market.*
- *Develop best practice principles for negotiated third-party access to gas storage so as not to disadvantage new entrants or consumers seeking competitively provided gas supplies.*

### Coal

- *Search for a sustainable solution for using coal resources, including consultative processes* (e.g. *facilitating community consultations and environmental impact statements).*
- *Monitor concentration of mining interests to maintain diversity in the market.*
- *Continue to reduce government payments to defunct coal companies while maintaining responsibility for environmental rehabilitation and former workers.*

### Oil

- *Sustain efforts to increase the utilisation of the IKL pipeline with further diversification of import sources.*
- *Promote sufficient demand for biofuels to stimulate increased investment in bioethanol production facilities.*
- *Continue to maintain a consistent record of meeting the IEA stockholding obligation.*

## Electricity

- *Closely monitor the electricity market and prevent possible abuses of dominant position.*
- *Consider possible impediments to competition resulting from ČEZ's horizontal and vertical integration in the electricity sector, and maintain a robust approach to eliminating any anti-competitive behaviour.*
- *Ensure non-discriminatory access to the grid.*

- *Work with industry and international partners to remove any remaining constraints on international electricity trade to help enhance energy security and reduce the dominant position of the incumbent; consider the advantages of a regional power pool as a longer-range project.*
- *Seek to expand the Electricity Market Operator's (OTE) wholesale market in order to create a viable reference price and increase market transparency.*
- *Ensure that consumers given supplier choice are provided protection from excessive prices in the transitionary phase towards a competitive market.*
- *Maintain a transparently arm's length relationship with ČEZ and clarify the various roles it plays with regard to ČEZ.*

## Nuclear Power

- *Maintain the nuclear option while ensuring that additional units would be built in an open market situation.*
- *Continue regular monitoring of nuclear safety in both Dukovany and Temelín nuclear power plants.*
- *Assure an atmosphere and a solid framework for open discussions on nuclear waste management issues to involve the public in the decision-making process.*
- *Continue to assure that the fund generated is in compliance with the costs of fuel backend and decommissioning.*
- *Pursue final nuclear waste storage solution.*
- *Pursue the closure and clean-up of the Dolní Rožínka uranium mine.*

## Energy Research and Development

- *Examine the effect that reduced government R&D spending could have on meeting the country's energy objectives.*
- *Incorporate more fully the government energy policy into the formulation of energy R&D strategy by targeting those technologies that can help the country achieve its specific energy goals.*
- *Develop a more comprehensive qualitative and quantitative picture of current energy R&D efforts and a vision for the future.*
- *Examine possibilities for greater international co-operation in energy R&D given budget constraints and the opportunities offered by the country's participation in international entities such as the IEA and the EU.*
- *Investigate private-public partnerships to ensure continued energy R&D efforts by energy companies in the competitive market.*

# LUXEMBOURG

There have been commendable developments in energy policies in Luxembourg since the last in-depth review. With the Electricity Law of July 2000 and Gas Law of April 2001, more than half of the electricity and gas markets were opened for competition by April 2004. The independent regulator in charge of both the electricity and gas markets has been established. A new combined-cycle gas turbine (CCGT) power plant came into operation in May 2002, providing a solution to the needs of large consumers for stable electricity supply and predictable prices, reducing Luxembourg's import dependence on a single supplier of electricity and diversifying its natural gas supply sources. Luxembourg ratified the Kyoto Protocol in 2001 and submitted its National Allocation Plan based on the EU Directive on Emissions Trading in April 2004. Despite a high dependence on imported energy, it currently faces no significant energy supply problems. Luxembourg consumers have also been enjoying lower energy prices, compared with neighbouring countries.

In the years to come, a major policy challenge for Luxembourg is how to achieve its Kyoto target. While greenhouse gas (GHG) emissions in 2002 were 21% below 1990 levels, this is entirely attributable to a 70% decrease in the industrial sector due to the restructuring of the iron and steel industry. Such restructuring cannot be repeated. On the other hand, Luxembourg's population is growing, mainly as a result of immigration. Because of its small size, any development in emissions (*e.g.* the start of a new CCGT plant) could result in enormous movements in terms of percentage.

A large number of foreign drivers are refuelling in Luxembourg where taxation on automotive fuels is low compared to neighbouring countries and whose location at the crossroad of Europe, makes it extremely challenging to achieve the Kyoto target. While the tax differential of automobile fuels does not depend only on Luxembourg, this needs to be addressed in the wider context of further tax harmonisation efforts at the EU level but efforts from Luxembourg are also imperative.

The National Allocation Plan anticipates that the bulk of emissions reductions will be achieved through the implementation of Kyoto mechanisms. While this is explainable given Luxembourg's specific circumstances and the high cost of domestic climate change mitigation policies, Luxembourg could explore more possibilities to reduce GHG emissions domestically. Energy efficiency could contribute not only to GHG emissions reduction, but also to energy security, which purchasing credits from abroad will not achieve.

Luxembourg's energy demand per capita remains among the highest in IEA member countries. While the government has been implementing regulatory measures and introducing voluntary agreements, more emphasis should be placed on energy efficiency to achieve the 3Es – Energy security, Economic development and Environmental sustainability. The government needs to intensify its efforts to assess the costs and benefits of measures to improve energy efficiency. The performance of voluntary agreements with industry should be closely monitored. In the building sector, rapid implementation of the *carnet de l'habitat* in a simplified manner, enhancing standards for new buildings and the refurbishment of existing buildings should be explored. In the transport sector, economic and regulatory measures to curb the increase in passenger transport, such as vehicle taxation and road pricing, should be considered.

Luxembourg does not often comply with its 90 days stockholding obligation under the International Energy Program (IEP). This will weaken the IEA's solidarity at a time of great oil market uncertainty and instability. The government should now swiftly develop a plan with concrete measures to achieve its obligation by creating a centralised stockholding agency and increasing the level of physical oil stocks on national territory. The current dominance of short-term leasing contracts could limit Luxembourg's capacity to cope with supply disruptions.

As of April 2004, Luxembourg has liberalised its gas market up to 76% and its electricity market up to 57%. Both markets will be opened for full competition in 2007. While few customers have switched suppliers, many of the existing contracts have been renegotiated. It should be borne in mind that Luxembourg's gas and electricity markets have several specificities: its domestic market is very small; the demand is led by a few large energy-intensive industries; and the number of players is limited. The government should make efforts to generate as much benefit from competition as possible. Even with continuing state ownership in the gas and electricity sectors, the government should continue to refrain from interfering in the daily management and strategic decisions of the companies, which is a prerequisite to ensure a level playing field. Because of the country's size and location, effective competition in gas and electricity markets is very much affected by the market condition of neighbouring countries. Therefore, the regulator should keep in touch with its counterparts in those countries, in particular in such areas as network access and interconnection. Despite technical and economic challenges, the potential benefit of linking two domestic electricity grids (CEGEDEL and SOTEL) should be explored with a view to expanding the market size and enabling greater choice for Luxembourg consumers.

Electricity generating capacity from renewable energy has expanded rapidly thanks to generous buy-back tariffs and direct subsidies. However, the current buy-back tariff scheme does not have any time limit or degression element to lower the tariff over time. This lack of an incentive for investors to increase productivity could be very costly to the economy. While the number of installed photovoltaic (PV) cells per capita in Luxembourg is very high thanks to the generous subsidy and feed-in tariff scheme, given Luxembourg's natural resource endowment, this may not be the most cost-effective option to achieve its energy policy objectives. The responsibilities for promoting renewable energy have been shifted from the Ministry of Economic Affairs to the Ministry of Environment. Splitting renewable energy policy from the overall energy policy could make it difficult to compare the cost-effectiveness of renewable energy policy with other policy options.

Despite growing challenges and complexities arising from market liberalisation and climate change mitigation, Luxembourg has only six permanent staff in the Energy Directorate and two permanent staff for energy regulation at the *Institut Luxembourgeois de Régulation.* Even taking into account the small size of the country, this could hamper the capacity of Luxembourg to address the above challenges.

## RECOMMENDATIONS

*The government of Luxembourg should:*

### Energy Policy and Market Trends

- *Recognise the increasing importance of larger markets and international policy developments, allocate sufficient resources – particularly staffing – to participation in the relevant processes and to carrying out the necessary strategic planning.*
- *Review energy tax policies to better internalise environmental externalities within the wider efforts for tax harmonisation at the EU level.*
- *Enhance close co-operation and co-ordination among all the ministries involved in energy policy.*
- *Expand the responsibilities of the energy regulator to include approval of grid access tariffs.*
- *Consider participating in IEA Implementing Agreements.*

### Energy Efficiency

- *Establish a national energy efficiency strategy incorporating targets and strong cost-effective measures at national and sectoral levels.*
- *Closely monitor the performance of the voluntary agreement with the industrial sector. Require participants in the voluntary agreement to provide details on how they will implement energy efficiency.*

- *Complement the existing voluntary agreement with company-based sectoral efficiency improvement targets.*

- *Conduct more evaluation of the results of efficiency measures.*

- *Enhance energy efficiency standards for existing and new buildings, and enhance their monitoring with stronger oversight of implementation. Take first steps to implement the* carnet de l'habitat.

- *Formulate and implement economic and regulatory measures such as the revision of vehicle taxation and road pricing to curb growth in energy demand in passenger transport.*

- *Consider participating in the IEA Implementing Agreements on "Electric and Hybrid Vehicles", "Hydrogen" and "Advanced Motor Fuels".*

## Energy and the Environment

- *Develop as soon as possible an action plan to decrease GHG emissions in a cost-effective manner. Efforts should be focused on road traffic since that sector represents the most important increase in emissions up to the year 2012.*

- *Prepare a strategy on how the recourse to Kyoto mechanisms will be implemented.*

- *Evaluate the cost-effectiveness of the various subsidies.*

- *Continue to explore more possibilities to reduce GHG emissions domestically, bearing in mind the goals of energy policy and of cost-effectiveness, even if the largest share of emissions reductions may be obtained through an active international strategy.*

## Oil

- *Urgently develop a plan to achieve the IEP obligation with concrete measures within a specific time period through:*
  - *Creating a centralised stockholding agency.*
  - *Increasing the level of physical oil stocks on national territory.*
  - *Limiting the number of short-term leasing contracts of 3 months in favour of longer-term leasing contracts of 6 months or more.*

- *Given the limited scope for strong competition in the oil products sector and the large volumes of oil products sold in Luxembourg, make sure that the calculation of price ceilings does not generate undue rent.*

## Natural Gas

- *Maintain an arm's length relationship with the companies having state-ownership in the gas sector.*
- *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*
- *Finalise and implement the ten-year gas security of supply plan.*

## Electricity

- *Maintain an arm's length relationship with companies having state-ownership in the electricity sector.*
- *Keep under technical review the possibility of interconnecting the SOTEL and CEGEDEL networks in view of integrating further the Luxembourg market into the European electricity market.*
- *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*
- *Further consider cost-effective ways of supporting highly efficient co-generation, including linking financial support to efficiency criteria and environmental benefits or phasing out subsidies to co-generation.*

## Renewables

- *Review the cost-effectiveness of the current scheme for PV.*
- *Review the tariff scheme and consider introducing degressivity over time. Try to find a more cost- effective system for renewables.*
- *Explore the possibilities of broadening the base of financial support for renewables promotion in Luxembourg.*
- *Assess renewable energy policies in the broader portfolio of energy policy.*

# NORWAY

Energy policy in Norway is receiving sizeable political attention and is conducted by highly respected professionals. The economically efficient development of its large oil and gas resources has made Norway Europe's largest exporter of petroleum (oil, oil products and natural gas), and it is contributing significantly to Europe's security of supply. Income from the oil and gas sectors represented 18% of GDP and 24% of government revenue in 2004. The development of the long-term scenario for the production of petroleum resources and the responsible management of wealth derived from natural resources through for instance the Petroleum Fund, are examples of a transparent and forward-looking way to manage the petroleum wealth of the country, and should be commended.

Norway enjoys extensive access to cheap and clean hydropower and has developed this resource extensively. Abundant offshore oil and gas resources and relatively cheap hydropower have enabled Norway to enjoy a high level of security of supply and one of the highest standards of living in the world.

In terms of economic efficiency, Norway is to be commended for its role as a pioneer in liberalising its electricity market and promoting the Nordic electricity market. In the oil and gas sector, Norway has made important progress in boosting efficiency by the partial privatisation of Statoil.

Despite its successes, Norway is facing important energy policy challenges. Since 1990, onshore energy consumption has grown slowly, but even this relatively slow growth has not been matched by an extension of onshore energy production. In spite of the government's authorisation in the 1990s, the construction of gas-fired power stations has been delayed owing to environmental concerns about carbon dioxide ($CO_2$) emissions, and the construction of a gas supply network onshore is delayed because of regulatory and economic uncertainties. The construction of additional hydropower stations and onshore wind farms has also been delayed by environmental concerns. Electricity grid operators face constraints on expanding their capacity. Little relief can be expected in the coming years unless these concerns are resolved. Initiatives to resolve these issues will not go ahead unless a better understanding by the general public of Norway's future challenges in terms of energy supply/demand is ensured. In this context, the publication of long-term energy forecasts could play a significant role.

Environmental sustainability has been very highly positioned in Norwegian energy policy. The Norwegian Continental Shelf and the Barents Sea have very high standards of environmental regulation for petroleum production. In carbon capture and storage (CCS) the Sleipner field is an important pioneering project. The country ratified the Kyoto Protocol, which dictates a tough target for greenhouse gas (GHG) emissions of 1% above 1990 levels. However, Norwegian $CO_2$ emissions are rising owing to an increased production of offshore petroleum and an increase of demand in all sectors of the economy even though energy intensity has decreased. The concentration of emission increases in the offshore and transport sectors, the predicted growth of offshore activities, together with the commissioning of gas-fired power generation, will make the achievement of Norway's Kyoto target difficult without the extensive use of the Kyoto mechanisms. Meeting its Kyoto target without compromising security of supply is Norway's biggest energy policy challenge. Micro-management of investment decisions for individual power projects may paralyse decision-making without contributing to the achievement of the Kyoto target. A comprehensive public and political debate looking at the entire portfolio of tools of climate change policy, including intensified use of flexible Kyoto mechanisms, is recommended.

Norway has been a pioneer in introducing a $CO_2$ tax system. However, the effectiveness of the tax has been limited owing to significant exemptions for major emitters. The government should clarify the role of the environmental taxation in climate change mitigation, evaluate their effectiveness and review their design if appropriate. Norway has introduced a quota-based emissions trading system (ETS), which it is aiming to link to the European Union's (EU) ETS. This will present a challenge to the future of $CO_2$ taxation in Norway because it is difficult to design the tax in a way that is compatible with emissions trading. The greatest challenge will be to decide whether to include the offshore sector in the ETS after 2008. The current trading system is restricted to a small part of emissions, and this may reduce its effectiveness. The government will make use of the Kyoto Protocol's project-based mechanisms to help achieve its targets, and it should be commended for its efforts to build up an understanding of these mechanisms.

Norway is expecting that CCS will play a significant role in reducing emissions from gas-fired power generation. Technological and economical realities of CCS need to be considered by the public and energy policy-makers, and every effort should be made to ensure that a realistic understanding of the possibilities of CCS in reducing emissions from power generation informs both the public debate and decision-making.

Norway's energy demand is unusual when compared with that of other IEA countries because it primarily consists of hydroelectricity in stationary use and oil for transport, with a very high share of the electricity being used for heat production. While Norway has increased energy consumption and production considerably since 1973, demand has now caught up with supply. Energy efficiency has the potential to increase security of supply in Norway, and the government has had conservation policies in place since 1993. Investment in energy efficiency appears to be very cost-effective.

Norway has set up Enova SF as a state-owned company tasked with achieving energy savings. The underlying structure of Enova as an independent body with its own long-term funding and clear objectives is exemplary. The 2002/03 programme of support for energy efficiency in the residential sector has shown that great success is possible. This is commendable, and Norway should consider expanding efforts to reduce building and transport energy use.

The Norwegian oil and gas industry on the Norwegian Continental Shelf (NCS) is most likely close to reaching the peak of production. The government should be commended for the transparent and forward-looking way in which it intends to manage the decline of the industry, and to extend production for as long as possible. The government has taken significant action to increase exploration and to open the industry further, while reducing state involvement. Altogether, Norway's management of its oil and gas resources is an example of best practice for the management of valuable natural resources in a small economy.

Norway reopened the southern part of the Barents Sea for petroleum activity in 2003, recognising environmental and fisheries interests. The first development in the Barents Sea is the Snøhvit field, which is planned to come on stream in 2006. With the first development in this area, the government is encouraged to investigate whether other currently closed areas further south can be opened, bearing environmental considerations in mind.

The high cost base of the petroleum industry in Norway presents a challenge for the achievement of the long-term scenario. Comparatively higher costs than in the United Kingdom (UK) sector of the North Sea are driven by a combination of high environmental standards, and significantly higher cost for labour. The government should take all possible steps to ensure that the economics of marginal assets on the NCS are improved, taking into account environmental and safety considerations.

The use of gas is very limited within Norway, even though it has increased slightly in recent years. Increasing domestic access to gas can make a significant contribution to security of supply in the power sector, as it contributes to the diversification of generation sources recommended before. Despite significant commercial interest in establishing an industry, this has been held back by uncertainties about the investment framework, and the failure to construct the licensed gas-fired power stations, which could become a major driver in creating demand pull for the industry.

Norwegian domestic production of electricity is almost exclusively based on hydropower. The government is encouraging the development of new renewables such as biomass and wind, and this is commendable. The goal of 3 TWh delivered wind energy for 2010 would still represent a small share of the forecast electricity consumption of Norway by that date. Norway has a good resource base of high wind speeds and a very long coastline, but the future integration of wind into the

Nordic grid, and the transportation cost for wind-generated electricity from the north of the country should also be considered in expansion plans for renewable capacity. The planned introduction of a green certificates system replacing direct subsidy is a positive development. The liberalised electricity market provides a good framework for this, and it can lead to a more market-based and cost-efficient allocation of financial resources. Norway should continue to work closely with Sweden so that the integrated market can launch from 2007. The government should consider the introduction of support policies helping to overcome non-market barriers to renewable energy sources.

In the 1990s, Norway fundamentally reformed its electricity sector, leading to the development of the Nordic electricity market, which was more market-based, and increased cross-border trade. The effectiveness of these arrangements was demonstrated during the 2002/03 precipitation shortage when market prices encouraged efficient use of the electricity system. Yet this also highlighted some emerging challenges such as a tightening of the supply-demand balance, and some issues in the policy and regulatory framework. A critical factor in determining whether the Nordic electricity market can continue to deliver affordable and reliable outcomes for Norway is the degree to which it remains an integrated market. Congestion has become a more regular feature in the Nordic market and this could become an important issue in dry years. Nordel's proposal to increase transmission capacity has the potential to strengthen the ability of the market to provide reliable and affordable electricity services. This is a very welcome development. However, co-ordination to this end could perhaps be improved.

More integrated regulatory and planning arrangements supported by efficient, transparent and cost reflective network pricing could help to remove uncertainty. Regulatory and institutional responsibilities should be further clarified and the co-ordination among and between regulators and system operators should be strengthened. NVE, the regulator for the Norwegian electricity industry and the country's hydro assets, is reviewing its income cap methodology in the context of preparing for the regulatory period starting in 2007. Getting the balance right between incentives for lowering costs and for efficient investment will be a challenge in this context.

The 2002/03 experience also highlighted the importance of wider trade to secure reliable electricity services. The recent announcement of a new transmission link between Norway and the Netherlands (the NorNed cable) is commended. Efficient domestic investment in generating capacity could also strengthen the reliability of Norwegian electricity supplies. It is important to ensure that investors have a clear path for the approval of their projects available to them. Removal of the asymmetry in the concession rules applying to private and public ownership of hydroelectric facilities could help to further stimulate private investment. Uncertainty about the regulatory arrangements for gas-fired power plants and related infrastructure projects risks discouraging potentially efficient generation investment.

Representatives of large energy users have suggested that the degree of flexibility shown in 2002/03 should not be taken for granted. Further investigation of a market-based means to stimulate efficient demand responsiveness, especially to broaden the potential group of responsive end-users, should be encouraged. Many energy-intensive users currently enjoy long-term supply contracts with favourable prices. Most of these contracts will expire within six years.

Government funding for energy research and development (R&D) has increased substantially over the past two years. The increase is commendable. Nevertheless, the current funding level still does not appear to fully reflect the importance of the energy sector in the Norwegian economy. In order to achieve the long-term scenario for oil and gas production, the government may need to consider further increases of the energy R&D budget to address the technological challenges of exploration and production in extreme climatic conditions and in deep water.

Norway's energy R&D is also closely aligned with its energy policy and presents good examples in terms of strong private-public co-operation, its monitoring and assessment efforts and collaboration among relevant institutions. Results from the Norwegian R&D programme will contribute to enhanced oil recovery (EOR) worldwide, and the government should be praised for its efforts.

Norway has set up Gassnova as an agency dedicated to develop technological solutions for CCS and reduced emissions from onshore gas use. It should be ensured that Gassnova has the resources to manage the technological and project co-ordination issues in this complex field, while participating in international information exchange. The set-up and work of the agency appears to be exemplary, and Norway should be commended on this comprehensive approach to technology development.

## RECOMMENDATIONS

*The government of Norway should:*

### General Energy Policy

- *Facilitate further oil and gas exploration in the Barents Sea and other areas containing important undiscovered resources within a framework of sustainable development.*

- *Continue pursuing Norway´s active role in advancing the further integration of the Nordic electricity market.*

- *Facilitate the introduction of gas-fired power generation and associated network infrastructure by proactively clarifying under which regulatory framework commercial projects could materialise.*

- *Publish energy projections for Norway for the coming decades in order to establish a common information basis for public debate on the future choices facing Norway´s energy policy.*

- *Continue the co-operation in the European Economic Area to ensure rapid implementation of relevant EU directives.*

## Energy and the Environment

- *Clarify how Norway's climate change policy is supposed to meet its Kyoto target by a national climate strategy to allow secure investment decisions in the energy sector.*

- *Continue to evaluate the effectiveness of environmental taxation, and act on results from these evaluations to ensure the efficient development of the taxation system.*

- *Consider making stronger use of Kyoto's flexible mechanisms by putting Norway's quota system as soon as possible on the same wide basis as the EU emissions trading scheme and pursue the integration of the EU and the Norwegian ETS.*

- *Widely and internationally disseminate Norwegian experience in CCS.*

- *Ensure that decisions about diversification of energy supply take into account the current technological realities of CCS.*

- *Pursue further cost-effective reductions of non-$CO_2$ GHG emissions.*

## Energy Efficiency

- *Evaluate whether Enova's objectives are delivering the expected improvements in all target areas of work, in particular energy efficiency.*

- *Closely monitor Enova's work and disseminate lessons learned internationally through publication of Enova's literature in other languages.*

- *Reconsider the need for direct investment aid to industrial energy efficiency.*

- *Consider measures to increase the household sector's ability to react to price increases by reducing and/or shifting load.*

- *Gather statistical data required for effective policy-making, in particular in the building sector.*

- *Pursue cost-effective technological solutions for public transport, such as ferries, buses and commercial vehicles as appropriate through, for example, further use of the public transport fund as an incentive to local authorities.*
- *Encourage congestion charging aiming to achieve modal shifts in city transport.*
- *Introduce a taxation link to vehicle labelling at the earliest opportunity.*
- *Evaluate the effectiveness of the $CO_2$ tax as a means of fulfilling Kyoto obligations cost-effectively.*

## Fossil Fuels

- *Promote the innovative and proactive approach to acreage management and the award of exploration and production licences internationally as an example of best practice.*
- *Consider the opening of currently restricted acreage off the Lofoten taking into account environmental concerns to ensure that environmental restrictions on offshore petroleum activities are not unduly hindering further exploration.*
- *Consider making available smaller stakes from the State Direct Financial Interest for new entrants and small specialised operators.*
- *Take all possible steps to control cost increases for operations on the Norwegian Continental Shelf, as they might diminish value creation.*
- *Monitor closely the decision-making on upstream pipeline investments to promote the exploration and production from smaller or more remote fields.*
- *Support the market-driven development of onshore gas use by clarifying the legal and regulatory framework in order to give investors long-term security.*
- *Leave Store Norske Spitsbergen Kulkompani to operate on a commercial basis with no government support.*

## Renewables

- *Work to clarify as quickly as possible the regulatory framework for the green certificates system to be introduced together with Sweden from 2007, in order to provide the market with certainty and ensure timely implementation and smooth phasing-in.*
- *Further investigate the potential for heat production from renewable sources to make carbon-free hydroelectricity available for international trade.*

- *Examine the additional measures for wind generation management and smooth grid integration with a view to avoid creating problems in the grid owing to the introduction of new wind generation.*
- *Take into account the cost-effectiveness of further support for renewable energy on the integrated power system and compare it with other energy policy options, such as energy efficiency.*

## Electricity

- *Continue to promote greater harmonisation within the Nordic market in relation to economic regulation, system operation, competition surveillance and co-ordinated planning and development of the Nordic transmission "backbone".*
- *Ensure that the income cap methodology adopted for the regulatory period commencing in 2007 provides sufficient incentive for efficient and timely network investments.*
- *Facilitate the development of efficient transmission links between Norway and other countries.*
- *Review regulatory arrangements with the potential to discourage or delay efficient investment in new generating capacity, or to hinder efficient diversification of ownership. In particular, opportunities may exist to: clarify regulatory requirements; streamline and accelerate licensing approval processes; and remove any inconsistencies in the treatment of public and private ownership.*
- *If introduced, ensure that the capacity reserve programme does not undermine the development of efficient, market-based demand responses or generation investment. Consider a transparent activation trigger linked to water reservoir levels. Ensure that any such programme is compatible with emerging Nordic-wide approaches.*
- *Further promote market-based methods to help broaden demand responsiveness. Consider pursuing this work in a Nordic context, as appropriate.*
- *Existing long-term supply contracts with terms set by the government for energy-intensive users should not be renewed.*

## Energy Technology and R&D

- *Examine the appropriateness of the current level of funding for energy R&D taking into account the importance of the energy sector for Norway.*
- *Continue to give the Research Council of Norway the flexibility to manage the energy R&D programmes, in alignment with strategic guidance, to*

*ensure the optimal mixture of top-down and bottom-up approaches to R&D management.*

- *Examine potential synergies between the PETROMAKS and RENERGI programmes with a view to realising any potential synergies in the underlying sciences.*
- *Continue and further deepen the commendable efforts in the area of international R&D collaboration through the IEA and the EU Research and Technology Development Framework Programmes, and through other bilateral initiatives such as Norway's recently adopted Strategy for Research and Technology Co-operation with North America.*

# SPAIN

The Spanish energy sector has undergone many positive changes since the last review. These include an increase in the use of natural gas and renewables in power generation leading to increased security of supply and reduced environmental impacts, further liberalisation of its markets ahead of EU directives and the entrance of new players into the energy market competing with the incumbents. The energy industry has coped very well in satisfying the rapidly increasing demand for energy. Notwithstanding all these positive developments, the energy sector in Spain and the Spanish government will face a number of challenges over the next years.

One of the most pressing issues is that Spain's demand for energy has grown rapidly and that this growth shows no sign of abating. Spain's indigenous energy resources are limited and unlikely to increase significantly, with the exception of some form of renewable energy production, in particular wind. Furthermore, weak cross-border gas and electricity interconnections and low electricity trade compared to total demand lead to a situation not dissimilar to that of an island. This carries risks for Spain's security of supply that will become greater with increasing demand for energy. Increasing interconnection capacity between Spain and the rest of Europe could not only reduce these risks, but also contribute to general European security of supply, because Spain could provide an additional entry point for non-Russian and non-Algerian gas to the European Union (EU) through its regasification terminals, and Spanish electricity generators could contribute to supply in neighbouring countries. The introduction of the Iberian Energy Market MIBEL will also help to create a stronger base for the Spanish energy markets when it happens, and should be commended. The decision to delay the introduction of the Iberian Electricity Market MIBEL appears sensible at this stage, however, because it will allow necessary improvements to be made to the market framework.

In the area of environmental protection, major efforts will be required by Spain to initially stabilise and subsequently reduce $CO_2$ emission levels to achieve its EU burden-sharing agreement to limit its GHG emissions at 15% above the 1990 level by 2008-2012. However, greenhouse gas (GHG) emissions in 2002 had already increased by 39% over the 1990 level. This trend creates a risk that, despite the efforts by the government to reduce $CO_2$ emissions, these might continue to grow further, thereby widening the compliance gap. Energy related $CO_2$ emission increases have been exceptionally high in the transport sector, in the residential, commercial and institutional sectors and in waste treatment. While some policies have been developed to deal with these problems, the concrete implementation measures required to realise significant improvements of energy intensity in Spain still have to be designed and agreed upon. There is no national climate change strategy in place that could support the implementation of measures aimed to reduce $CO_2$ emissions by providing an overarching conceptual and legislative framework. Furthermore, comprehensive cost-effectiveness analysis and monitoring/evaluation processes remain to be developed. Also, Spain is not sufficiently considering action on reducing non-$CO_2$ GHG emissions, despite these being responsible for almost 25% of all GHG emissions in the country. There is likely to be considerable potential for emissions reductions from these gases, as other countries have found.

While Spain has developed the E4 energy efficiency strategy with sectoral targets, its implementation has been delayed and detailed measures to achieve the targets have not yet been developed. The government is advised to develop a concrete package of such policies and measures with appropriate funding and strong interministerial co-ordination without delay. The industry sector could potentially achieve further increases beyond the targets of the strategy in energy efficiency. It is recommended to evaluate the role of energy audits by the Institute for Energy Diversification (IDAE) in this context. It is also a challenge to curb the growing energy demand in household and tertiary sectors owing to its diffuse nature. The transposition of the EU directive on the energy performance of buildings offers the Spanish government the opportunity to take significant steps towards increasing energy efficiency in these sectors. It should, therefore, implement it rapidly and ensure its vigorous enforcement. Improved enforcement of energy labelling for appliances and the extension of advanced metering should also be pursued. Transport is another sector in which demand growth continues unabated. The Spanish government will have to address this with a comprehensive set of measures for urban mobility, modal shifts and fleet rejuvenation. For example, the effect of the existing vehicle renovation programme PREVER would be enhanced by linking the reduction in taxation with the purchase of fuel-efficient replacement cars making use of the EU fuel efficiency label.

The Spanish government has had great success in fostering the fastest growing natural gas market within the EU, at the same time as liberalising it well ahead of EU Directives. The government forecasts a growth rate of 17% for 2005, mostly driven by consumption at new combined-cycle gas turbine (CCGT) power stations that deliver increased security of electricity supply and reduced $CO_2$ emissions at the same time. This will require substantial investments in gas infrastructure such as gas transmission networks, LNG terminals and storage facilities. The government is mandating investment in the gas infrastructure and all consumers are shouldering their risks. While this has been instrumental in expanding the gas infrastructure, care should be taken that the guaranteed rates of return allow focusing investment on the most needed facilities. The government could also encourage market-funded development of the infrastructure with which Spain is well provided. At the same time, as witnessed in the supply cuts in December 2004 and February 2005, it is necessary to determine transparent procedures to deal with disconnection of interruptible consumers in case of a major supply disruption. The government will also have to accelerate the development of underground storage to ensure security of gas supply. The access tariff to gas infrastructure is the same across the system, with Spain treated as one zone, a system which could hamper removal of bottlenecks. It is recommended to consider the introduction of locational signals in the gas market.

The gas market has been fully open since January 2003, and in 2004, 80% of the gas was delivered in the competitive market, where almost all industrial consumers are supplied. On the other hand, only 1.2% of residential consumers have moved into the competitive market. With a view to strengthening consumer confidence in the gas market, the standardisation of contracts and market supervision need to be enhanced. For maximising the benefit of competition, the still considerable market power of Gas Natural needs to be continuously supervised by the regulator and the independence of the transmission system operator (TSO) needs to be enhanced through the publication of a network code.

Spain's traditional indigenous fossil fuel resource is coal, in the form of both hard coal and lignite. Quality problems and cost of production make Spanish coal less competitive, compared to imported coal. It is unlikely that recent price increases for coal on the world markets will change that situation. As a consequence, Spanish coal production was further reduced between 2000 and 2004, and there was significant investment expended to attempt to economically restructure the areas affected. Due to the importance of coal mining in the already economically depressed production areas, the Spanish government sees coal primarily in terms of a social and regional issue.

Spain has ambitious targets for renewable energy, another indigenous resource, of increasing the share of renewable energy sources in TPES and electricity generation to 12% and 29.4% respectively by 2010. To achieve this target, Spain has set up the 1999-2010 Renewables Promotion Plan. A fixed feed-in tariff that is differentiated by technology has been the primary tool to promote renewable electricity in the past, and has delivered impressive growth rates for wind generation, putting Spain in third place worldwide for wind generating capacity. In an attempt to increase cost-efficiency, the government introduced a new regime for selling renewable electricity in 2004, whereby renewable energy producers can directly sell their power to the market receiving the average market price plus differentiated premiums based on the market price. This is to be commended as a first step to incorporate a market-based element. However, care should be taken by the Spanish government to ensure that the whole system to promote renewable energy is cost-effective in achieving its goals. The premium will be reviewed every four years, and the technology learning curve should be appropriately incorporated. Allowing renewable energy producers to switch between the old feed-in tariff system and the new premium scheme to maximise their profits could increase the overall cost to the economy. Guaranteeing prices without a time limit could also result in over-subsidisation. In the mid- to longer-term perspective, the government is advised to study the potential of a more market-oriented approach such as a quota obligation with a green certificates trading system to achieve the national target in a more cost-effective manner. Overcoming supply bottlenecks is essential for the introduction of biomass, which lags far behind the target.

Spain embarked on the liberalisation of its electricity sector in the mid-1990s, ahead of the timetable set by the European internal market directives. The liberalisation process was very comprehensive and led to the establishment of all the necessary regulatory and market institutions. Spain is now among the IEA member countries with the longest experience in electricity market reform. Spain is still in a transitional phase where commitments made by companies ahead of liberalisation have been addressed, and where one aim has been to protect consumers from the effects of the uncertainties liberalisation may bring. With the many other energy policy challenges that have also been met during the transition, the electricity market has, however, evolved with a continuously high level of regulation and political involvement. This regulation has served a purpose but has also created many distortions in the market. The Spanish electricity market is now at a stage where the regulation that was meant to ease the transition has become a hindrance for its further development. Spain has an opportunity to revise the role that the market is given in the Spanish electricity sector to meet the objective of higher efficiency for the long-term benefit of all electricity consumers in Spain. Political and regulatory involvement should then be focused on establishing a regulatory framework for the areas where transparent regulation is crucial to maintain market efficiency, such as system reliability, market design, competition, regulation of networks and public service obligations.

Successful liberalisation with the objective of increasing efficiency in the sector is achieved by introducing competition among market players. Success will depend on the market concentration of incumbent utilities and whether there is regulation in place to enable newcomers to build new plants and to easily trade the electricity in the market. In this context, the Spanish electricity market could benefit from reducing the concentration of large electricity companies by encouraging further new entry into the market and improving the regulation of the electricity pool. It is important to ease the access for newcomers to lower the entry costs into the market. The number of generating companies is increasing and an important share of new and expected investment in CCGT is made by the smaller and newer entrants. CCGT plants are likely to set the market price most of the time in the future, so this may prove a particularly important development for market efficiency and competition. There are still some important pieces of information that are not published broadly. Information about the status of production plants, such as their availability and technical status, is not submitted to the market place. Information that is fundamental for analysing the demand/supply balance should be made public to all market players without delay.

The transmission grid and the operators of the Spanish electricity system seem to be able to meet the challenges from the increasing share of intermittent resources and other generating capacity. The few problems in the delivery of electricity to Spanish electricity consumers that were observed in recent years seem to derive primarily from problems in the distribution grid. This could indicate a need for a revision of the regulation of distribution activities. It should be considered whether local grid companies have the right incentives to make efficient investments. The introduction of regulation with an element of financial responsibility for the failure to deliver is commended. Since Spain covers a large geographic area, strong and transparent locational signals in price formation could improve the system efficiency. This will reduce the potential risk that congestion management is used by incumbents for market abuse. This is also crucial for the development of the interconnection capacity, in particular in the Iberian market with interconnection bottlenecks.

Enabling active participation by the demand side in the form of direct demand response to prices could provide efficiency gains. In particular, large industrial consumers have the potential to play an active role in balancing supply and demand when the system is constrained. So far, large industrial consumers have not had the incentive to participate in the liberalised market or even to change supplier. All consumers have the opportunity to be supplied through an integrated regulated tariff. The regulated tariff is based on a calculation of costs and the outcome of the calculation makes it difficult for suppliers to compete with an offer based on real market prices. In particular, the integrated regulated tariff offered to large industrial consumers and households seems to deprive these consumer groups of the incentive to go to the liberalised market.

Nuclear power is the most important indigenous energy source playing a vital role in terms of security of supply and GHG emissions reduction. The nuclear industry in Spain offers services and products that largely cover the needs of its nuclear power plant operators. Yet the current government has publicly expressed its willingness to phase out nuclear energy at least in the mid-term. This could hamper the stable and predictable operating of the market, further development of the regulatory environment and discourage further investment. Even though construction of new nuclear power plants may be difficult in the competitive market owing to economic reasons, the regulatory uncertainties caused by the government should be minimised. It should also be borne in mind that a nuclear phase-out could have significant implications for Spain's future energy security and climate mitigation policies. It is essential for the government to develop a reliable estimate of short-, mid- and long-term consequences of the phase-out.

Spain has a wide-ranging R&D programme that is reflecting well the country's energy supply mix. Spain has some very unique research programmes, and a well-skilled research base. Nevertheless, the Spanish energy R&D budget per thousand units of GDP is significantly lower than that of other European countries. Budgetary support for energy R&D should be continued and further strengthened to close this gap. Research activities funded by the government should attempt to bring in private partners, where appropriate, in order to enhance the cost-effectiveness of public research spending.

# RECOMMENDATIONS

*The government of Spain should:*

## General Energy Policy

- *Devote more attention to the demand side in energy policy-making.*
- *Improve energy forecasting outside the infrastructure planning process and beyond the current 2010-2012 time horizon.*
- *Reinforce security of supply and competition through enhanced interconnections by making them priority items within the energy infrastructure planning.*
- *Enable speedier decision-making and policy development by enhancing co-ordination of energy policy measures between different ministries and other layers of government.*
- *Strengthen the responsibility and independence of the regulator, the National Energy Commission (CNE), by investing it with more decision- and rule-making power.*

## Energy and the Environment

- *Develop a comprehensive set of measures (National Climate Change Strategy) specifically directed at decoupling GDP growth from energy use and $CO_2$ emissions, by investigating, identifying and quantifying the many promising fields for cost-effective reduction of $CO_2$ emissions.*
- *Closely monitor and annually evaluate the results and cost-effectiveness of this strategy.*
- *Closely monitor the availability of international carbon credits from Joint Implementation (JI) and the Clean Development Mechanism (CDM) and prepare necessary actions in case they are not available as planned.*
- *Look into additional cost-effective GHG reduction options in the field of non-$CO_2$ GHGs.*
- *Increase the use of fiscal instruments to internalise the environmental externalities of energy use. In particular, examine fuel taxation in relation to environmental externalities.*

- *Strengthen the dialogue among the central government, Autonomous Communities and town councils to achieve more sustainable energy systems.*

## Energy Efficiency

- *Develop concrete and effective policies and measures to implement the E4 Strategy and review it in the following years in order to more fully exploit the energy efficiency potential.*
- *Consider a shift of IDAE's budget to more investment in energy efficiency, and in particular strengthen IDAE's industrial energy efficiency activities.*
- *Implement and enforce significantly strengthened building codes. Regularly review and further strengthen these codes and support follow-up action in building certification. Train sufficient numbers of building inspectors to ensure successful implementation of the directive.*
- *Extend individual metering and billing of energy consumption in dwellings to existing buildings.*
- *Ensure that statistical information required for the planning and evaluation of energy efficiency policies is collected.*
- *Investigate the potential of smart metering for the reduction of energy use.*
- *Raise awareness of the benefits of energy efficiency through information campaigns and improved enforcement of energy labelling.*
- *Adopt measures to decouple transport demand growth from economic growth and encourage modal shifts towards more energy-efficient transport modes,* e.g. *the railways. The role of pricing should be investigated in this area.*
- *Use the PREVER system to improve car fuel efficiency by linking the registration tax reduction to EU fuel efficiency labels. Evaluate the experience of other EU countries in this respect.*
- *Encourage energy retailers and distributors to offer energy services and audits to their customers.*
- *Restrict support for combined heat and power (CHP) to plants that achieve energy efficiency gains.*

## Oil

- *Closely observe the market for oil products, including liquefied petroleum gas (LPG), and promote further competition by, for example, encouraging new entrants, such as hypermarkets, and by removing planning obstacles.*
- *Co-operate with the local authorities to avoid delays in licensing new filling stations.*

- *Encourage the use of gasoline hybrid and alternative fuel vehicles, including converting bus operation to natural gas.*
- *Ensure continuous fulfilment of IEA emergency stock requirements.*

## Natural Gas

- *Closely monitor and encourage the development of interconnections and liquefied natural gas (LNG) terminals, wherever possible by market-funded developments outside the system of guaranteed returns. Investigate whether especially new regasification capacity can be developed outside the regulated system.*
- *Create an environment in which the development of new storage facilities will be encouraged by allowing market fundamentals to be reflected in the price of gas; by reviewing the rate of return allowable for storage facilities relative to that for transportation; and by addressing siting, NIMBY and permitting issues to speed up the planning process.*
- *Set up an emergency plan in line with the EU directive on security of gas supply (2004/67, article 8).*
- *Monitor closely the development of the competitive market for natural gas and ensure that Gas Natural does not abuse its market power.*
- *Increase the transparency and independence of the transmission system operator (TSO) to avoid any risk of discriminatory behaviour.*
- *Review the access tariffs to the gas network with a view to introducing locational signals and correct pricing of congested assets.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Finalise and adopt a network code to ensure fair and standardised technical and commercial decisions for connection and access of third parties to the gas infrastructure.*
- *Promote and facilitate the development of the Spanish gas hub, and a liquid spot and balancing market.*
- *Review the policy on security of gas supply (particularly the 60% quota) in light of new developments in LNG and pipeline and move the focus towards the density of supply.*
- *Facilitate the timely transfer of market information to all participants.*

## Coal

- *Continue to reduce the subsidy to the coal sector, and at the same time accelerate investment into the regeneration and economic change of regions affected by reductions in mining in order to reduce the welfare and regional impacts.*

## Renewable Energy

- *Increase the transparency of the costs and benefits of the current renewables support system.*
- *Review the current scheme in order to assure cost-effectiveness while ensuring investor confidence with a view to reflecting the technology learning curve. Consider limiting the duration of the subsidy.*
- *Avoid hopping back and forth between old and new schemes.*
- *Eliminate possible double counting of carbon value between the European Union Emissions Trading Scheme (EU-ETS) and renewable energy promotion schemes.*
- *Consider and investigate more market-oriented mechanisms different from feed-in tariffs, taking into account other countries' experiences.*
- *Investigate the requirements of reliability and stability of the electricity network, given the significant increase of wind power on the grid.*
- *Identify the barriers to the increased use of biomass and address them in close co-operation with local governments and relevant ministries, in particular the Ministry of Agriculture. Due attention should also be paid to the potential available for the use of biofuels in transport.*

## Electricity

- *Consider removing the capacity payment or, as a temporary measure, replace it with a more efficient instrument.*
- *Redesign the cost of transition to competition system (CTC system) to remove its distortionary effect on the formation of electricity prices as soon as possible.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Ensure that all market players have equal access to all information that is fundamental to the demand-supply balance, including the status of generating plants.*
- *Encourage participation of particularly large-scale consumers in the wholesale market,* e.g. *through load-shifting.*

- *Review the regulation of distribution grids to ensure that the right incentives are given to allow for efficient investment and operation.*
- *Consider the introduction of transparent locational signals in price formation and tariffs. This is particularly important with the development of the Iberian market.*
- *Reinforce efforts to establish the Iberian market by agreeing on common rules.*
- *Improve trade across the Spanish-French border.*
- *Ensure transparent licensing procedures for electricity-related infrastructure.*

## Nuclear Energy

- *Ensure a stable and predictable operating and regulatory framework for nuclear.*
- *Assess the implication of extending the operating lives and increasing the capacity of existing nuclear plants on the national energy policy objectives, while ensuring high safety levels.*
- *Develop a clear vision about the future of nuclear backed by a quantitative assessment of the consequences of the nuclear phase-out on energy security, environmental protection and economic growth. Make such analysis publicly available and understood before taking a national decision.*
- *Ensure transparent and immediate disclosure of information on nuclear safety-related events and close monitoring of safety performance by the Nuclear Safety Council (CSN).*
- *Continue to develop high-level radioactive waste management solutions and take all the necessary steps to facilitate the decision-making by 2010 as planned.*

## Energy Technology and R&D

- *Continue and further strengthen a sustained support to energy RD&D*
- *Ensure close co-ordination between the Ministry of Education and Science and the Ministry of Industry, Tourism and Trade in the implementation of the national energy RD&D programme.*
- *Further enhance public-private co-operation.*
- *Continue and deepen the evaluation of the performance of the energy R&D programme.*

# TURKEY

Turkey has made impressive progress since the last IEA in-depth review in 2001. The government has made considerable efforts to address the "3 Es", namely energy security, economic efficiency and environmental protection, in a sustainable manner. New legislation will reduce the role of the government in energy markets and strengthen market forces in the sector. An independent regulator (EMRA) has been established, an ambitious privatisation programme has been announced, the United Nations Framework Convention on Climate Change (UNFCCC) has been ratified and the country is preparing legislation to address energy efficiency. A renewable energy law has been submitted to the Parliament for approval. Some important oil and gas transit pipeline projects are under way or nearing completion, which will improve the security of supply in Turkey and make it an important "energy corridor" between East and West. Investments have been made to extend domestic gas infrastructures and upgrade refineries. Nevertheless, Turkey still faces many challenges in all areas of energy policy.

Forecasts serving as a basis for the government's energy policy and energy enterprises' investment plans have been overestimating demand growth in Turkey, mainly owing to the previous overly optimistic assumptions of gross domestic product (GDP) growth and the effect of the economic crisis in 2001. While it is encouraging that most recent forecasts appear to be more realistic, the government needs to continue such efforts taking into account the effects of market liberalisation and privatisation.

Despite significant efforts to liberalise the energy markets, Turkey continues to rely on its state-owned companies. Although privatisation is not a prerequisite for market reform, it is necessary to restructure the state-owned enterprises into a corporate form operating under market competition and to prevent the Treasury from requesting annual income for the state budget. This would allow them to act as a player in the liberalised markets without government intervention, thus creating a level playing field. The already announced privatisation of the generation company (EÜAŞ) into several parts would bring immediate competition to the market and enhance efficiency within the company. The government is determined to create a *domaine réservé* for state enterprises for security of supply, including keeping large parts of the hydro generation facilities. Lack of transparent criteria for the level of government intervention could create uncertainties for market entrants and potential investors.

It is positive that the Energy Market Regulatory Authority (EMRA) has been given considerable powers such as setting the third-party access (TPA) tariffs, providing licences and making decisions not to be overruled by the government. At the same time, it is important that EMRA consults the different stakeholders and benefits from their experience in energy markets when preparing regulations.

Turkey has made significant progress with regard to environmental protection but more still needs to be done. The UNFCCC entered into force in May 2004. The country is in the process of developing its Climate Change Strategy and first national communication to the UNFCCC. The government should strive to monitor the effectiveness of the chosen policies and measures, both in terms of costs and emissions reductions. It should also consider defining an emissions target based on the momentum of the UNFCCC ratification. Co-ordination among the various government bodies will be key to the success of the strategy. Turkey has made significant progress in reducing local air pollution, particularly in large cities, but work remains to be done to ensure existing standards are met and to prepare for further reductions in air pollution. In this respect, it will be important to ensure that all market operators, including those owned by the State, comply with the existing air quality and emissions legislation. While investments have been made to increase security in the congested tanker traffic through the Turkish Straits, further action, such as seeking alternative transport routes, continued co-operation with other Black Sea nations and increased involvement of large oil and gas importing countries, appears necessary.

The general approach of Turkey's energy policy has been highly supply-oriented, with emphasis placed on ensuring additional energy supply to meet the growing demand, while energy efficiency has been a lower priority. Consistently high energy intensity and its imminent increase, partly attributable to the improving living standards, are matters of concern. To realise an energy savings potential of 25-30%, an Energy Efficiency Strategy was developed in 2004 and the government is preparing an Energy Efficiency Law. These positive developments lift the status of energy efficiency and conservation as part of the government's energy policy but stronger policies beyond those in the law are still needed. The evident lack of a comprehensive and co-ordinated energy efficiency policy for the transport sector is of particular concern.

The oil sector has gone through a profound reform. The 2003 Petroleum Market Law liberalised oil market activities, lifted price ceilings and removed import quotas on petroleum products at the beginning of 2005. EMRA has been assigned the responsibility to issue secondary regulations and licences, approve certain tariffs and carry out investigations concerning market activities. While its role in, for example, licensing is indispensable, it appears that there has been some level of over-regulation in other areas, possibly owing to a stated lack of consultation with the oil industry. Large-scale fuel smuggling in Turkey is a problem that degenerates the operating conditions for the legitimate market operators and reduces state revenues. The recent introduction of a national chemical oil marker will help.

Natural gas accounts for 23% of total primary energy supply (TPES) in Turkey. Gas demand has been growing rapidly but the overestimated demand forecasts, caused principally by the 2000-2001 economic crisis, have led to some risk of oversupply because most of the imports are based on long-term take-or-pay contracts. The domestic gas network is being extended quickly to allow more consumers to access gas. The new gas storage facilities can help to meet peak demand but decisions to build storage facilities to cover seasonal peak supply should be made on the basis of economic criteria taking into account alternative approaches, namely more flexible supply contracts, interruptible consumers and multi-firing in power plants. Large-scale gas transmission projects will enhance supply diversity, security of supply and competition in Europe and Turkey. However, their success will depend on the regulatory systems, including pricing, for gas transit, which will affect the viability of transit routes. It will also depend on the gas market reform given the large share of domestic consumption out of the total volumes of new pipelines.

The full implementation of the 2001 Natural Gas Market Law will substantially modify the gas market by transforming the monopolistic market structure into a competitive one through encouragement of new market entry and investments. While most of the necessary secondary regulation has been issued by EMRA and, in principle, 80% of the market is free to choose suppliers, competition has not developed because of the Petroleum Pipeline Corporation's (BOTAŞ's) *de facto* monopoly in imports. Other factors hampering competition are the lack of an independent transmission system operator (TSO) and incentives for eligible consumers to change suppliers owing to TPA tariff structures in the distribution networks. A flat price cap on all consumers constitutes cross-subsidies both between different consumer groups, notably from industrial consumers to residential consumers, and between different geographical areas.

The government wishes to maintain hard coal production to enhance fuel diversity, and consequently security of supply, but the policy is also closely related to social, regional and employment policies. Given its poor competitiveness, Turkish hard coal receives high and increasing subsidies per tonne. The International Energy Agency (IEA) considers that these indefinite subsidies are not justified because the international market in hard coal is well established and offers secure and reliable sources of fuel at prices, both now and in the future, that Turkish national production cannot match. Furthermore, Turkey has large lignite resources, which make a far bigger contribution to its security of supply and are much more competitively priced (without subsidies) than its hard coal resources ever could be. Nonetheless, there is a need for vigorous pursuit of productivity so that coal can compete as a fuel on equal grounds, even in the face of costs associated with tightening environmental requirements.

Turkey's use of hydropower, geothermal and solar thermal energy has increased since 1990. However, the total share of renewables in TPES has declined, owing to the declining use of non-commercial biomass and the growing role of natural gas in the system. The fixed feed-in tariffs and purchase obligation for distribution companies under the proposed new Renewable Energy Law can encourage investments. The maximum level, 6 eurocents per kWh, is moderate as compared to the levels given, for example, to wind power in some other IEA member countries. While the scheme may not become excessively expensive for consumers, which is a common risk in feed-in tariffs, careful monitoring and adjustment of the cost of the scheme will be necessary until it is fully replaced by the purchase obligation in 2011. Given the diverse availability of resources among different distribution areas, it needs to be ensured that distribution companies can buy renewable electricity from certified producers located in other distribution regions to be able to fulfil their obligation at minimum cost. Despite a large potential for use of heat from renewables (geothermal, solar thermal and biomass), there are no specific policies in place for heat production from renewables.

Turkey has recently announced that it will reopen its nuclear programme in order to respond to the growing electricity demand while avoiding increasing dependence on energy imports. The competitiveness of nuclear power in a liberalised electricity market in Turkey needs to be clarified. Investment decisions should be made on the basis of efficient and transparent price signals regardless of whether power plants are being built by private or public companies. Furthermore, waste disposal options need to be defined from the outset of launching a nuclear power project.

Despite a high reserve margin of 40%, Turkey will need more capacity in the mid-term because electricity demand will continue to grow rapidly. The recently launched rehabilitation programme for the thermal power plants to increase their efficiency is a prudent approach as it postpones the need to invest in new capacity. Nonetheless, new capacity will be needed in the next decade, which requires a good investment climate. Despite some reductions in distribution losses during the last couple of years, both technical and non-technical losses (totalling about 18% in 2004) are still a concern. One notable development is the progress in the project to interconnect with the European Union for the Co-ordination of Transmission of Electricity (UCTE) network, which is scheduled for 2006.

To date, there have been cross-subsidies in electricity prices both between different consumer groups, notably from industrial consumers to residential consumers, and between different geographical areas. It is positive that the government has announced that energy prices for each consumer group will be based on cost and that transparent tariff calculation rules have been established by the regulator. However, regional cross-subsidies will remain at least for the next five years.

The government should be highly commended for the initiative to create competitive electricity markets. The steps taken so far have created a window of opportunity to implement successful reform with clear and significant benefits. Now, decisive action will need to be taken to see the process through to a successful conclusion.

The adoption of the 2001 Electricity Market Law was a major milestone. It established EMRA, which has issued most of the necessary secondary legislation. The legislation has been supplemented by the 2004 Electricity

Strategy. Despite the good legislative and regulatory framework, not much competition has developed for a number of reasons. There is a lack of consumer choice caused by the small number of market players; new entrants have difficulties competing with the state-owned incumbent who owns competitive depreciated generation units including hydropower. Furthermore, the current generation overcapacity and lack of cost-reflective prices have made new investment unattractive. In addition, the Build-Own-Operate (BOO) and Build-Operate-Transfer (BOT) schemes have a relatively high market share (with high guaranteed price) and only 29% of the market has been made eligible to choose suppliers. The Electricity Strategy contains the key elements for tackling these issues, including the privatisation of EÜAŞ and handling the stranded cost issues caused by the BOO and BOT schemes. However, it will also be important to consider if the share of the liberalised market can be increased sooner than planned and to ensure that the transmission system and market operator (TEÍAŞ) is independent from government control in its normal operation. Establishment of an electricity exchange would facilitate trade and introduce more competition. Cost-reflective pricing will be vital.

Given that Turkey is facing significant energy and environment policy challenges, the government needs to explore all possible means to respond to these challenges, including formulating a coherent energy research and development (R&D) policy. To implement such a policy, a coherent energy R&D strategy with adequate financing as well as good co-operation among the different ministries is necessary. This could be done by building on the work done for the National Research and Technology Foresight Programme (Vision 2023 Programme).

## RECOMMENDATIONS

*The government of Turkey should:*

### General Energy Policy

- *Take into account the effects of liberalisation in the energy forecasts. Continue to revise forecasts regularly to enable the creation of a robust long-term energy policy framework in light of the sharp demand growth.*
- *Increase focus on the demand side (energy efficiency) in energy policy planning and implementation.*
- *Continue the process of liberalisation and privatisation of the energy sector in a transparent way. Specifically:*
  - *Determine clearly the role of the involved parties,* i.e. *the government, the regulator, state companies and other energy industries.*

- *Create a level playing field for market entrants and avoid giving state enterprises a special role in competitive areas of the market beyond the predefined transition period.*
- *Ensure that the interests of the final consumers remain in the central focus of the liberalisation process.*
- *Ensure that privatisation is implemented in a way that contributes to the creation of competitive markets.*

- *While avoiding interfering with the work of the energy market regulator, ensure that it follows the appropriate consultation processes when formulating regulations.*
- *Improve co-ordination among government agencies in all areas related to energy. Involve all stakeholders, in particular consumers, in developing energy policies.*
- *Ensure that energy prices are cost-reflective.*

## Energy and the Environment

- *Complete the national climate change mitigation strategy and first national communication to the UNFCCC as soon as possible.*
- *Define a framework to monitor and evaluate, in terms of costs and carbon emissions, the effectiveness of the policies and measures included in the national climate change mitigation strategy.*
- *Build on the momentum created by the ratification of the UNFCCC to consider defining an emissions target.*
- *Clearly define the roles of the different ministries and agencies involved in air quality monitoring and enforcement.*
- *Ensure the Ministry of Environment and Forestry has adequate resources to monitor and enforce environmental legislation.*
- *Ensure that all market operators, including those owned by the State, comply with the existing air quality and emissions legislation.*
- *Put in place a clear investment schedule to complete the retrofitting of flue gas desulphurisation equipment on all old power plants.*
- *Clearly define a schedule for the introduction of the new legislation on air quality standards giving clear signals to market participants.*
- *Clearly define how responsibilities are shared among ministries and municipalities with regard to transport-related air pollution and encourage co-operation.*

- *Continue efforts to reduce the risk of marine pollution in the Black Sea and Marmara Sea, notably through enhanced co-operation with countries bordering the Black Sea and with large fossil fuel-importing countries.*

- *Consider the reintroduction of tax benefits for liquefied petroleum gas.*

## Energy Demand and End-use Efficiency

- *Promptly enact the Energy Efficiency Law, implement the measures in the Energy Efficiency Strategy and carefully monitor and evaluate their impacts, including the cost-effectiveness.*

- *Strengthen energy efficiency measures in the industrial sector by:*

  - *Introducing specific fiscal and financial incentives and third-party financing.*

  - *Expanding energy audit and energy manager obligations beyond large enterprises.*

  - *Exploring the possibility of voluntary agreements with industries with quantitative targets.*

- *Encourage energy efficiency in buildings by:*

  - *Demonstrating leadership by improving energy efficiency in public buildings.*

  - *Strongly enforcing the building standards for new buildings.*

  - *Introducing mechanisms to improve energy efficiency in existing buildings.*

  - *Setting high efficiency standards for air-conditioning equipment and other appliances.*

- *Integrate energy efficiency objectives in developing transport policy by, for example, promoting public transport, fostering inter-modal changes away from road transport and improving the energy efficiency of the vehicle fleet through economic and regulatory incentives. Improve transport statistics.*

## Oil

- *Solve the problem of fuel smuggling.*
- *Encourage the industry to develop a Turkish Straits bypass, which is commercially feasible and is located far enough from the environmentally sensitive zones of the Black Sea, the Strait of İstanbul and the Marmara Sea.*
- *Ensure that the regulator focuses on the monitoring of competition in the downstream oil market and takes a light-handed regulatory approach.*
- *Complete the privatisation of the Turkish Petroleum Refinery Corporation (TÜPRAȘ) in a way that reduces its dominant role in the refining market.*
- *Corporatise the Turkish Petroleum Corporation (TPAO) and consider its privatisation. Give TPAO the possibility to integrate vertically in the downstream oil market.*
- *Establish clear and precise oil stockholding arrangements to define the obligation for each type of oil market operator.*

## Coal

- *Promote the advantages of domestic coal reserves as a fuel and continue reforms of the coal industry to ensure it can compete on equal and competitive terms in an open electricity market, but refrain from intervention (such as providing subsidies for coal or allowing exemption from environmental regulations), which would distort the market.*
- *Rapidly step up efforts to increase productivity in coal mining, including through possible privatisation of state-owned operations, or accelerating current moves to lease and contract mining operations.*
- *Reduce coal subsidies with the aim of eliminating them, and set a clear deadline for this abolition. Replace the subsidies by restructuring programmes to address social impacts.*

## Natural Gas

- *Encourage the expansion of the gas distribution networks to new cities for the environmental benefits and to enable imports by new entrants from any supplier, thereby reducing BOTAȘ's market power.*
- *Continue to promote gas transit routes and establish the necessary regulatory framework.*
- *Make natural gas prices cost-reflective for all consumer groups. Eliminate cross-subsidies between different customers.*

- *Develop and support mechanisms to divest existing imports, in accordance with a defined schedule, to provide a fair chance for new entrants. Clarify the role of the government and BOTAŞ in this process.*

- *Lift the restrictions on sources of natural gas imports by other parties from countries where BOTAŞ is importing, while paying due attention to diversification of supply sources.*

- *Monitor the market power of external gas suppliers.*

- *Define the exact steps to be taken to establish a fair and transparent open market as envisaged in the Gas Market Law. Closely monitor the progress.*

- *Establish an independent gas transmission system and storage operator by effective unbundling of BOTAŞ. Corporatise BOTAŞ.*

- *Review third-party access tariffs to the distribution networks and storage to enhance the possibilities of eligible consumers to switch suppliers.*

## Renewables

- *Consider steps to accelerate economic hydropower projects, including refurbishment, consistent with the protection of the environment, to utilise the remaining hydropower potential.*

- *Enact the Renewable Energy Law as envisaged and monitor and evaluate its cost and effectiveness.*

- *Share information and experience with other countries introducing quota- and certificate-based promotional schemes for renewables.*

- *Assess the impact on the network reliability and stability resulting from increased penetration of intermittent wind power and explore ways to minimise such an impact. Consider a combination of wind power and pumped storage hydro for this purpose. Share information and experience with other countries on technical and regulatory approaches to intermittency.*

- *Investigate the extent to which policies and measures are needed to promote the use of renewables in heat production, co-generation and transport.*

## Electricity, Nuclear Power and Co-generation

- *Encourage the rehabilitation of the thermal power plants to increase their efficiency where economically feasible.*

- *Allow the market participants to decide when and what kind of new power capacity will be built. Clarify the level of intervention which is considered necessary for security of supply and environmental reasons, and clearly specify the criteria under which such interventions should occur.*

- *Continue the efforts for synchronisation of the Turkish power system with the European grid of the Union for the Co-ordination of Transmission of Electricity (UCTE).*
- *Ensure that effective regulation creates incentives for distribution companies to continue decreasing technical and non-technical losses.*
- *Make sure that the transmission system and market operator (TEİAŞ) is independent from government control in its normal operation, including the development of the network.*
- *Encourage the establishment of an electricity exchange to facilitate trade and to introduce more competition.*
- *Carefully consider the sequence of market reform. In particular, ensure that the legal and regulatory framework, independent transmission system operator and spot market are fully implemented before proceeding with privatisation.*
- *Ensure that the privatisation programme can be efficiently implemented without delays.*
- *Create a sound legal framework for the use of nuclear power. Clarify the role of nuclear power in the future in terms of economic competitiveness. Define nuclear technology choices and waste disposal options before building nuclear power plants.*
- *Evaluate the potential for co-generation and pay due attention to the cost-effectiveness of future policies.*

## Research and Development

- *Build on the work done within the Vision 2023 Programme to prepare a coherent energy R&D strategy. It should have adequate financing and efficient allocation in line with energy policy objectives to maximise energy R&D's contribution to the significant energy policy challenges in coming years.*
- *Concentrate on the adaptation of existing technologies and their early deployment, particularly in areas where there is a clear competitive advantage and need.*
- *Improve the collection of data on governmental R&D funding.*
- *Actively encourage the formation of private-public partnerships and, as appropriate, provide incentives for energy companies to increase R&D expenditures.*
- *Facilitate adequate R&D investment by the state-owned entities and ensure that incentives are provided post privatisation.*

PART 2.2

## STANDARD REVIEWS

This part contains the 2004/2005 Standard Reviews for the following seven countries, updating the situation since these countries underwent the in-depth reviews of the 2002/2003 review cycle. The report reflects the situation when they were drafted from July to September 2005.

### FINLAND

### HUNGARY

### IRELAND

### ITALY

### JAPAN

### SWITZERLAND

## SUMMARY OF RECENT DEVELOPMENTS

The year 2004 was largely marked by the implementation of the Emissions Trading Directive. In 2004, the Finnish government adopted a decree on emissions trading and the Ministry of Trade and Industry (MTI) adopted a decree on the monitoring of emissions. The entire Emissions Trading Act was enforced by a separate decree from 15 December 2004. In December 2004, the government also approved the allocation of emission allowances by installations for the years 2005-2007. Emissions trading began in January 2005.

The revision of the National Climate Strategy (completed in 2001) began in 2004. The implementation of the Emissions Trading Directive will be an integral part of the revised climate and energy strategy, which includes outlines for the use of the so-called Kyoto mechanisms and carbon sinks, such as forests, that absorb emissions. The guidelines for the period after 2012 are also part of the work. Several studies and evaluations have been carried out in order to provide background information for the preparation of the strategy. Among these are the evaluations of the different elements of the current Climate Strategy. The government is to present a report on the new climate and energy strategy to Parliament in autumn 2005.

In January 2004, electric utility, Teollisuuden Voima Oy (TVO), applied to the government for a construction licence for a new nuclear power plant unit. The government granted the construction licence in February 2005.

The amendments to the Electricity Market Act and the Natural Gas Market Act came into force at the end of 2004. The aim was to implement the EU's new Directives on the Internal Markets for Electricity and Natural Gas adopted in 2003 and the central outlines for the development of the electricity market included in the government programme. Among other issues, these concern the supervision of the markets and the return of excess charges collected.

## GENERAL ENERGY POLICY

### GOVERNMENT ENERGY ORGANISATION

The tasks of the Energy Market Authority, which is responsible for regulating the electricity and natural gas markets, were extended to cover all regulatory activities related to emissions trading. The Energy Market Authority was designated the national emissions trading authority and the unit responsible for maintaining a national emissions registry. In addition, the amendments made to the Electricity Market Act and the Natural Gas Market Act (covered more in the Electricity section below) mean a new era in the regulation of distribution pricing. The process for monitoring reliable delivery of electricity was improved by giving the Energy Market Authority new tasks relating to the monitoring and reporting of the balance between electricity production and consumption. The resources of the Energy Market Authority have been enhanced by expansion of the staff.

Statistics Finland was designated the national inventory unit for the evaluation and reporting of greenhouse gas emissions.

## ENERGY TAXATION

In line with the Climate Strategy, energy taxation was reformed from the beginning of 2003. Tax subsidies can now be granted for electricity produced from recovered fuels and biogas, and higher subsidies can be paid for electricity produced from forest chips than from other wood sources. Other tax subsidies for electricity production remain unchanged. In addition, energy taxes were raised by some 5%, effective from the beginning of 2003.

## OUTLOOK/OFFICIAL FORECASTS

Projections of energy supply, consumption and related emissions up to the year 2020 have been developed using the so-called WM scenario (or With Measures) produced in 2004. The WM scenario assumes the continuation of all current measures affecting energy consumption and production. These include the Biofuel and Renewable Energy Sources Directives; the building regulations affecting the heat economy of buildings; energy taxes and subsidies; the financing of research and testing related to energy technology; and other decisions already made that affect the structure of the energy market (*e.g.* electricity import capacities, nuclear energy capacity and hydropower). It should be noted that the new climate and energy strategy will introduce additional measures that are aimed at decreasing $CO_2$ emissions and thus influence the figures below.

The total consumption of energy will grow from approximately 1 400 PJ in 2002 to 1 540 PJ in 2010 and further to 1 630 PJ in 2020. This represents a clear slow-down in consumption growth compared to previous years. The projected average annual growth for the years 2002-2020 is 1% a year, whereas it was over 2% per annum in the years 1985-2001. Carbon dioxide ($CO_2$) emissions from combustion of fossil fuels and peat will increase to 69 Mt in 2008.

Following the start-up of a new nuclear power plant in 2009, emissions will fall to 62 Mt in 2010 and then grow to 65 Mt by 2020.

The use of oil and hydropower will remain more or less at the current level with the most significant growth seen in the use of natural gas, nuclear power and wood-based fuels. The volume of peat consumption and electricity imports will decrease.

**Energy Consumption for Each Primary Energy Source** (PJ)

| *Energy source* | *1990* | *2002* | *2010* | *2020* |
|---|---|---|---|---|
| Oil in total | 376 | 360 | 354 | 351 |
| Coal, coke, furnace and coke gases | 167 | 187 | 179 | 191 |
| Natural gas | 91 | 155 | 194 | 215 |
| Nuclear power | 198 | 233 | 339 | 378 |
| Net imports of electricity | 39 | 43 | 31 | 25 |
| Hydropower and wind power | 49 | 38 | 46 | 46 |
| Peat | 56 | 88 | 81 | 87 |
| Waste liquors from wood refining industry | 86 | 145 | 155 | 164 |
| Other types of wood use | 81 | 151 | 156 | 169 |
| **Total** | **1 141** | **1 401** | **1 535** | **1 626** |

Source: Government submission.

## ENERGY SUPPLY AND DEMAND

In 2003, Finland's estimated total primary energy supply (TPES)[1] was 37.6 Mtoe, a 5.4% increase from 2002. Over the medium term (1990 to 2003), TPES has grown at an average annual rate of 2.0% and over the longer term (1973 to 2003) TPES has grown by 1.9% annually. For European IEA countries as a whole, the annual average growth of TPES from 1973 to 2003 was 0.9%. Finland has one of the most diverse ranges of fuel supplies within the IEA with five different energy sources accounting for at least 10% of the total primary energy. In 2003, oil was the most widely used fuel, accounting for 28.6% of the total, followed by biomass (19.5%), nuclear power (15.8%), coal (15.7%), and natural gas (10.9%). Other fuels are peat (6.3%), hydropower (2.2%) and imports of electricity (1.2%). The most significant anticipated change in these percentage figures in the coming years is the increase in the share of nuclear. With the introduction of the new nuclear facility in 2010, its share will rise to 21.5% in 2010.

1. These and all statistics in this section are drawn from *Energy Balances of OECD Countries*, IEA/OECD, 2005.

In 2003, Finnish total final consumption (TFC) was 26.2 Mtoe, the same figure as in 2002. Over the medium term (1990 to 2003), TFC has grown at an average annual rate of 1.1% and, over the longer term (1973 to 2003), TFC has grown by 1.0% annually. In 2003, industry accounted for 48.1% of TFC, followed by the residential sector (19.8%), transport (18.1%) and other (mainly commercial, 13.9%).

## ENERGY AND THE ENVIRONMENT

The Emissions Trading Act implementing the Emissions Trading Directive (2003/87/EC) came into force in August 2004. At the same time, the government also adopted a decree on emissions trading while the Ministry of Trade and Industry adopted a decree on the monitoring of emissions. The entire Emissions Trading Act was enforced by a separate decree as from 15 December 2004.

In December 2004, the government approved the allocation of emission allowances to installations for the years 2005-2007. The total amount of emission allowances was set at 136.5 million tonnes of carbon dioxide for the three years, which includes a reservation of 2.5 million tonnes for new entrants. When presenting the allocation plan to the European Commission, Finland also applied for permission to include district heating plants with a rated thermal power of 20 MW or less within the sphere of emissions trading. The justification is that all utilities and installations producing heat for the same district heating network would then be treated equally. On 2 December 2004, the EU Climate Change Committee approved Finland's application unaltered.

On 10 February 2005, the Ministry of Trade and Industry issued a decree on the verification of the GHG emission monitoring methods and the annual emission reports of the operators within the scope of the Emissions Trading Act. According to the Emissions Trading Act and related decrees, an installation covered under the emissions trading scheme shall have its emissions verified by an external independent verifier. The new decree on verification of emissions includes provisions on the conditions for authorising a verifier, the authorisation procedure and the verification process itself. The Energy Market Authority authorises all verifiers while the Finnish Accreditation Service (FINAS) evaluates verifiers' competence.

Regarding the flexible mechanisms of the Kyoto Protocol, in 2003 Finland joined the Baltic Sea region's Testing Ground Agreement and the Carbon Fund. The agreement will help to bring closer co-operation between the Baltic Sea States on issues such as the Kyoto Protocol mechanisms. As a member of the Carbon Fund, Finland benefits from a certain proportion of the carbon emissions reductions in the Baltic Sea region, which can help it reach its national emissions reduction commitment.

Implementation of the climate change communications programme is continuing under the leadership of the Ministry of Trade and Industry (MTI), together with three other ministries and the National Board of Education.

Regarding air quality, the amendment of the Directive relating to the Quality of Petrol and Diesel Fuels (2003/17/EC) was adopted as a part of national legislation. The statute on the combustion of waste came into force in 2003. The following year the government approved a plan to decrease the $NO_x$ emissions from old combustion plants. This plan is part of the implementation of the LCP-directive and the Commission's approval for the plan is still pending.

## ENERGY DEMAND AND END-USE EFFICIENCY

The implementation of the Action Plan for Energy Efficiency (2003-2006) has continued.

Since 2003, energy aid for dwellings has been granted for measures that improve the heat insulation of residential buildings, renew and repair ventilation and heating systems and their operation, or that introduce renewable forms of energy. The aid concerns buildings comprising at least three dwellings.

The stricter building regulations on the energy efficiency of new buildings entered into force in October 2003. The energy efficiency of heat insulation and ventilation was tightened by 30% compared to the previous required level. The implementation of the Directive on the Energy Performance of Buildings is ongoing and several aspects of the energy efficiency of buildings will be dealt with in this context.

## RENEWABLE AND NON-CONVENTIONAL FUELS

The implementation of the Action Plan for Renewable Energy (2003-2006) has continued. According to the Action Plan, the use of renewable energy should be increased by around 30% by the year 2010, compared to the year 2001. The vision is that by 2025 the renewable energy sources would be used approximately two-thirds more than at present. The Action Plan is expected to cut the carbon dioxide emissions by 4-5 million tonnes from the "business-as-usual" scenario in 2010. The amount of the reduction will depend on the fuels replaced.

Among central measures included in the Action Plan are the development and commercialisation of new technology and financial incentives, such as energy taxation, investment aid and subsidies for the production of wood chips. Voluntary agreements, information dissemination, education and training are also used to increase the utilisation of renewable energy sources.

Recently, the relevant government authorities have clarified the interpretation of land-use planning, which has made the licence application process for wind power plants more straightforward.

## NATURAL GAS

The Finnish gas company, Gasum, is studying the possibility of increasing its gas imports by some 20 TWh/year (1.9 billion cubic metres, bcm) from 2009 with the construction of a new sub-sea gas pipeline linking Finland to Estonia. Finland consumed 4.7 bcm of gas in 2004. The 100-kilometre pipeline would then join to Latvia's gas network to allow Gasum and Estonia's Eesti Gaas to receive gas from the Latvijas Gaze-operated underground gas storage unit at Incukalns. Gas could start to flow from Incukalns to Estonia and Finland in 2009/10. Investment in the offshore pipeline and an accompanying compressor station is estimated at USD 155 million.

In February 2005, Gasum and Russian gas supplier Gazprom agreed to extend a long-term gas supply deal to 31 December 2025. The deal envisages the volume rising over 15% to reach 6 bcm per year by 2008. No details of terms were given.

## ELECTRICITY

### LEGISLATION ON THE ORIGIN OF ELECTRICITY

Legislation on the origin of electricity was adopted in December 2003 and came into force at the beginning of 2004. This law requires that the transmission system operator (TSO) provide guarantees of origin for all electricity that passes through the grid. These guarantees concern the respective power plants' production method, fuel source and quantities generated.

### INTERNATIONAL TRANSMISSION CONNECTIONS

A submarine cable (350 MW) will be constructed between Finland and Estonia. By April 2004, the European Commission, and Finnish and Estonian authorities had approved an exemption from the Electricity Market Directive that allowed the Estlink submarine cable project to proceed. According to the exemption, the owners of the cable are given a special right regarding its use. Estlink is the first interconnection between Baltic and Nordic electricity markets. Estlink will be a direct current cable between two substations – Harku 330 kV substation (Estonia) and Espoo 400 kV substation (Finland). The completion of the Baltic-Finnish submarine cable is scheduled for the end of 2006. The Baltic companies Eesti Energia, Latvoenergo and Lietuvos Energija have, together with the Finnish Pohjolan Voima och Helsingin Energia, founded a company called Nordic Energy Link SA to build the cable and control its operation. The Finnish parties own altogether 10.1% of the company.

Russia and Finland are linked by a 1.3 GW electricity interconnector. At the beginning of 2005, 900 MW of this capacity were to be made available, with the remaining 400 MW still under long-term contract. Eleven companies bid for the 900 MW of available interconnections. The winning bidders were EGL Nordic AS (200 MW), Norsk Hydro ASA (200 MW), RAO Nordic Oy (250 MW) and Scaent AB (250 MW). Finnish transmission system operator, Fingrid, announced that as of the end of 2004, the total capacity of the Russian interconnector has been in almost full use, except occasionally during nights and on week-ends.

A pan-Nordic scheme to reduce bottlenecks in the region's high-voltage network took a step forward on 22 February 2005 with the decision by Finnish and Swedish TSOs, Fingrid and Svenska Kraftnät, to construct the first of a series of new cross-border transmission connections. The 600-800MW Fenno-Skan 2 sea cable is one of five new lines within the Nord Pool price area proposed by Nordel, the association of Nordic electricity transmission companies. The two companies would share investment and ownership equally. The cable, to cost approximately EUR 200 million, will be a 300-kilometre direct current connection with power converter stations at each end. In Finland, the cable will connect to the main grid at the Rauma substation and in Sweden at the Finnböle substation located north of Stockholm. It and the other four interconnectors planned under the scheme are all scheduled to be in operation by 2010.

The connection would reduce the price differentials between Finland and Sweden and decrease hedging costs for market players. Imbalances within the Nordic area and the formation of individual spot price areas within Nord Pool became particularly noticeable during early 2004 when reservoir levels were low. Electricity transmission volumes from Finland to Sweden were high during the early part of 2004 and until autumn 2004, with Finland frequently forming a price area of its own in the market.

## ELECTRICITY AND NATURAL GAS MARKET ACTS

The control of the electricity and natural gas grids was revised by introducing a new system of supervision based on four-year surveillance periods. Under this system, the bases for calculation and the terms of fees to be observed by the system operators are confirmed in advance. The periodic examination of operations allows companies to adapt more flexibly to annual changes, for example in investment needs. According to the new system, after the surveillance period, the operator must return any excess yield to customers, through pricing during the following surveillance period. As regards decisions made by the Energy Market Authority, a two-tier appeal system was introduced.

Appeals concerning decisions on the supervision of fees are processed by the Market Court, which acts as a first court of appeals.

In addition, distribution companies with at least 200 million kWh of electricity transmitted annually should separate their distribution operations from any generation and/or sales functions of the company by the beginning of 2007. This obligation covers some 35% of the distribution companies in Finland and 85% of the electricity transmitted in the distribution systems. Small distribution companies may continue to operate in accordance with the traditional company structure, if they so wish.

The provisions concerning the metering of the electricity supply were reformed. The new requirements include a higher precision of measurement and the installation of meters for individual dwellings. Distribution companies are now required to offer their customers at least four different standardised metering service packages.

To meet the requirements set out in the Electricity Market Directive, legislation on the procedures for organising an invitation to tender to ensure the adequacy of electricity was introduced as part of the revision of the Electricity Market Act.

## NORDIC ELECTRICITY MARKET

At their meeting in Akureyr in 2004, the Energy Ministers of the Nordic countries agreed on measures to further develop the functionality of the electricity markets and guarantee the supply of electricity. The first phase will review questions associated with main grid operations, system responsibility and realisation of the electricity transmission investments important to the Nordic markets. The aim is to carry out the work in close co-operation with the Nordic main grid companies responsible for these functions.

## NUCLEAR POWER

In January 2004, Teollisuuden Voima Oy (TVO) applied to the government for a construction licence for a new nuclear power plant unit. The MTI set in motion an extensive consultation process, after which the Radiation and Nuclear Safety Authority (STUK) gave its own statement on the matter. During the review of the licence, the aim was to ensure that the selected plant would meet the safety requirements set for it. Throughout this process, the government solicited comments from the public, industry and various ministries, and received comments from 30 different authorities and over 40 private individuals and organisations. The government granted the construction licence on 17 February 2005. Under the terms of the licence, TVO may construct a new power plant unit, to be called Olkiluoto 3, with a thermal output of 4.3 GW and net electric output of 1.6 GW. The plant will be built on the island of Olkiluoto, in the municipality of Eurajoki in western Finland, and will be supplied by the French-German consortium of Framatome ANP and Siemens.

Preparatory work has already been carried out on the site and a building permit from the municipality of Eurajoki was granted in January 2005. The construction of the plant itself will take approximately four years. In 2007, TVO is to submit a statutory application for an operating licence to the government. The government processing of this licence will take around one year and, if granted, TVO will then be allowed to load nuclear fuel into the reactor. According to TVO's plans, the new unit could start operating in 2009.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

The beginning of 2003 saw the launch of a new four-year nuclear safety research programme called SAFIR. The Nuclear Energy Act was amended and the amendment came into force at the beginning of 2004. According to the amendment, the National Nuclear Waste Management Fund is now the major provider of financing for both SAFIR and the Finnish Research Programme on Nuclear Waste Management (KYT). The funds will be collected from the owners of the nuclear power plants and parties with responsibility for nuclear waste disposal, and they will be placed in the Fund under two separate research provisions.

Energy conservation and renewable energy sources are important areas in the ClimBus Technology Programme launched in 2004 by the National Technology Agency Tekes. Reduction of greenhouse gas emissions offers new possibilities for companies to increase their business and ClimBus aims to find and promote technological options to mitigate climate change. The programme focuses on the development of technologies, services and business models. The programme lasts for five years (2004-2008) and it is managed by Tekes, which also provides approximately half of the funding. ClimBus is based on the earlier technology and climate change programme, Climtech (1999-2002). Within Climtech, information was gathered about technological options to mitigate climate change and related business opportunities for Finnish companies.

## MAJOR POLICY DEVELOPMENTS

EU accession has had significant implications on energy policies in Hungary. The transposition of the *acquis communautaire* and the unification of Hungarian markets with EU markets, including conformity with the relevant EU directives (electricity, gas, emissions trading, etc.), are acting as the main drivers for such changes.

The most recent developments are the modification of the Electricity Act and the Natural Gas Act in order to bring them into line with the new EU market liberalisation objectives, which means that 100% of both markets will be opened from mid-2007. Hungary has partially liberalised both the electricity (1 January 2003) and natural gas markets (1 January 2004). From 1 July 2004 all non-household consumers are defined as eligible consumers. The "real" competitive market is currently 27% in the electricity sector, and 6% in the gas sector. Since the approval of its National Allocation Plan, Hungary is now participating in the EU Emissions Trading Scheme (ETS).

The Hungarian government also decided to prepare a new long-term (to 2030) energy strategy. In line with this decision, 17 working groups have been established to prepare the details. The deadline for completing the preparation of the strategy is the end of 2005 for submission to the Parliament early in 2006.

## GENERAL ENERGY POLICY

### GOVERNMENT ENERGY ORGANISATION

The Hungarian Energy Office (HEO) has developed into a large institution covering electricity and gas, as well as heat that is sold by power stations with a capacity above 50 MW to district heating facilities.

The HEO has the following responsibilities:

- Licensing of companies operating in the gas and electricity markets.
- Calculating wholesale and end-user regulated gas and electricity prices for users in the competitive markets and preparing the corresponding decrees which are signed by the Minister of Economy and Transport.
- Protecting consumers' interests.

The HEO is an independent organisation. It submits an annual report to the Parliament, not to the government. HEO's president and vice-president have six-year mandates. They are selected by the Prime Minister based on a proposal made by the Ministry of Economy and Transport. Decisions taken by the HEO can only be opposed by a court decision. Its financial independence is secured by different licensing fees. The HEO has authorised staff of about 100. Decisions on pricing for captive consumers are taken by the ministry, not the HEO.

## ENERGY TAXATION

Hungary has started the revision of taxation to conform to EU requirements on energy taxation and has also introduced a new environmental levy on air, water and soil.

## OUTLOOK/OFFICIAL FORECASTS

In line with the preparation of the new Energy Strategy, a working group has been established on the energy forecast issue. The deadline for the delivery of the new official energy outlook (up to 2030) is mid-autumn 2005.

# ENERGY SUPPLY AND DEMAND

In 2003, total primary energy supply (TPES) was 26 Mtoe, which is 9% below the 1990 figure. The share of coal decreased from 21% to 14%, while that of gas increased from 31% to 45% during this period. The share of combustible renewables and waste increased from 1.3% to 3.1% over the same period. In 2003, oil represented 24%, and nuclear 11% of TPES. About 83% of Hungary's TPES was derived from fossil fuels.

Hungary's total energy production declined substantially by 27%, from 14 Mtoe in 1990 to 10 Mtoe in 2003, with most of the decline coming from a 40% reduction in gas production, and closures in coal production resulting in a 35% reduction. Hungary's net imports grew slightly from 14 Mtoe in 1990 to 16 Mtoe in 2000. About 61% of Hungarian net imports are gas, while 29% are oil.

Hungary's TFC saw very slight growth in 2003, from 18.5 Mtoe in 2002 to 19 Mtoe in 2003. This was led largely by the transport and residential/commercial sectors where energy consumption grew by 0.16 Mtoe and 0.63 Mtoe respectively, while the industrial sector saw a reduction of 0.26 Mtoe.

## ENERGY AND THE ENVIRONMENT

Hungary became a signatory to the Kyoto Protocol in 2002. The Hungarian commitment is minus 6%, based on average GHG emissions of 1985-1987. The Hungarian Parliament approved the new Act on Carbon-dioxide Emissions Trade in April 2005 to harmonise with the EU-ETS Directive (2003/87/EC). The principles of the National Allocation Plan were approved by the government and by the EU Commission in December 2004.

On the basis of the Hungarian official forecast, the continuing growth in economic activity throughout the period 2008-2012 will lead to increased greenhouse gas emission levels. From a level of 79.5 Mt $CO_2$ in 2001, greenhouse gas emissions are expected to rise to 102 Mt $CO_2$ by 2012. In the Kyoto Protocol's first commitment period – that is, in the five years from 2008 to 2012 – expected average gross greenhouse gas emissions will be equivalent to 97 Mt $CO_2$. This is less than Hungary's commitment under the Kyoto Protocol, 105 Mt $CO_2$. The growth rate of greenhouse gas emissions is also increasing. It is expected to increase from 2.04% in 2001/02 to 2.44% in 2011/12.

Hungary projects greenhouse gas emissions for the whole economy using a General Equilibrium Model. This will be supplemented with the greenhouse gas emission projections from twenty studies to be undertaken for individual sectors. These two approaches have different purposes. The studies for the individual sectors will show the emission levels that are expected to follow from the projected activity level of the various sectors, whilst the macroeconomic study will show the relationship between the expected national emissions and the Kyoto targets.

## ENERGY DEMAND AND END-USE EFFICIENCY

Energy intensity measured in TPES/GDP[2] decreased from 0.51 in 2003 to 0.48 in 2004, a decrease of 0.18 from 1990.

Because of budgetary restrictions, the main priority of the Energy Saving and Energy Efficiency Improvement Action Programme is now the municipal sector, along with small and medium-sized enterprises. The household sector was the priority sector from 2000 to 2004, but in mid-2004 the household programme was stopped.

2. Measured in toe/USD 1 000 of GDP in 2000 US dollars.

# RENEWABLE AND NON-CONVENTIONAL FUELS

The transposition of the *acquis communautaire* and conformity with the EU renewable energy source directives are acting as the main drivers for renewable energy development in Hungary. Hungary, as an EU accession country, agreed in 2002 to a national indicative target for electricity production from renewable energy sources at the level of 3.6% by 2010 from 0.5% at that time (the forecast 2005 figure is above 2%). Also, by 2010, the government aims to increase the share of renewables in TPES to at least 5%.

The total share of renewables in the energy balance has reached 3.6%, and the share of electricity generated from renewables is about 2%. In accordance with the 1999 "Energy Efficiency Programme of the Government until 2010" Hungary has to nearly double the share of total renewables in energy supply from 28 PJ to 50 PJ per year. Based on this target the Inter-Ministerial Committee led by the Ministry of Economy and Transport has now prepared a draft Strategy for Renewable Energy Sources.

The most important tool for increasing the share of green electricity is the preferential feed-in tariff system. The legal basis of the feed-in tariff system was laid out by the Act on Electricity (2001). The implementation details and prices are defined by Decrees of the Minister of Economy and Transport. The general regulations are in 56/2002 (XII.29) Decree of Minister of Economy and Transport (updated 105/2003 (XII. 29) GKM, the actual price fixed by Decree of Minister of Economy and Transport 2/2005 (I. 13) 9/2005 (I. 21) GKM.

In line with the regulation, there is a uniform price for all types of green electricity, and the price depends on the demand-driven real price. There are three periods based on demand: peak, valley and deep valley. The prices are HUF 28.74/kWh[3], HUF 16.51/kWh and HUF 9.38/kWh respectively, while the average price is HUF 20.20/kWh. For comparison, this average price is ca. 70% higher than the price for electricity generated from fossils. From September 2005, in line with the amended Electricity Act (approved in June 2005), the new uniform price is HUF 23/kWh.

Hungary is also planning to increase the amount of energy produced from biomass, and the process of planting energy forests has already started. The process of producing energy grass has also begun in Hungary. There is a potential to produce 500 000 to 700 000 t/year of this fuel.

The Hungarian government will monitor this system as laid out in the National Renewable Energy Strategy, and if necessary some modification is possible to strengthen its long-term predictability and stability.

3. 1 EUR = 244 Hungarian florint (HUF).

MOL, the Hungarian oil company, is planning to retrofit its Duna and Tisza refineries to produce ETBE and MTBE in the future, by investing HUF 8-10 billion. This is in connection with the Hungarian target for biofuels of 2% contribution by 2010.

## COAL

Government Decision No. 2163/1999. (VII.8.) on the medium-term strategy of coal mining sets the measures for the closing-down of independent mines, and for the management of social aspects. In line with the decision, the last independent mine (Lencsehegyi Szénbánya Kft.) was closed in 2004.

The future of integrated coal mines is similar, except for two open pits. Only one underground mine will operate until 2012 in Vértesi ErŒmı Rt. The others ceased production in 2004. The government passed a decree to help the affected miners. Those who worked at least 25 years or 5 000 shifts underground will be retired. Other programmes are available to help younger miners find new employment.

## NATURAL GAS

The entry into the EU and the introduction of EU legislation had a significant effect on the Hungarian gas market. The harmonisation with the new EU legislation [EU Gas Directive (2003/55/EC)] was the main reason for the amendment of the Act on Natural Gas. The proposal for an amendment of the Act on Natural Gas was submitted to the Parliament in the first half of 2005, and the Parliament approved the proposal on 20 June 2005.

The main characteristics of the Hungarian natural gas market in 2005 are as follows:

- Share of gas in primary energy consumption: 43.3%.
- Settlements connected: 87%.
- High-pressure pipeline system: 5 300 km.
- Distribution pipelines: 77 687 km
- Consumption: 14.56 bn $m^3$/year.
- Domestic production: 3.2 bn $m^3$/year.
- Underground storage capacity: 3.3 bn/$m^3$.

The main steps in opening the natural gas market are listed below:

- First step: 1 January 2004 for consumers with consumption above 500 $m^3$/h.
- In accordance with the existing EU Gas Directive (2003/55/EC), from 1 July 2004 all non-household customers become eligible. Market opening

made about 69% of consumers eligible for procurement of gas in the liberalised market.

- Real market opening: 5.2 % of the whole natural gas demand is procured in the liberalised market (23 big industrial customers)

MOL is the company in charge of the production, transport and foreign trade of natural gas; it plays the role of single buyer and supplies the distribution companies, as well as large industrial users. In 2003 MOL legally unbundled its gas activity into three fully-owned subsidiaries (storage, transport and wholesale).

Panrusgas, a joint venture between MOL and Gazprom (50-50), is in charge of gas imports coming from Russia.

The latest development in the natural gas market is the partial sale of MOL's gas business, following MOL's decision to focus on its oil business. MOL Hungarian Oil and Gas Company has announced that the Hungarian Energy Office approved the partial sale of MOL's gas business to E.ON Ruhrgas International. Approval is subject to certain preconditions. On 4 November 2004 MOL and E.ON Ruhrgas International signed an agreement on the partial sale of MOL's gas business. The transaction remains subject to the approval of the relevant competition offices. E.ON also acquired two Hungarian gas distribution companies in 2004, Kögaz and DDGaz, and already has stakes in FÖGAZ, another distributor.

## ELECTRICITY

As with the gas sector, EU entry made it necessary to revise electricity legislation to bring it into line with EU legislation. The directives driving the need to amend the Act on Electricity are:

- New Electricity Directive 2003/54/EC.
- The Co-generation Directive 2004/8/EC.

The proposal for an amendment of the Act on Electricity was submitted to the Parliament in the first half of 2005, and the Parliament approved it on 13 June 2005.

Main elements of the amendment:

- Extending the scope of duties of the Hungarian Energy Office (regulator) in order to strengthen its independence.
- Specification of the legal consequences applicable against the licensees.
- Strengthening consumer protection.
- Definition of the main compulsory elements of the public service contracts.
- More information for consumers, for example concerning network maintenance work.

- More stringent requirements for network developments.
- Authorisation – small generators will also be subject to authorisation.
- Unbundling of activities, more stringent unbundling rules (organisation and decision-making) by the TSO and network licensees in cases of vertically integrated companies.
- Facilitating consumers' entry into the free market.

Main steps in opening the electricity market:

- First step: 1 January 2003 for consumers with consumption above 6.5 GWh annually. Declared market opening was about 30-35%.
- In accordance with the existing Electricity Directive (2003/54/EC), from 1 July 2004 all non-household customers become eligible – market opening made about 67% of consumers with 22 TWh consumption eligible for participation in the liberalised market.
- Real market opening: 24% of the whole electricity demand is procured in the liberalised market (December 2004).

## NUCLEAR ENERGY

Without nuclear energy, it will not be possible for Hungary to meet the Kyoto targets and the possible targets beyond Kyoto. The government thinks that the extension of the operational licence to the Paks power station is the most cost-effective way to keep GHG emissions within the limits of Hungary's Kyoto commitment. Nuclear power also contributes significantly to Hungary's security of supply, with the availability of alternative fuel supply, no significant fuel price risk and the easy reserve-feature of fresh nuclear fuel. This situation would change significantly after 2012 if the units of Paks Nuclear Power Plant (NPP) were shut down on the expiry of their operational licences.

An expert team has conducted a study including a detailed assessment of the plant status, ageing and lifetime prognosis of plant structures, systems and components, and definition of necessary reconstruction. This study demonstrates that the condition of the plant is excellent, and the continuation of safe operation for another 20 years after the expiry of the current operational licence is feasible. A detailed business analysis supports the decision on the extension of operational lifetime.

The extensive decision-making process resulted in the owner's decision to prepare the formal licence renewal application for Paks Nuclear Power Plant as required by Hungarian legislation. The renewal of the operational licence of the Paks NPP is a strategic decision, which will have to take into account all circumstances, including the social aspects and public acceptance, which is high in Hungary.

Safety has been considered as the highest priority of the operation of the Paks power station. The Final Safety Analysis Report was compiled in 2000 in accordance with best international practice, such as the US Nuclear Regulatory Commission Guidelines. The most important outcome of these analyses was the definition of a comprehensive safety upgrading programme, which was implemented in the period 1996-2002. In 2004 the Final Safety Analysis Report was renewed, including the reconstitution of the design base information and also the assessment of effects of the implemented safety upgrading programme.

Hungary is a state party to the Nuclear Safety Convention, and at the two past review meetings of the convention, Hungary gave a full picture on the safety of the Paks Nuclear Power Plant and related activities. The third report prepared for the review meeting in April 2005 contains a detailed description of the serious incident that occurred in April 2003. Based on experience gained from the incident and as a result of the subsequent investigations, several measures, recommendations and suggestions were formulated to improve operating and regulatory activities. A mission by the International Atomic Energy Agency (IAEA) to Hungary in February 2005 reviewed the activities of the plant and the regulatory body, addressing the recommendations and suggestions of the previous IAEA`s mission. Considerable progress has been made on all issues.

Another high priority condition regarding the long-term operation of the plant is to find a solution for the final disposal of radioactive waste and spent fuel. The intermediate storage of spent fuel is possible at the site by extending the already existing storage capacities, while an optimal back-end solution will have to be developed.

Preparatory work for the high-level waste repository has already started. Construction of a low-level waste depository would be feasible within a relatively short time, if the political consensus is reached and the licensing process is not delayed.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

The institutional and legal framework for Hungarian energy RD&D has been revised. The Science and Technology Policy Board (TTPK) was re-established in 2003 and is chaired by the Prime Minister. The Vice Presidents of TTPK are the Minister of Education and the President of the Hungarian Academy of Sciences. The members are the ministers concerned and the invited member is the President of the National Office for Research and Technology. The Science and Technology Advisory Committee (TTTT) has been set up as advisory body for the TTPK. It includes a number of distinguished scientists and R&D experts.

A new government office, the National Office for Research and Technology (NKTH) was established in 2004, supervised by the Minister of Education.

NKTH is responsible for implementing the government's science and technology policy. Its duties are to provide a new framework for the national innovation system and to promote research and development that will boost the Hungarian economy.

To create a predictable environment for the exploitation of R&D results, the Research and Technology Innovation Fund was established in 2003. The fund is managed by NKTH. Apart from micro- and small enterprises, every enterprise is obliged to pay at least 0.25% of its turnover into the fund. The Hungarian government contributes an equivalent amount to the fund. The goal of NKTH is to provide sufficient funding for innovation programmes that aim to create innovative services and products. These programmes will be simple, transparent and evaluated by independent experts. Representatives of the academic and industrial spheres will submit proposals together.

## SUMMARY OF RECENT DEVELOPMENTS

The Department of Communications, Marine & Natural Resources is currently drafting a comprehensive energy policy statement (White Paper) due to be published in early 2006. This policy document will have both a medium-term outlook (2010) and a longer-term perspective (2025). The absence of an up-to-date and composite long-term energy policy paper has been the subject of much criticism from stakeholders and energy players in general. The last White Paper on Energy Policy dates back to the mid-1970s.

The department has recently published a discussion paper on energy research development and demonstration (Energy RD&D). This follows from the recommendations contained in the IEA's in-depth review of Irish Energy Policy (2003) and concerns expressed about the *ad hoc* nature of RD&D in the energy area. Current activity in this area is not co-ordinated nor is it closely aligned with overall national policy objectives. In addition, there is growing awareness that the demands of creating a sustainable energy future make it necessary to have a better focus on this important area as well as ensuring adequate levels of investment.

The publication of this discussion document was followed by a number of public forums aimed at those who had responded to the original paper. The department is now in the process of finalising a policy document which is to be published in Quarter 4 of 2005. This will also feed into the forthcoming energy White Paper.

Substantial progress has been made in the ongoing dialogue with Northern Ireland aimed at creating an All-Island Energy Market. In November 2004 the two governments published the joint "All Island Energy Market Development Framework" which is a blueprint for the creation of this market.

The department has also recently undertaken a public consultation on how to better achieve the country's renewable energy targets. Following on from this, a Renewable Energy Development Group was established and is now finalising its first report to the minister.

Ireland has of late experienced difficulties in delivering major energy infrastructure projects. This has been particularly evident in the construction of electricity transmission lines where a number of projects have been delayed and others abandoned because of objections and legal challenges. In order to overcome these problems, the government will put in place new streamlined planning procedures aimed at short-circuiting many of the existing arrangements.

# GENERAL ENERGY POLICY

## GOVERNMENT ENERGY ORGANISATION

The Department of Communications, Marine & Natural Resources is responsible for the formulation and implementation of government energy policy. The Department of the Environment, Heritage and Local Government is responsible for the formulation and implementation of government policy in relation to climate change and environmental issues.

The Commission for Energy Regulation (CER) is the independent body statutorily responsible for overseeing the liberalisation of Ireland's energy sector. In 2005, the CER was expanded to become a three-member commission. This will bolster decision-making and increase regulatory accountability.

## ENERGY TAXATION

In September 2004 the government decided not to proceed with the introduction of a carbon tax and opted instead to intensify action on non-tax measures of the National Climate Change Strategy (NCCS).

## OUTLOOK/OFFICIAL FORECASTS

The Economic and Social Research Institute (ESRI, an independent, not-for-profit research group used by numerous government branches) published forecasts for energy supply over the coming fifteen years in its *Medium-Term Review: 2003-2010.* The forecast demand for primary energy under different scenarios is shown in the table below.

**Energy Supply Forecast, 2005 to 2020**

| | *2005* | *2008* | *2011* | *2014* | *2017* | *2020* |
|---|---|---|---|---|---|---|
| Benchmark | 15.44 | 16.25 | 17.03 | 17.69 | 18.14 | 18.58 |
| High growth | 15.30 | 16.38 | 17.46 | 18.44 | 19.20 | 19.93 |
| Low growth | 15.23 | 15.61 | 15.95 | 16.28 | 16.55 | 16.92 |

Source: *Medium-Term Review: 2003-2010*, ESRI.

The CER is legally obliged to produce an annual statement providing a forecast of capacity, flows and customer demand on Ireland's natural gas system for the following eight years. This in turn provides a timely indication of the need for new investment in gas transmission over the forecast period and indicates any uncertainties that may affect the decisions to make this investment.

In 2005, the CER published its 3rd such statement, covering the period 2004/05 to 2011/12. The statement shows that further growth in gas demand is likely over the forecast period. Consequently Ireland's dependence on gas in the total energy portfolio is expected to increase from current levels of approximately 24%. Its main conclusions can be summarised as follows:

- The existing transport pipeline system is sufficient to cope with reasonable expectations of demand, both on the peak and on the minimum days under most scenarios.

- The timing and availability of indigenous gas supply remains a significant source of uncertainty, particularly with respect to peak day scenarios.

- The Irish market is becoming increasingly affected by changes to gas markets elsewhere.

- In order to avoid potential capacity constraints resulting from the low-supply scenario, the CER is considering a number of measures, including additional infrastructure in Scotland, discussions with Marathon and BGE on the Kinsale Storage project and measures to reduce peak-day demand.

Under Section 38 of the Electricity Regulation Act 1999, ESB National Grid, in its role as the transmission system operator (TSO) is required to prepare the "Generation Adequacy Report" or GAR. The GAR is an annual statutory report on system generation adequacy which forecasts needs over a seven-year time horizon. The most recent report was published in November 2004. It concluded that while many of the forecast scenarios examined showed surplus capacity over the forecast period, there will nevertheless be plant shortages throughout the 2005 to 2011 window if plant availability remains at current levels (77%). If plant availability rises to the levels projected by generation owners of between 81% and 89%, capacity shortages would not be evident until at least 2009. The next GAR will be released in November 2005 with early indications that forecasts will not differ from the previous year's report.

The TSO is also obliged to produce the "Transmission Forecast Statement" which provides information on the status of the national grid as well as information on regional grid strengths and weaknesses. The latest version of this document was released in September 2005. In it, the TSO stated that: opportunities for new generation existed in Cullenagh, Waterford, Ennis, Limerick and Cahir; large demands above forecast levels can be accommodated following completion of planned reinforcements; transfer capabilities with Northern Ireland will be improved following completion of the new 275-kV interconnector; and the grid is currently incapable of supporting the proposed 500-MW subsea interconnection without reinforcements.

## ENERGY SUPPLY AND DEMAND

In 2003, Ireland's estimated total primary energy supply (TPES) was 15.1 Mtoe, a 1.5% increase from 2002. This rare annual decrease in TPES resulted primarily from a 2.4% decrease in oil supply to Ireland from 2002 to 2003, although other fuels such as natural gas and peat also saw decreases. Over the medium term (1990 to 2003), TPES has grown at an average annual rate of 2.9% and over the longer term (1973 to 2003), TPES has grown by 2.5% annually. For European IEA countries as a whole, the annual average growth of TPES from 1973 to 2003 was 0.9%. In 2003, oil was the most widely used fuel, accounting for 56.3% of the total, followed by natural gas (24.2%), coal (11.4%), peat (5.8%), biomass (1.1%), electricity imports (0.7%) and other renewables (0.6%).

In 2003, Irish total final consumption (TFC) was 11.7 Mtoe, a 1.2% decrease from 2002. This decrease came largely in the industrial sector where TFC fell by nearly 16%. The transport sector TFC rose by 0.9% while other TFC (primarily residential and commercial) rose by 5.8%. Over the medium term (1990 to 2003), TFC has grown at an average annual rate of 3.3% and, over the longer term (1973 to 2003), TFC has grown by 2.6% annually. In 2003, transport accounted for 38.8% of TFC, followed by the residential sector (23.5%), industry (20.5%) and other (mainly commercial, at 17.2%).

## ENERGY AND THE ENVIRONMENT

Under the EU's burden-sharing agreement for Kyoto Protocol obligations, Ireland must limit emissions of greenhouse gases to 13% above 1990 levels for 2008 to 2012. Irish government figures show 2003 emissions at approximately 24.7% above 1990 levels, down from 29% in 2002 and a peak of 31% in 2001. The reductions result from a number of developments, including cleaner generation of electricity, a reduction in livestock numbers and the closure of ammonia and nitric acid production plants in 2002.

In order to meet its target, Ireland must reduce current greenhouse gas emissions by an average 9.2 million tonnes per annum by the first Kyoto period, 2008 to 2012. The bulk of Ireland's target will be met through:

- 4.3 million tonnes reduction per annum achieved through the EU Emissions Trading Scheme (EU-ETS), by a combination of emissions reductions and the purchase of allowances.
- Credits for up to 3.7 million tonnes per annum may be purchased by the government at an estimated total cost of EUR 185 million.
- A range of measures in the sectors of the economy not covered by the EU-ETS.

The National Climate Change Strategy was published in 2000 and includes the following key measures:

- Switching towards less carbon-intensive fuels[4].
- Expanding renewable energy.
- Promoting greater energy efficiency in transport, industry and construction.
- A range of measures to reduce emissions from agriculture.

An ongoing review of the National Climate Change Strategy will be completed in 2006, when a revised Climate Change Strategy will be published. The review will take account of developments since the strategy was first published, including the entry into force of the Kyoto Protocol and major national policy developments as well as the introduction of the EU-ETS and possibility of a national carbon tax. In relation to the latter, the government decided in September 2004 not to proceed with a carbon tax, given concerns over the potential economic and social impacts that would have resulted.

There are some 105 installations in Ireland participating in the EU-ETS, whose emissions are capped to incentivise reductions in emissions either through more efficient use of energy or the purchase of emission allowances from other installations in the scheme. The National Allocation Plan for Ireland allocated a total of 22.32 million tonnes per year to the sector, or 66 457 million tonnes of $CO_2$ over the three-year period. In the pilot phase, $CO_2$ emissions from the following sectors are included: cement and lime; glass; bricks and ceramics; paper; mineral oil refineries; energy activities (power generation); and energy activities (other combustion).

In its role as National Allocations Authority, the Environmental Protection Agency is responsible for the allocation of allowances to installations. Although allowances were allocated free of charge, they were 2% below the overall projected needs during the pilot phase 2005-2007, although individual installations and sectors of the economy have more restrictive allocations. For example, the power generation sector's allocation is 8% below "business-as-usual" requirements.

## ENERGY DEMAND AND END-USE EFFICIENCY

The Large Industry Energy Network (LIEN) is a voluntary networking initiative comprising 80 of the largest industrial energy users in Ireland. These companies, which are committed to reducing their energy usage on an individual basis, recognise the benefits of collaborating with like-minded organisations. The main elements of the LIEN programme are:

- Reporting energy performance progress and setting realistic targets.
- Sharing information and experience to achieve best practice.

4. The main action related to this goal was the replacement of the coal-fired Moneypoint power station with gas-fired electric capacity. However, for energy security reasons (primarily concern about over-reliance on natural gas), this idea has been abandoned.

- Improving competitiveness by reducing energy costs.
- Helping companies to meet their environmental and regulatory requirements.

A new Irish Standard on Energy Management has been promulgated by the National Standards Authority of Ireland following extensive development work by a working group led by Sustainable Energy Ireland; this is one of the first such standards in Europe. This standard (IS 393) is aimed at ensuring energy-conscious thinking in companies, and covers energy-conscious design, procurement, plant operation and maintenance practice. All companies will be encouraged to have written procedures for energy management in their business, aligned where appropriate with the corporate energy or environment policy, and all employees will be encouraged to contribute to the development and implementation of such procedures. It is intended to have a series of events over the next six months to promote the application of this new standard.

As set out in its Statement of Strategy (2005-2007), a key objective for the Department of Transport is to secure a sustainable transport network which balances economic, social and environmental considerations. The achievement of this objective presents a considerable challenge, particularly in circumstances of rapidly escalating fuel prices, coupled with an increasing demand for transport to underpin economic growth and modern lifestyles. In addition, Ireland needs to control transport $CO_2$ emissions, including through exploring the potential of alternative fuels and promoting greater energy efficiency where possible. In seeking to meet these challenges, a variety of approaches are currently being adopted:

## PUBLIC TRANSPORT INITIATIVES

Achieving modal shift by creating an attractive alternative to the private car is central to the department's public transport programme. A significant investment programme is under way, which delivers benefits such as a new light rail system and increased capacity on the suburban rail network in Dublin. Furthermore, a strategic transport investment framework for Ireland is currently being developed which provides for additional significant investment in improving public transport infrastructure, facilities and services.

## DEMAND MANAGEMENT

Demand management is a fundamental method of improving transport energy efficiency. The Dublin Transportation Office (DTO) is currently engaged in formulating policy recommendations in relation to demand management measures for the Greater Dublin area. The recommendations are being designed to focus on policies that will help authorities respond to growing travel demand

and to specific problems such as long-distance commuting. In this regard, road pricing and congestion charging are being considered as options for managing traffic demand.

## TECHNOLOGICAL ADVANCES

In the absence of an indigenous automotive industry, Ireland is a technology taker and has little ability to influence the development of cleaner vehicle technology. Nevertheless, the government recognises the key role of innovative technologies (such as alternative fuels and more fuel-efficient engines) in reducing tail-pipe $CO_2$ and air pollutant emissions in the long term. In particular, it supports the EU Voluntary Agreement between car manufacturers as a cost-effective and efficient means of increasing the fuel efficiency of passenger cars.

## ALTERNATIVE FOSSIL FUELS

Dublin Bus undertook trials of LPG and CNG in the late 1990s to test the feasibility of using these fuels in the public transport fleet. The results of the pilots showed that these fuels were not commercial compared to fossil fuels at that time. Nevertheless, public transport companies and the department continue to monitor trends in the use of alternatively fuelled buses in other countries and are considering the applicability of such technologies in Ireland.

## RENEWABLES AND NON-CONVENTIONAL FUELS

Ireland has set a target of a minimum of 13.2% of electricity consumption from renewable sources by 2010. To help achieve this target, the government initiated a public consultation on renewable electricity policy in early 2004 and established a Renewable Energy Development Group (REDG) in July 2004 to assist the development of a co-ordinated approach to grid and market issues. The group draws its membership from government departments, National Grid, CER, state agencies, academic institutions and industry representatives. Analysis carried out by the group has enabled the minister to announce that Ireland is changing the renewable energy support mechanism away from competitive tendering to a feed-in tariff system. The details of this are currently being finalised and will be launched on the market shortly.

The REDG calculates that Ireland requires approximately 1 450 MW of renewable capacity to achieve its 2010 targets. At present, the country has 675 MW built and operating, with a further 175 MW under construction. Sufficient grid connection offers and planning consents are in place to achieve the capacity required to attain the target, and the new feed-in tariff is intended to ensure the required additional capacity will be built.

## BIOFUELS

The government is actively pursuing expanded biofuel use. In April 2005, DCMNR, on behalf of the Department of Finance, issued a call for proposals for mineral oil tax relief on pilot biofuels projects. The programme provides excise relief for pilot projects designed either to produce biofuel or test the technical viability of biofuel for use as motor fuel. The scheme will cost in the region of EUR 3 million per annum in revenue foregone and covers three biofuels categories as follows:

- Six million litres per annum of pure plant.
- One million litres per annum of biodiesel blended with mineral diesel.
- One million litres per annum of bioethanol, which is blended with petrol.

There was a significant response to the scheme and eight successful projects were selected and offered excise relief over a period of 24 months, with immediate effect.

In tandem with this development, Sustainable Energy Ireland is funding a number of biofuels projects and studies through its Renewable Energy Research Development and Demonstration (RE RD&D) programme, including a study on the optimum policy options for achieving biofuels market penetration in Ireland.

## WASTE/BIOMASS

The majority of biomass energy in Ireland is derived from wood products which are converted into heat. Within the electricity market, technology to date has concentrated on harnessing landfill gases for electricity production. Ireland has an excellent growing climate and an ongoing supply of raw material for wood fuel. Wood residues are already being used to produce heat for sawmills across the country and the wood energy market is poised for growth, with a number of commercial start-ups and a supply chain emerging.

In December 2003, DCMNR, in association with Sustainable Energy Ireland (SEI), set up a Bioenergy Strategy Group (BSG) to consider the policy options to stimulate increased biomass use. This group has fed in to the Renewable Energy Development Group.

## COAL

The major recent coal development has been the decision to retain Moneypoint Generating Station despite its closure being advocated in Ireland's National Climate Change Strategy. The Electricity Supply Board (ESB) will now proceed with a EUR 360 million investment to install technology to reduce emissions of $NO_x$ and $SO_x$. Carbon emissions will be dealt with via the EU-ETS.

This decision was taken primarily on security of supply/fuel diversity grounds. Analysis carried out by independent economic and technical consultants as well as the CER showed that closure and a switch to gas would put Ireland at over 80% gas dependence. Given that the large majority of that gas is (and will continue to be) imported, such a scenario was not acceptable as a way forward. While Moneypoint's closure would have resulted in a significant reduction in $CO_2$ emissions, fuel diversity in the electricity generating mix also had to be considered. While coal is in strong demand, the pricing is uncorrelated with gas, and the supply sources and chains are different.

## NATURAL GAS

Ireland is well on the way towards full opening of its gas market. The primary legislation necessary to give effect to this is expected to be enacted by the end of 2005 and the government hopes to have the market opened by early 2006. Recent years have seen substantial investment in Ireland's natural gas network, with further additions planned in the near future, such as the South North pipeline (linking Gormanstown to Belfast) and the Mayo-Galway pipeline. Additions such as the pipeline to the West and the second Scotland-Ireland interconnector have ensured that Ireland's network is well placed to accommodate growing gas demand in the medium term.

The gas network is now being planned on an all-island basis. The proposed South-North pipeline will be completed in 2006. This follows the completion of the Belfast-Derry pipeline last year. In addition to providing gas to the commercial and residential sectors in Derry, this pipeline also supplies ESB's new 400-MW CCGT plant in Coolkeeragh, just outside the city of Derry.

### NATURAL GAS SAFETY

In 2004, the minister conducted a public consultation on natural gas safety provisions which will give the CER explicit responsibility for safety and include proposals for the regulation and certification of natural gas installers. The decision was taken to prioritise these provisions and include them with the Energy (Miscellaneous) (Provisions) Bill, to be enacted by late 2005/early 2006.

### CORRIB/DOMESTIC PRODUCTION

Domestic gas production has fallen markedly in Ireland over the last ten to fifteen years. In 1990, production was 1.9 Mtoe, while in 2003 it had fallen to 0.5 Mtoe. The decline has come from the maturation and depletion of existing fields as well as the lack of any substantial new developments. The most promising new development currently being undertaken is the Corrib field, located approximately 70 kilometres off the Mullet peninsula in County Mayo. Corrib is being developed as a sub-sea tie back to a processing terminal onshore. The government views the successful delivery of the project as being important from a security of supply perspective.

The project has endured considerable delay due mainly to the time taken in processing the planning appeal in relation to the first planning application for the proposed onshore terminal. The costs of this delay have been estimated at more than EUR 100 million. All work on the Corrib project has now halted until at least 2006 because of serious ongoing local opposition to the proposed on-shore pipeline. Local landowners are opposed to the development, primarily on safety grounds. In an effort to meet local concerns, the minister has ordered a comprehensive health and safety review of the proposed onshore pipeline. The minister has put in place an independent Technical Advisory Group (TAG) to oversee the safety review.

## ELECTRICITY

Since February 2005, Ireland's electricity market has been fully liberalised. This is in advance of the deadline set by the EU for full market opening.

In June 2005, following extensive consultation with industry participants and interested parties, energy regulators from Northern Ireland and the Republic of Ireland jointly published a High Level Design Decision, setting out the high level principles that are to govern the proposed new Single Electricity Market (SEM) for the whole island.

The SEM will establish, for the first time, a single wholesale market in which generators and suppliers of electricity on the island will trade all their electricity on a daily basis, regardless of their location on the island. All trading will be carried out through a central pool. The SEM will send price signals to the market, influence the preferred location for new generation investment and, as a consequence, improve the security and reliability of electricity supplies throughout the island. In addition, the SEM is intended over time to remove market distortions and thereby minimise the cost of electricity to all customers on the island of Ireland. The design also includes a Capacity Payment Mechanism. The SEM is due to "go live" on 1 July 2007.

In addition, both regulatory bodies are proposing the construction of further electricity interconnections between north and south. This will enhance system security and reliability, and will facilitate the development of the SEM.

The government has given approval to proceed with the development of an electricity interconnector between Ireland and Wales. This is likely to be a single 500 MW line. The CER has appointed a consortium to advise on the financial, technical, commercial and procurement aspects relating to the new electricity interconnection. Subsequent to the receipt of the Consultancy Report, a decision will be taken on how best to take the project forward. Early indications are that there is little or no market interest in pursuing this project on a wholly merchant basis. It seems therefore that it will proceed on a hybrid basis, being part regulated/part merchant.

ESB has now closed all of its old peat-generating stations and has replaced these with two new state-of-the-art peat plants, operated and staffed to best international practice (250 MW in total).

Since 2000, ESB has spent some EUR 2.6 billion on modernising the transmission and distribution networks, with almost 350 000 new connections being made in the same time period. The main benefits of this investment are:

- Improved quality and reliability of supply.
- Reduced risk to public safety.
- Support to national economic development, especially in rural and isolated areas.

## COMBINED HEAT AND POWER (CHP)

There are currently 282 MW of installed CHP capacity in Ireland, including 150 MW at the Aughinish Alumina plant. CHP capacity has grown slowly due to a range of factors including unfavourable fuel prices, high connection charges and investment uncertainty. A report by the CHP Policy Group (set up in early 2004 to consider the most suitable and appropriate environments in which CHP can be implemented) will examine the development of CHP in Ireland to 2010 and beyond, and will address the types of support that might be provided to stimulate investment. The report will be considered as part of the ongoing work of the Renewable Energy Development Group.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

In April 2005, the department published a consultation paper which set out the options for co-ordinating energy R&D projects on a domestic, all-island basis as well as ensuring that Ireland's position be represented on an EU and international basis. There has been a substantive response to the paper and work is now under way formulating a strategy for implementation. A number of key issues are becoming apparent.

It is clear that capacity-building is a critical factor in the country's ability to innovate in the energy sector. The future direction of energy R&D must be structured to attract and retain graduates with the interest and capability to operate across a diverse range of disciplines. The approach will also need to maintain an appropriate balance between technical and policy/economic research. A specific issue raised by some stakeholders is that a scarcity of top-quality post-graduate opportunities, particularly in electrical engineering, needs to be addressed as a priority.

It will also be important to foster cross-sectoral links. Education has an essential role to play in providing appropriate paths for capacity, in terms of both academic research and an appropriate skills base for converting research into demonstration and implementation. Synergies with the agriculture sector (*e.g.* biofuels) and with the environment sector (*e.g.* energy efficiency and emissions reductions) are also paths to be pursued.

The department has invested considerable effort with the Department of Enterprise Trade and Investment in Northern Ireland and regulators in both jurisdictions to advance an All-Island approach to the energy sector. This is evidenced in the joint publication of "All-Island Energy Market, A Development Framework" in November 2004 as well as the development of the Single Electricity Market. The government would also like to adopt a similar approach to energy R&D to profit from synergies and opportunities for collaboration.

## GENERAL POLICY DEVELOPMENTS

The most relevant policy development in the energy sector since the last in-depth review in 2003 is the Parliament's approval of the Law on the Reorganisation of the Energy Sector on 23 August 2004. The law, also known as the Marzano Law, gives the government the powers necessary to reform the energy sector. The law aims to:

- Guarantee the safety, flexibility and continuity of Italy's energy supply.
- Promote the unified functioning of Italy's energy markets.
- Ensure reasonable costs of electricity in order to benefit Italy's competitiveness.
- Pursue improvements in the environmental sustainability of energy, also in terms of the efficient use of territorial resources.
- Promote the use of renewable energy sources.
- Further clarify the responsibilities of the regions and the central government in energy matters.
- Improve the efficiency of the final uses of energy.
- Promote and stimulate research and technological innovation in the energy field.
- Secure timely investments in energy-related infrastructure by requiring the regions to act within 180 days on applications for authorisation of new energy infrastructure that falls into their jurisdiction, and by transferring authority to the central government if a regional government does not respect the 180-day obligation.

Another notable development was the transposition of the European Directive on Emissions Trading[5] into Italian legislation on 30 December 2004. Italy's national allocation plan (NAP) was sent to the European Commission on 21 July 2004; additional NAP information was sent in February 2005 and approved by the Commission on 25 May 2005. The NAP allows for the maximum average annual emissions of 232.5 million tonnes of carbon dioxide (Mt $CO_2$), 56% of which was allocated to installations in the power sector. The remaining 44% was allocated to installations in non-power sectors. (For more information please see the Energy and the Environment section.)

5. European Directive 2003/87/EC for establishing a scheme for greenhouse gas emissions trading allowance within the community.

Since the last in-depth review, fiscal incentives for clean energy vehicles have been introduced. In 2003, incentives offered to private consumers have been more than doubled for the purchase of new gas-powered cars and for those converted within one year of leaving the factory. In addition, consumers who order the installation of a compressed natural gas (CNG) or liquefied petroleum gas (LPG) system on an existing family car within twelve months of the new car first being registered are given an installation discount of EUR 650 (under the previous decree the sum was EUR 310). For the purchase in Italy of a new approved car with either a hybrid or exclusively CNG or LPG system, the buyer is eligible to receive a EUR 1 500 discount off the price list (the previous discount was EUR 413).

The Italian government offers incentives for the purchase of cars not powered by traditional petroleum, or for the conversion of older cars to LPG and methane. The scheme is a joint project by the Ministries of Production, Environment and Transport and has set aside an initial funding of EUR 7.23 million. Motorists who buy or convert old cars (1988 to 1992 models) will receive EUR 300–400.

## ENERGY SUPPLY AND DEMAND

In 2003, total primary energy supply (TPES) was 181 Mtoe, a sharp increase of 4.3% from 2002 (in comparison, 2003 TPES was 4.8% higher than in 2000). Oil provided the lion's share of this supply, over 87 Mtoe (48% of total supply). Natural gas provided 63 Mtoe (35%); coal provided 15 Mtoe (8%); hydro, geothermal and other renewables provided the remaining TPES. Over the last few years, the relative shares of different fuels making up Italy's TPES have remained relatively constant.

In 2003, total final consumption (TFC) was 139 Mtoe, an increase of 4.0% from 2002 and an increase of 5.6% from 2000. Oil comprised nearly 50% of TFC, followed by natural gas at 30% and electricity at 18%.

## ENERGY AND THE ENVIRONMENT

The main elements of Italy's national allocation plan (NAP) based on EU Emissions Trading Scheme are as follows:

- Top-down approach by the European Community (EC) based on GDP growth and carbon intensity of GDP versus a bottom-up approach based on trading sectors.
- Maximum average annual emissions of 232 Mt $CO_2$ (a reduction of 23 Mt $CO_2$ in relation to the original NAP of 252 Mt $CO_2$ has been requested by the EC).
- Emission allowances were allocated at a ratio of 56% for the power sector and 44% for non-power sectors.

The national budget for procurement of emissions under flexible mechanism provisions is:

- EUR 100 million annually for 2006 and 2007.
- EUR 300 million for 2008.

Follow-up actions include: reallocation of 23 Mt $CO_2$, which is likely to be allocated to the power sector on a *pro rata* basis according to historical energy production and elasticity driven in the non-power sectors (*i.e.* brick and ceramics, cement, glass, iron, pulp and paper, oil refineries); monitoring the enactment of the NAP through a national authority; and pooling emission allowances allocated to the power sector based on the Emissions Trading Directive under consideration that would allow for flexibility.

As for the economic impact, it is expected that a EUR 10–15/t of $CO_2$ carbon price will increase the wholesale electricity price by EUR 3–6/MWh.

To reduce emissions in the transport sector, the Ministry of Environment has established a programme that will reimburse city governments for up to 65% of the cost of adding environment-friendly vehicles to each city's fleet. For 2004, the planned budget was EUR 58 million. From 2005 to 2007, the total budget is EUR 90 million. This programme is part of a bigger effort by the Italian government to focus on vehicle emissions.

## ENERGY DEMAND AND END-USE EFFICIENCY

Over the last few years, energy intensity has steadily decreased as a result of the development and implementation of energy policies based on energy efficiency standards and labelling of products, components and appliances; fiscal incentives; and, more recently, voluntary agreements. Nonetheless, considerable energy savings potential still exists and new technology provides additional opportunities for improving overall efficiency. Renewed attention to climate and geopolitical energy dependence together with energy market liberalisation have necessitated a stronger action plan to deliver these savings based on economically efficient policy instruments.

As part of the transition to a liberalised energy market, electricity and gas suppliers are required to achieve quantitative targets of energy efficiency improvements in end-uses. To achieve these goals, the government has implemented a white certificate scheme, allowing energy efficiency improvements to be freely traded in the market. Energy efficiency certificates (known as "TEEs" in Italy) are issued by the market operator, GME, once it has been certified that a quantified amount of energy savings will be achieved by a project's implementation – 1 TEE is awarded for each tonne of oil equivalent (toe) of energy savings achieved. A company that makes energy efficiency improvements beyond those required can sell them to gas and electricity suppliers that have not met their target internally. Electricity or gas distributors can be fined if they do not reach their own assigned targets through internal energy efficiency or the purchase of white certificates.

In order to overcome some problems that emerged during the first period of implementation, in July 2004 the Ministry of Production Activities and the Ministry of the Environment jointly issued an amended version of the two decrees that originally implemented the programme. The main changes relate to:

- Reductions in the yearly quantitative targets for energy savings from the original targets (the new energy savings targets are 100 ktoe annually in 2005 for electricity, rising steadily to 800 ktoe annually in 2009; the new natural gas objectives rise steadily from 100 ktoe/year in 2005 to 600 ktoe/year in 2009).
- Postponement of the implementation period (from 2005 to 2009).
- Introduction of a flexible mechanism in the deadline for achieving the annual savings.

Since the laws entered into force in 2001, distributors may demonstrate that they have reached additional targets for 2005 through projects carried out between 2001 and 2004.

Together with the new targets, Italy's energy market regulator (AEEG, *Autorità per l'Energia Elettrica e il Gas*) has issued a report[6] specifying that energy savings will be evaluated using various methods. Eligible projects must guarantee a minimum value of annual energy savings ranging from 25 to 100 toe depending on the evaluation method used. Currently, about 100 projects have been submitted to the AEEG.

## RENEWABLE AND NON-CONVENTIONAL FUELS

Italy has had green certificate and renewable portfolio standard schemes in operation since 2003. In addition, in December 2003 Italy implemented the EU Directive on Renewable Energy[7], which promotes renewable energy, particularly from distributed generation sources. It sets a timetable for the periodic reporting, review and monitoring by the Ministry of Productive Activities of progress towards the implementation of the objectives. It also sets a 0.35% annual rate of increase of the minimum share of electricity produced from renewable energy sources to be fed to the national grid for the period 2004-2006, resulting in a 2.7% share in 2006. The regulations also set deadlines for the establishment of further increases for the 2007-2009 and 2010-2012 periods.

6. AEEG, "Guidelines for the preparation, execution and evaluation of the projects and for the definition of the criteria for issuing the energy efficiency certificates".
7. EU Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market.

Sanctions for non-compliance are established and applied by the AEEG, the regulatory authority, based on reports from the grid manager (GRTN, *Gestore della Rete di Trasmissione Nazionale*). To assess the exploitable energy potential from biomass, an *ad hoc* experts' committee was created to assist in the design of appropriate legislation to support biomass. In addition, a six-month deadline is set for the adoption of legislation and criteria (*e.g.* minimum requirements, possibilities to accumulate incentives, preferential tariffs, capacity targets, use of green certificates) granting incentives for power produced from solar energy.

The decree includes specific provisions to favour dispatch of hybrid plants (*i.e.* those producing part of their power from renewables) over conventional fossil-fuelled ones. Regional targets for renewables-based electricity are encouraged and regional governments can establish their own plans for renewable energy support.

## COAL

Currently there is widespread opposition to coal use owing to its negative environmental impacts. As a result, new coal power plant proposals incur strong opposition in Italy. Nevertheless, Italy is now reassessing the importance of coal in the context of energy security and energy prices. A recent law allows for Italian participation in international R&D projects, including carbon capture and sequestration.

In 2004, imports of coal totalled about 26 Mt, up 17% from the previous year. Italy is moving away from oil-fired power generation. Currently about 5 000 MW of power generating capacity are being converted to coal-fired boilers, mostly by ENEL Produzione, the dominant, partially privatised generation company, and coal-fired gross electricity production was up 21% in 2004 to 47.1 TWh (compared with 26.3 TWh in 2000). As Italy moves further away from oil in the power generating sector, it is an open question as to whether the main beneficiary will be coal or gas, which relies on a very wide distribution network and has greater social acceptability.

Italy's coal reserves and production capacity are very limited. However, a small amount of coal is produced at the Sulcis mine in Sardinia, which has a production capacity of about 400 000 tonnes per year. Sulcis coal has a calorific value of 5 000 kcal/kg and is relatively poor in quality in terms of ash and sulphur content. The mine was recently brought back into operation in order to deliver 1 100 000 tonnes of coal over three years to supply the Sulcis 3 ENEL Produzione AFB power station in Portovesme. The price will be linked to the Rotterdam CIF coal price. The mine will also supply a new coal-fired power plant to be built in the Sulcis area, which will use 50% local coal and 50% imported coal.

After the failure in 2002 of the ATI project (*Associazione Temporanea d'Imprese* led by Ansaldo and SONDEL), a new plan for the mine's operation was developed in 2004. A May 2005 law outlined a tender for a contract to operate the new Sulcis-area coal-fired power plant; the contract is to be completed within one year. The plant will receive operation subsidies for its first eight years at a rate of about EUR 0.11/kWh supplied.

## OIL

There have been no major changes in the Italian legislation concerning the oil market. During 2004, total demand for oil and petroleum products was 88 Mt, 3.1% less than in 2003 due to a 23.7% drop in oil use in the electricity sector. Demand is met through a small amount of domestic production (6.1%); the rest is supplied from imports and existing stocks.

Total oil and product imports saw a reduction of 1.9 Mt (a 1.7% drop) in 2004 in relation to 2003, but it is worth noting that crude oil imports increased by 3% in 2004 as compared to 2003. There has been an increase in imports from the Middle East, rising from 27.2 Mt in 2003 to 28.6 Mt in 2004 (an increase of 5.2%).

## NATURAL GAS

In 2004, natural gas production plus imports reached 80.2 bcm in 2004, a 5.5% increase over 2003.

In the natural gas sector, since 1 January 2004 all gas providers serving households and small industrial clients are required to sell gas at a reference tariff defined and updated by the AEEG. The measure is intended to protect small consumers in the transition phase towards full gas market opening.

On the basis of the information gained from the experience of other European countries, the AEEG has proposed a series of regulatory provisions aimed at the creation of a centralised gas market (Gas Bourse). During 2004, a free access system for operators in the local gas distribution networks – shippers, sellers and final clients – was established. The objective is to simplify access to local gas networks in order to promote market development and the entrance of new enterprises.

Concerning transport infrastructure, the following activities have taken place to reinforce the security of gas supply:

- A new gas pipeline from Libya came into operation at the end of 2004, which will be able to transport 8 bcm per year when fully operational.
- A company has been selected to conduct a feasibility study on a potential Algeria-Sardinia gas pipeline.

- The construction of a liquefied natural gas regasification terminal near Brindisi with an initial annual capacity of 4 bcm, to be expanded to 8 bcm, was authorised at the end of 2002.
- An upgrade of the Transmed pipeline between Algeria, Tunisia and Italy is under consideration, which would increase its capacity to 6.5 bcm per annum. A similar project, including the same capacity, is being studied for the Tag pipeline from Austria, which carries Russian gas.

## ELECTRICITY

Total electricity production rose by 3.4% between 2003 and 2004, to reach 293 TWh. The largest absolute increase was in electricity produced from natural gas, which was 9.7 TWh greater than in 2003. In percentage terms, the largest increase was in energy produced from hydro, which grew by 22.1%. Renewables such as solar, wind and combustible waste grew by 17–18%, but still made up a small share of production in 2004. The greatest decrease in both absolute and percentage terms was from oil-fired generation, which fell by 22.7%, or 17.2 TWh, to 58.8 TWh total production. Natural gas-fired generation fuelled the greatest share of total electricity production (43%), followed by oil products (20%), coal (18%) and hydro (14%). Renewables – including solar, wind, combustible waste and geothermal – provided less than 5% of total production.

The slight increase in overall electricity demand was met by an increase in domestic electricity production (mainly hydro), resulting in a significant decrease in net electricity imports. Even with a reduction in electricity imports due to production from renewable sources, Italy's energy dependence remains relatively high (about 84%).

A 2003 law on urgent measures to ensure security of electricity supply gives operators who construct new interconnection capacity a 10–20 year exemption from third-party access rules. Such an exemption must be approved by the AEEG, the market regulator. The exemptions will be granted in accordance with the EU's 2003 regulations on cross-border exchanges of electricity[8]; they are expected to cover up to 80% of the new capacity and cannot be given to a company that owns or operates the transmission network in the area. This law also increases the capital gains tax on network investments and capacity payments.

The 2004 Marzano Law reinforced the earlier 2002 *Sblocca Centrali* law, introducing simplified procedures for receiving permits and building new power plants and transmission networks.

8. EU Regulation No 1228/2003 on conditions for access to the network for cross-border exchanges in electricity.

Since 2002, the Ministry of Productive Activities has issued 41 authorisations for the construction or refurbishment of more than 20 000 MW of new capacity as a result of the streamlined procedures for authorising construction and operation of new power plants with a capacity larger than 300 MW. The law instituted a single authorisation process, conducted by the Ministry of Productive Activities, substituting for the various separate authorisations, concessions and acts of agreement of the local authorities that were previously necessary. Evaluation of environmental impacts remains mandatory and is part of the unified process, which must be completed within 180 days of the official request.

Today, national power generating capacity is about 72 GW, thus the planned 20 000 MW represent almost one-third of the total installed capacity. About 12 000 MW are already under construction and 8 000 MW are expected to go on line before the end of 2006. The remainder should go on line between 2006 and 2010. Moreover, the shift from generation fuelled by oil (60 TWh) towards generation fuelled by natural gas (120 TWh), clean coal (40 TWh) and renewables (49 TWh) is predicted to be completed by 2010[9].

## MARKET REFORM

On 1 April 2004, the Power Bourse was launched on an experimental basis. Since then, the exchange of electricity has been determined by market forces; prices are now the result of supply and demand instead of being fixed administratively. Between April and December 2004, about 30% of all electricity delivered through the electricity grid was exchanged on the Bourse. *Acquirente Unico,* the single buyer set up in 2001 to forecast and procure supply for captive customers, began to operate along with the opening of the Electricity Bourse.

An 11 May 2004 decree approved the reunification of the transmission network's management by GRTN and ownership by TERNA (an enterprise owned by the incumbent, ENEL). This was done to eliminate co-ordination problems between GRTN and TERNA. In June 2004, 50% of TERNA's capital was sold to the public for EUR 1.7 billion. To ensure the independence of the new enterprise, beginning on 1 July 2007 non-transmission energy companies will be prohibited from owning more than 20% of the shares of the new combined company (voting rights must not be higher than 5%). The same decree entrusts TERNA with all of GRTN's responsibilities, except for the management of electricity currently under contract through the CIP6 support scheme, the green certificate scheme, Acquirente Unico (the single buyer for captive customers) and the Electricity Market Manager.

9. Director-General Sergio Garribba's Speech at Chatham House Meeting on Climate Change, June 2005.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

Italy's R&D priorities were outlined in its "Guidelines for the Scientific and Technological Policy of the Government", approved in March 2002. In March 2005, the "National Research Programme (PNR) 2005-2007" reviewed, confirmed and elaborated the priorities defined in the guidelines.

The energy R&D and innovation priorities identified in the PNR are:

- Energy diversification (better use of natural gas, gas-to-liquids and gas from coal).
- Energy conservation (efficiency in the final use of energy for the residential and commercial sectors).
- Power and storage technologies (clean coal, carbon sequestration, hydrogen and nuclear fusion).
- Renewable energy (solar and biomass).

Co-operation is ongoing to promote scientific research on climate variability, its uncertainties and its ecological, technological and health implications through bilateral agreement between Italy and the US.

In addition to national programmes, many regional R&D support schemes are available. In particular, taking advantage of the European Community Structural Funds 2000-2006, some regions of southern Italy have defined their own R&D programmes for sustaining innovative and demonstrative energy projects.

In the short to medium term, the themes to develop are classified into two categories. The first category is the use of conventional fuel through:

- Efficiency improvements of hydrocarbons transformation processes.
- Combustion simulation to improve pollution abatement.
- High-efficiency micro-turbine for decentralisation of CHP electricity generation.
- Clean coal with high efficiency and low emissions.
- Coal gasification for hydrogen production.
- $CO_2$ separation and storage.

The second category is renewable energy and new vectors for energy production:

- Capture and storage of solar high-temperature heat for energy production (550°C) and hydrogen production (850°C).
- New methods for hydrogen separation.
- Fuel cell development (electrochemistry and materials) using hydrogen as the vector.
- Solid-state physics and materials to develop photovoltaic equipments.

In the long term, the primary research area for government-funded R&D is nuclear fusion. ENEA *(Ente per le Nueve Tecnologie, l'Energia, e l'Ambiente)* is the national co-ordinator for research in this subject area.

## FUNDS FOR RESEARCH

Government funds for energy R&D were EUR 290 million in 2003, down 3.2% from 2002 and down 2% from 2001. The largest share of funding (27.5%) is for nuclear research, which represents a steady decline since 1997, when nuclear's share of R&D funds was 45.2%. Power and storage research funding constituted 27.2% of total funding, the second-largest share in 2003. Funding for renewables has increased steadily since 2000 and was EUR 55 million in 2003, 18.9% of total funding.

## FUNDS FOR INNOVATION

The funding of technological innovation, managed by the Ministry of Productive Activities, has the objective of financing pre-competitive development of enterprises that facilitate the design and implementation of new products, processes and services. The primary beneficiaries are small and medium-sized enterprises collaborating with ENEA, universities and public research centres. Between 2002 and 2004, funding for energy-related activities was around EUR 100 million.

In 2006 funding is expected to be around EUR 150 million, with an additional EUR 350 million for the realisation of new productive activities or plant modernisations. The last funding allocation for innovation projects is expected to be EUR 80 million in 2007.

Public funds for innovation are devoted to projects focused on improving energy efficiency and the use of renewable energy sources in the following specific areas:

- Thermal and electrical power from renewables and low-$CO_2$ emitting sources (integrating renewables in energy systems).
- Energy efficiency and energy conservation.
- Alternative fuels.

## INTERNATIONAL COLLABORATION

Italy maintains its existing collaboration through participation in many international research, development and demonstration programmes (*e.g.* through the EU and the IEA). A new area where Italy is promoting an enlarged G8 collaboration is bioenergy. To advance this goal, on 14 June 2005 an international workshop on bioenergy was held in Rome with the participation of G8 countries plus representatives of Brazil, China, India, Mexico and South Africa with the aim of building a common basis for the development of a new international partnership on bioenergy.

# GENERAL ENERGY POLICY

## BASIC ENERGY LAW

The Basic Energy Law was enacted on 7 June 2002, and was promulgated and came into effect on 14 June 2002. It stipulates three goals as the basic principles of Japan's energy policy:

- Security of a stable supply of energy.
- Adaptation to the environment.
- Utilisation of market principles with full consideration given to the other two goals.

Based on these goals, the Cabinet adopted the Basic Plan for Energy Supply and Demand on 7 October 2003, to promote comprehensive and systematic policies on energy supply and demand for the long term. The annual report (the White Paper on Energy) was published based on the law.

## POLICY REVIEW

In December 2003, the Energy Supply and Demand Subcommittee of the Advisory Committee for Natural Resources and Energy launched a review of the Long-Term Energy Supply and Demand Outlook that had been published in 2001. As a result of this review, in October 2004 the subcommittee adopted the Energy Supply and Demand Outlook in 2030 (Interim Report), which looks at the expected changes and considers the future long-term energy picture up to 2030.

## FOSSIL FUEL TAX REFORM

The Ministry of Economy, Trade and Industry (METI) implemented the revision of the energy tax on fossil fuels. The energy tax reform aims to fund measures to combat global warming and to promote alternative energy sources and conservation. Taxes were changed as follows:

- Tax on petroleum will remain unchanged.
- The tax on LNG and LPG will be increased.
- A new tax on coal will be introduced. (Coal used as a raw material in the manufacture of steel and other products would be excluded.)

## ENERGY SUPPLY AND DEMAND

In 2004, total primary energy supply (TPES) was 537 Mtoe, representing a growth of 21% over the 1990 figure. In 2003, the share of oil in TPES decreased from 51% to 43%, while that of gas increased from 3% to 14% during this period. The share of combustible renewables and waste increased from 1.3% to 4.1% over the same period. Coal represented 17%, hydro 2% and nuclear 19%. About two-thirds of Japan's TPES was derived from fossil fuels.

Japan's total energy production grew substantially by 79%, from 76 Mtoe in 1990 to 135 Mtoe in 2003, with most of the growth coming from a 92% increase in nuclear production. Japan's net imports grew from 372 Mtoe in 1990 to 401 Mtoe in 2000. About 23% of Japanese net imports are coal, while 58% are oil and 20% gas.

Japan's TFC saw very slight negative growth in 2003, shrinking from 356 Mtoe to 354 Mtoe. This was led largely by the transport and residential/commercial sectors where energy consumption reduced by 1 Mtoe and 3.5 Mtoe respectively, while the industrial sector saw growth of 1.9 Mtoe.

Energy intensity measured in TPES/GDP[10] stayed stable at 0.11 between 1990 and 2003.

## ENERGY AND THE ENVIRONMENT

### CLIMATE CHANGE PROGRAMME

The Ministry of the Environment is in the process of reviewing its Climate Change Programme, which has been in force since May 2002. In August 2004, it published an interim report, which includes the following measures as possible complementary options to mitigate climate change:

- A voluntary emissions trading scheme from 2005 to 2007.
- A mandatory emissions trading scheme starting in 2008.
- A requirement for businesses to publicly report their greenhouse gas emissions in the next climate change programme. By mandating annual emission reports, the government plans to compile data on energy consumption by 14 000 sites which jointly account for 40% of all GHG emissions in Japan.
- A requirement for all cars to be equipped with an idling-stop function and fuel consumption meters to alert drivers to how much petroleum they consume.

10. Measured in toe/USD 1 000 of GDP in 2000 US dollars.

## CARBON TRADING DEMONSTRATION PROGRAMME

METI announced that it would demonstrate the programme for experimental trading and transferring of Certified Emission Reductions (CERs)/Emission Reduction Units (ERUs) in 2004. The programme will be implemented in order to demonstrate appropriate institutional settings such as national registry, law, accounting, and tax, with the participation of 116 companies and associations from major industry sectors. It is expected that GHG emissions reduction by the Kyoto mechanism could contribute to meet Japan's target in the Kyoto Protocol. So far, six projects (five clean development mechanisms and one joint implementation) have been approved.

## CARBON FUND

On 1 December 2004, two government-owned banks – the Development Bank of Japan and the Japan Bank for International Co-operation – and Japanese private enterprises established the Japan GHG Reduction Fund (JGRF), a fund for purchasing greenhouse gas emissions reduction from CDM/JI projects. The initial size of the fund is USD 140 million with investments coming from the two banks as well as approximately 30 Japanese private enterprises. Target projects include biomass power generation, co-generation plant construction, improvement of the operating efficiency of existing thermal power plants, and repairs of such plants.

## LAW CONCERNING THE PROMOTION OF MEASURES TO COPE WITH GLOBAL WARMING

All the clauses of the Law Concerning the Promotion of Measures to Cope with Global Warming amended in 2003 came into effect with the entry into force of the Kyoto Protocol on 16 February 2005. The main points are as follows:

- Establishment of the Council of Ministers for Global Environmental Conservation by law.
- Development of the Kyoto Achievement Plan.
- Stipulation of the establishment and implementation of countermeasures by local governments.

## INTERIM REPORT ON FUTURE MEASURES FOR GLOBAL WARMING

The Global Environmental Subcommittee of the Industrial Structure Council started deliberations on countermeasures for global warming in January 2004. The main issues for deliberation were as follows:

- Evaluation and review of the New Climate Change Policy Programme in order to fulfil the reduction targets defined in the Kyoto Protocol.

- Work towards establishing a future sustainable international framework.
- Direction of countermeasures for global warming from the mid- and long-term viewpoints – such as technical development.

As a result of its deliberations, the subcommittee published its interim report in August 2004 so that reasonable and effective countermeasures for global warming according to the principle of contribution to both the environment and the economy can be executed.

## INTERIM REPORT ON SUSTAINABLE FUTURE FRAMEWORK ON CLIMATE CHANGE

In January 2004 the Special Committee on a Future Framework for Addressing Climate Change of the Industrial Structure Council started deliberations on a concrete approach to a future framework on climate change to apply after 2013, and published its interim report in December 2004. Specifically, the committee recommends that, on top of a national cap approach, action-oriented commitments need to be introduced, such as:

- Co-operation for emission limitation in developing countries.
- Development and diffusion of innovative technologies.
- Cross-border and sectoral intensity improvement.

# ENERGY DEMAND AND END-USE EFFICIENCY

## ENERGY CONSERVATION LAW

The Law concerning the Rational Use of Energy, or Energy Conservation Law, which was revised in June 2002 to reinforce the energy conservation measures in the commercial/residential sector, was put into effect in April 2003, making it mandatory for the owners of large office buildings, as is the case with that of large factories, to submit reports on the status of energy usage and mid-term plans for rational use of energy, as well as to submit to the competent authorities the energy conservation measures that are taken during the construction stages of buildings.

In December 2003, the Energy Efficiency and Conservation Subcommittee of the Advisory Committee for Natural Resources and Energy started discussing future energy-saving measures for the industrial, transport and commercial sectors, and produced an interim report in July 2004 on what such future energy-saving measures ought to be.

In November 2004 and March 2005, the Energy Efficiency and Conservation Subcommittee of the Advisory Committee for Natural Resources and Energy discussed the radical strengthening of the Law concerning the Rational Use of Energy or Energy Conservation Law, and revised it in August 2005; the revised law will come into effect in April 2006. The revised version places new obligations on the energy supply, transport, and electrical product retail sectors, and strengthens existing obligations on the residential and the commercial/manufacturing sectors.

## TAXATION

The government has adopted preferential taxation on fuel-efficient and low-emission vehicles. In order to accelerate sales of these vehicles, the taxation on automobiles was revised to focus on more fuel-efficient and lower-emission vehicles and to cover LPG cars in addition to existing targets towards CNG cars, electric cars, hybrid cars, methanol cars, etc.

## PROGRAMMES

The "TopRunner Programme" that is stipulated under the Energy Conservation Law was extended to LP gas passenger vehicles in July 2003 and to gas cooking grills and ovens as well as gas water heaters with room-heating functions in October 2004.

In 2003, the Voluntary Energy-Saving Labelling Programme was extended to include space heaters, gas cooking appliances, gas water heaters, oil water heaters and electric toilet seats, and to computers, magnetic disk units and transformers in 2004.

A new system was established in 2003 to assess retail shops that sell energy-saving products. Under the system, retail shops that actively provide consumers with appropriate information about energy-saving equipment such as home electric appliances, etc. are highly valued.

An ESCO (Energy Service Company) project was introduced as a model case in the office building of the Ministry of Economy, Trade and Industry for the first time in fiscal year 2004, as a way to promote the ESCO business through a public-sector initiative.

## RENEWABLE AND NON-CONVENTIONAL FUELS

The Special Measures Law Concerning the Use of New Energy by Electricity Retailers came into effect in April 2003, making it mandatory for electricity retailers to purchase a certain amount of electricity derived from renewable energies. The Japanese government considers hydropower and geothermal energy as mature technologies. It calls other renewable energy sources and fuel cells as “new energy”.

The Supply and Demand Subcommittee of the Advisory Committee for Natural Resources and Energy of the Agency of Natural Resources and Energy held discussions on new energies in the year 2030. The discussions were based on the assumption that the costs of new energies are reduced, the progress of technology is accelerated, and that new energies are significantly moved forward by the active efforts of society as a whole to introduce such energies, bringing the ratio of renewable and new energies to primary energies supplied to about 10%.

As the introduction of wind power generation is subject to large fluctuations in output due to wind conditions, deliberations on the measures for grid connection of electricity generated by wind power began in April 2004, and an interim report on the organised measures concerning frequency fluctuation and transmission capacity was worked out in July 2004.

# OIL AND NATURAL GAS

## JOGMEC

Based on the Reorganisation and Rationalisation Plan for Special Public Corporations that was decided in December 2001, the Japan National Oil Corporation and the Metal Mining Agency of Japan were merged and re-established as an independent administrative corporation named Japan Oil, Gas and Metals National Corporation (JOGMEC) on 29 February 2004. JOGMEC is designed to perform its duties with a view to achieving the "medium-term targets" prescribed by the government in order to fulfil its mission of establishing Japan's resource and energy security.

## EMERGENCY PREPAREDNESS

Japan's stockpile oil and oil stockpile sites are now owned by the central government, which is responsible for raising the necessary funds, replacing the Japan National Oil Corporation. The management of state-owned stockpile oil and oil stockpile sites had previously been entrusted to the Japan National Oil Corporation (and has been contracted since 29 February 2004, to JOGEMC).

Stockpiles of LPG (liquefied petroleum gas) are required because the high dependence on the Middle East makes its supply structure vulnerable. In order to achieve a national stockpile of 1.5 million tonnes in FY 2010, five national stockpile sites (three above-ground tanks and two underground cavern tanks) are under construction.

## METHANE HYDRATE

Methane hydrate is expected to be a new domestic energy resource, and it is important for the Japanese government to play a central role from a medium- and long-term perspective in steadily promoting technology development, basic exploratory drilling, etc. For this purpose, Japan is now conducting research on reserve assessment, production methodology, environmental impact assessment, etc., aiming at establishing the technology for commercial production by fiscal year 2016. In 2003, Japan carried out offshore basic exploratory drilling.

## DEVELOPMENT OF AZADEGAN OILFIELD

Azadegan oilfield located in the south-west of Iran is one of the largest oilfields in the world. Its crude oil reserves and recoverable reserves are estimated to amount to 26 billion barrels and 5-7 billion barrels, respectively, and it has the world's second-largest reserves, after Kashagan oilfield, among the oilfields newly found in and after 1980. Negotiations started in November 2000, and a contract for the development of Azadegan oilfield was signed in February 2004.

## DEVELOPMENT OF KASHAGAN OILFIELD

Kashagan oilfield, which was discovered in the Caspian Sea off the coast of Atyrau in Kazakhstan, is a large oilfield that is estimated to have recoverable reserves of 13 billion barrels. From Japan, INPEX North Caspian Sea, Ltd. has participated in the project with an 8.3% stake. Oil and natural gas were found in this field in 2000, and it was declared commercial in 2002. The development plan for commercial production was worked out in 2004, and crude oil production is scheduled to start in 2008.

## SAKHALIN PROJECTS

Sakhalin is expected to contain significant reserves of oil and natural gas. This is an important region that could contribute to the further diversification of Japanese supply sources.

### Sakhalin I Project

The Sakhalin I Project is an international joint development project of companies from America, Russia, India and Japan. The Japanese firm Sakhalin Oil and Gas Development Co., Ltd. has a 30% stake in the project. According to their announcement, the planned amount of investment is about

USD 12 billion, and the recoverable reserves of crude oil are estimated at about 2.3 billion barrels and that of natural gas at about 17 trillion cubic feet (tcf). The Sakhalin I Project was declared commercial in December 2001, and is now in its development period.

### Sakhalin II Project

The managing operator of the Sakhalin II Project is Sakhalin Energy Investment Co., Ltd., a joint venture established by Royal Dutch/Shell and Japanese firms. From Japan, Mitsui & Co., Ltd. and Mitsubishi Corp. have participated with a 25% stake and a 20% stake, respectively. According to their announcement, the planned amount of investment is about USD 10 billion, and the recoverable reserves of crude oil are estimated at about 1.1 billion barrels and that of natural gas at about 17 tcf, including the Piltun-Astokhskoye and Lunskoye blocks. Now under Phase I development, the project started crude oil production in summer from July 1999, and the production amounts to about 11.7 million barrels/year at present. The project is aiming for year-round production of crude oil in 2006. It plans to transport natural gas in the form of LNG (liquefied natural gas), and Phase II development scheduled to start shipping LNG in 2007 commenced in May 2003. Basic agreements have been reached with Japanese firms including Tokyo Gas Co. and Tokyo Electric Power Co. to take delivery of LNG from the project on a long-term basis. Moreover, similar agreements have also been reached for delivery to North America and South Korea.

## CASPIAN SEA ACG OILFIELD DEVELOPMENT PROJECT/BTC PIPELINE PROJECT

This is an offshore oilfield located off the coast of Baku in Azerbaijan. The ACG Project to develop three oilfields in Azeri, Chirag and Gunashli is a large development project that has estimated recoverable reserves of about 5.4 billion barrels. From Japan, Itochu Oil Exploration Co. has participated with a stake of about 4%, and INPEX Corp. with a stake of about 10%. The project started crude oil production in November 1997, and production now amounts to 130 000 barrels per day (bpd). Production is expected to be increased up to 1 million bpd in 2008.

As the Caspian Sea is located inland, the crude oil produced there must be exported by means of pipelines. The crude oil produced from ACG is to be transported to the Mediterranean through the BTC Pipeline that links Baku in Azerbaijan, Tbilisi in Georgia and Ceyhan in Turkey.

A pipeline project from Siberian fields to the Far East is currently being developed. Depending on its eventual terminal location, this could have far-reaching impacts on Japanese access to Siberian oil reserves.

# GAS INFRASTRUCTURE AND MARKET REFORM

It is important for Japan to construct gas supply infrastructure, such as natural gas pipelines, while ensuring their cost-efficiency. The Japanese government also recognises that it is important to promote the maintenance of an appropriate regulatory and investment environment. In addition to the newly created "Gas Pipeline Business" under the revised Gas Utility Law that was put into effect in April 2004, a variety of public privileges was introduced to support the construction of gas pipelines, in addition to the newly created "Gas Pipeline Business". The trunk gas pipelines that are particularly strategic are given incentives.

Under the revised Gas Utility Law, mandatory third-party access regulation is applied to all general gas suppliers and gas pipeline providers. In August 2004, the behavioural regulations related to third-party access information firewall, discriminatory treatment were introduced, and details were clarified by partial revision of the "Guideline for Fair Gas Trade." The scope of liberalisation was expanded to consumers with an annual demand of more than 500 000 cubic metres (Article 3 of Enforcement Regulations of Gas Utility Law). The accounting related to third-party access is mandatory, and accounting separation between services of third-party access and services other than third–party access has been introduced. The licensing system for large-scale retail supply has been shifted from a permission to a notification system.

To promote the transparent and non-discriminatory negotiations between LNG terminal owners and third-party users of LNG terminals, the "Guideline for Fair Gas Trade" were partially revised in August 2004 and the provisions related to the third-party use of LNG terminals were added.

# COAL

In January 2004, the Clean Coal Cycle (C3) Study Group initiated discussions on Japan's new coal policy towards 2030, in order to ensure a stable supply of coal and the development of clean coal technology. It published an interim report in June 2004. Japan has already developed this technology, examples of which are the full-scale construction of a 1 700 tonnes/day pilot plant which commenced in 2004 in Nakoso, Fukushima Prefecture, for the demonstration of the integrated coal gasification combined cycle (IGCC) technology. The reliability and stability of the integrated coal gasification fuel cell combined cycle (IGFC) technology has been proven to some degree through the long-term and continuous operation now under way at a 150 t/d pilot plant in Wakamatsu.

## ELECTRICITY

The Electric Utilities Industry Law was revised in June 2003 to promote measures for the utilisation of market principles with the aim of ensuring the stable supply of electricity in an environment-friendly way based on the Basic Plan for Energy.

Under the revised law, the following reforms of the electricity industry system have been carried out to ensure equal conditions for competition:

- To create a transmission system operator with representation from new entrants and academic experts as well as electricity utilities to promote the transparent and fair utilisation of the transmission and distribution system.
- To introduce regulations on business practices such as information firewalls, prohibition of discriminatory treatment and accounting separation, with a view to ensuring the neutral operation of network divisions of the General Power Utilities (the GPUs).

From fiscal year 2005, the regulations on business practices will be applied to the GPUs. The result of the regulations will be evaluated.

The new electricity industry regime is based on the concept that it is most rational and most effective to leave industry activities as much as possible to the voluntary efforts of the private sector. It is advantageous to allow the private sector to use its specialty knowledge and initiative rather than having the government stipulate detailed rules with laws and regulations, thus restricting the industry. The aim is to reduce *ex ante* regulation by the government and replace it with *ex post* control of the industry, in addition to proactive checking of decision-making, *e.g.* when market rules are worked out by the private sector. The Electricity Industry Committee has discussed the introduction of the new industry regime. The relevant ordinances have been developed based on such consultation.

## NUCLEAR POWER

Between 2002 and 2005, 17 of the Japanese power company TEPCO's nuclear plants were affected by a high number of unscheduled outages due to data falsification of safety records. This affected Japan's power supply owing to the high proportion of electricity generated from nuclear power. To solve this problem, the Japan Nuclear Energy Safety Organisation (JNES) was established in October 2003 to carry out a review of the inspection system, and an enhancement audit by the Nuclear Safety Commission (NSC).

As of 11 July 2005, all of the 17 nuclear power plants which were put in outage have been allowed to commence operation again.

## PROMOTION OF FINAL DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE (HLW)

The Nuclear Waste Management Organisation of Japan (NUMO), the central government, electric power companies, and others provide information about the final disposal of high-level radioactive waste to enhance public understanding about such final disposal.

In December 2002, as part of its efforts to realise final disposal of HLW, NUMO started open solicitation of volunteers from all Japanese municipalities for the preliminary investigation in the stepwise siting approach.

## REVIEW OF INSPECTION SYSTEM

The Study Group on Desirable Inspection, which was formed in December 2001 by the Nuclear Safety and Security Subcommittee, launched a study on the inspection of nuclear power facilities in February 2002. The group presented an interim report titled *Direction of Review of Nuclear Power Facility Inspection System* in June 2002. In response to the interim report, the Nuclear and Industrial Safety Agency started work on the review of the inspection.

In August 2002, fraud was found in the inspection records of nuclear power stations, confirming the need to review the system. As a measure to prevent such fraud from happening again, it was decided to add the regular voluntary inspection by operators to the framework of the inspection system. The Electricity Utilities Industry Law was revised, and the periodical operator inspection and periodical safety management examination were created as a new inspection system.

The revised ministerial ordinances related to the Nuclear Reactor Regulation Law and Electricity Utilities Industry Law were put into effect in October 2003, and the performance requirements relating to quality assurance and maintenance management rules as the backbone of the new inspection system were clarified.

This was followed by the safety regulations that were approved in May 2004 based on the Nuclear Reactor Regulation Law, including the quality assurance and maintenance management rules. The implementation status of the regulations is now being checked by safety inspection.

## SECONDARY SYSTEM PIPING RUPTURE ACCIDENT

On 9 August 2004, a secondary system piping rupture accident took place in Unit 3 of Mihama Nuclear Power Station of Kansai Electric Power Co., which is located in Fukui Prefecture. The accident took place when the preparation for a periodical inspection was under way. When the accident happened, a total of 105 workers were engaged in the preparation in the turbine building. Of these workers, those who were working near the ruptured A-system condensate pipes fell victim to the accident by being exposed to high-temperature steam and water leaked from the ruptured pipes. Five were killed and six were injured. The METI formed the "Committee on Investigation of Secondary System Piping Rupture Accident of Unit 3 of Mihama Nuclear Power Station," and the committee investigated and examined the accident, and released an interim report on 27 September 2004.

In response to the interim report, as measures to prevent such an accident from occurring again, the Enforcement Regulations (2005/77 Ministerial Ordinance of METI) of the Electricity Utilities Industry Law were partially revised as of 28 December 2004, to clarify the equipment to be inspected, and inspection methodologies.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

To improve the practical effectiveness of energy conservation technology development, the "strategic development of technology for rationalised energy utilisation" commenced in fiscal year 2003, as a technology development scheme under which proposals are invited publicly. The following basic plans for energy-related programmes were presented in July 2004.

- *Energy conservation technology development programme*
  Projects in technology development programmes that have larger ripple effects and larger investment effects will be promoted.
- *New energy technology development programme*
  The programme covers technology development of renewables, including projects expected to lead to cost reduction through further development and improvement of performance, and leading to the stabilisation and efficiency improvement of Japan's energy supply. Projects that are expected to produce solutions to global warming and regional environment pollution issues, the creation of new industries and employment opportunities, and the advent of a hydrogen-based energy society, are also covered.
- *Fuel technology development programme*
  Stable supply of energy will be ensured and environmental issues will be addressed (reduction in emissions of $CO_2$, $NO_x$ and particulate matter) through the improvement of production technology related to fuels (oil, gases, coal and new fuels), and the development of environmentally acceptable utilisation technology.
- *Electric power technology development programme*
  Well-balanced and smooth power supply from distributed power sources and grid power will be achieved by the effective use of electric power

generated by distributed power sources and the technology development that contributes to stable and highly-efficient power supply.

- *Nuclear power technology development programme*
  The nuclear power generation as bulk power sources and the nuclear fuel cycle will be promoted by research and development related to nuclear reactors, nuclear fuel cycle, and disposal of radioactive wastes.

## GENERAL ENERGY POLICY

Switzerland's energy policy is guided by Article 89 of the country's federal Constitution, which calls for sufficient, reliable, diversified, cost-effective and environmentally sound energy supply, and emphasises the importance of energy efficiency. As a landlocked country with no domestic energy resources except hydropower – which accounted for some 14% of total primary energy supply (TPES) and 55% of electricity production in 2004[11] – securing energy supplies through a range of trade relations and fuel diversification is important.

Currently, Switzerland's main energy policy challenges are:

- Reform of grid-bound energy sectors. This is mainly focused on electricity; natural gas is not a priority issue.
- Reaching the national targets under the Kyoto Protocol, the $CO_2$ Law and the SwissEnergy programme, using an array of demand-side and renewables policies and measures.
- Filling the electricity supply gap starting in 2020 when the first nuclear plants will reach the end of their operational lifetime. In 2006, the Federal Council – Switzerland's federal government – will review all options for long-term electricity supply, based on the findings of the revisited energy perspectives (see the section on Energy Supply and Demand below).
- Adoption of procedures that will enable a nuclear waste repository to be operational by 2040.

### SWISS ENERGY PROGRAMME

The ten-year SwissEnergy programme was launched in 2001 as a successor to the Energy2000 programme of the 1990s. SwissEnergy has four main areas of activity. Three focus on end-use efficiency: *i)* public sector and buildings, *ii)* industry and services, including appliances, and *iii)* transport. The fourth focuses on renewables (see the sections on Energy Efficiency and Renewables below). The programme sets several targets for 2010 as compared with 2000: a 10% reduction in fossil fuel consumption, an electricity demand growth cap of 5% total over the decade, the stabilisation of available hydropower generating capacity and targets for electricity and heat production from non-hydro renewables.

11. Please note the Switzerland TPES figures used in this review are revised figures not reflected in the *Energy Balances and Key Statistical Data* tables of Part 2.3 and Annex A. The revised data will be reported in subsequent IEA reviews and statistical tables.

As part of a Swiss government-wide austerity programme, SwissEnergy's regular annual budget has been curtailed from CHF 55 million in 2003 to CHF 50 million in 2004. In 2003, a special CHF 45 million biomass promotion programme – which was launched in 2000 after the winter 1999 Lothar storm that caused heavy forest damage – was phased out, compounding the cutbacks. These cuts were slightly buffered by *ad hoc* grants from Parliament and sustained funding from the cantons, the Swiss regional units. In sum, overall federal spending dwindled from CHF 74.5 million in 2001 to CHF 63.3 million in 2003 (not including CHF 26 million of cantonal funding and CHF 48 million by private partners). Federal spending amounted to CHF 49.1 million in 2004, and is budgeted at 42.8.million in 2005.

Pilot and demonstration projects carried the brunt of the cuts, from CHF 15 million to CHF 6 million in 2005. Financing of countrywide energy efficiency and awareness-raising programmes (*e.g.* private-sector voluntary agreements, building codes, standards and labels, networks for sustainable energy policy at the municipal level) remained unscathed at CHF 20 million. So has federal co-funding of cantonal energy programmes (CHF 15 million in addition to CHF 26 million of cantonal funding in 2003). But starting in 2004, federal allocation became contingent on the size and efficiency of the cantonal programmes. This entailed a shift towards more efficient programmes (quantified in terms of saved or renewable-produced energy per CHF), such as those aimed at improving the energy efficiency of buildings, at the expense of less efficient programmes such as photovoltaics. Thus, federal spending on energy efficiency programmes remained almost stable (from CHF 24 million in 2003 to CHF 22 million in 2005), whereas the budgets of renewables programmes (including pilot and demonstration projects) were slashed from CHF 25.3 million in 2003 to CHF 9 million in 2005.

## ENERGY TAXES

Fuel tax reform for transport fuels is currently being debated and is scheduled to take effect in 2007. The aim is to keep fuel tax revenues constant by offsetting a tax reduction on natural gas and an exemption on biofuels (mostly bioethanol) against higher taxation of gasoline. For reference, the fuel tax is separate from Switzerland's newly approved $CO_2$ tax on heating fuels, which is discussed in the Energy and the Environment section.

Another fiscal proposition currently being debated is to differentiate car taxes, with 2008 as a target date. Taxes on vehicles with A and B labels (which denote high fuel efficiency) would be reduced by up to CHF 5 000 (A- and B-labelled diesel vehicles must have particulate filters to qualify). Revenue shortfalls would be compensated by increasing taxes on gasoline guzzlers from 4% to up to 6–8%. This measure would reinforce many cantonal incentive schemes on car circulation fees, which are annual fees that owners must pay for each car in order to drive it in Switzerland.

## ENERGY SUPPLY AND DEMAND

Switzerland's TPES has increased 14% since 1990 and reached a new record high of 27.9 Mtoe in 2003, a 1.9% rise over the previous year. Oil accounts for 46% of TPES, followed by nuclear (24.2%), hydro (14.0%) and natural gas (9.4%).

Total final consumption (TFC) amounted to 21.6 Mtoe in 2003, a 2.5% rise over 2002. The largest increase was in the residential (+4.6%) and services sectors (+3.7%), whereas the transport sector witnessed a 0.9% decrease. Transport accounted for 32.9% of TFC, households for 28.4% and industry for 19.7%.

The government is currently revisiting its long-term energy perspectives to 2035. Crucial choices will need to be made in the coming years as policy targets beyond 2010 (when the SwissEnergy programme and $CO_2$ Law targets will lapse) need to be defined, and the oldest nuclear power plants will reach the end of their operational lifetime around 2020. Their replacement could impact the country's energy and electricity mixes and $CO_2$ emissions. The new perspectives are not yet finalised, but basic assumptions include a demographic stabilisation at 7.6 million inhabitants in the next decade and GDP growth varying between +0.5 and +1.5% annually. One scenario without $CO_2$ taxes indicates a 3.7% TFC rise and 23.5% rise in electricity demand by 2035 as compared with 2003. Another scenario with $CO_2$ taxes indicates that by 2035 there will be a 1.4% TFC decline and a larger (*i.e.* 24.6%) increase in electricity demand (due to heat pumps replacing heating oil).

## ENERGY AND THE ENVIRONMENT

In July 2003 Switzerland ratified the Kyoto Protocol, by which it committed itself to reduce its greenhouse gas emissions by 8% below 1990 levels by the 2008–2012 period. Switzerland had already adopted a $CO_2$ Law in 2000 in order to reach its Kyoto target. The law sets a more stringent target for $CO_2$ emissions: 10% below 1990 levels by the same period. It mandates a $CO_2$ tax to be introduced at the earliest in 2004 should voluntary measures prove insufficient. Energy-related $CO_2$ emissions have remained roughly stable since 1990. In March 2004, business-as-usual projections showed that the Kyoto and $CO_2$ Law targets would be missed; total $CO_2$ emissions would be only 3.9% below 1990 levels, with heating and process fuel emissions at 11.4% below 1990 levels (as compared with a target of 15% below) and transport fuel emissions would be higher, 8.5% above 1990 levels (well inferior to the target of 8% below 1990 levels).

The foreseeable failure to meet the Kyoto target prompted the Federal Council to take action. Four options were proposed for public consultation, taking into account the requirements of the $CO_2$ Law, including a maximum tax rate of CHF 210 per tonne of $CO_2$ ($tCO_2$), economic considerations (the looming $CO_2$ tax is the key driver for voluntary agreements with industry) and political sensitivities. The most stringent option was to levy a $CO_2$ tax on heating fuels (CHF 35/t$CO_2$ or CHF 0.09/litre) and transport fuels (CHF 64/t$CO_2$ or CHF 0.15/litre starting in 2006, rising to CHF 128/t$CO_2$ or CHF 0.30/litre from 2008 onwards). This tax was expected to reduce oil demand sufficiently to meet the Kyoto target, albeit some 60% of the demand cuts were expected to be mere displacement of "tank tourism" (foreign drivers filling up their cars with cheaper Swiss gasoline). The laxest option was a proposal by the Swiss oil industry association with support from opposition towards the tax: to levy a so-called "climate cent" (CHF 0.013 to 0.019/litre) on transport fuels only. The expected CHF 70 to 115 million revenues would be earmarked for domestic and foreign emissions-mitigating projects and purchases of international $CO_2$ certificates.

In March 2005 the Federal Council passed a compromise decision based on the results of the public consultation: a CHF 35/t$CO_2$ tax on heating fuels will be introduced in 2006. Regarding transport fuels, the "climate cent" will be granted a grace period until the end of 2007 to demonstrate its effectiveness. "Climate cent" revenues will be managed by the private sector, which agreed to a $CO_2$ reduction target with the government (see the following paragraph). Failing that, a $CO_2$ tax will be introduced on gasoline, while diesel (which is already heavily taxed by European standards) may be exempted. By virtue of the $CO_2$ Law, the tax must be fiscally neutral, *i.e.* revenues will be recycled to the population and the economy through health insurance and employers' pension cost refunds. Enterprises can be exempted by entering voluntary agreements to reduce their emissions. The tax rate must ultimately be approved by Parliament (debate is scheduled for the autumn of 2005).

Under a business-as-usual scenario, Switzerland's $CO_2$ emissions will exceed the $CO_2$ Law target by 2.9 Mt by 2010. The projected surplus is to be eliminated as follows:

- 0.7 Mt $CO_2$ reduction as a result of the $CO_2$ tax.
- 1.8 Mt $CO_2$ reduction through the "climate cent" (including 0.2 Mt $CO_2$ from domestic measures and 1.6 Mt $CO_2$ from international measures).
- 0.4 Mt $CO_2$ reduction by reforming transport fuel and car taxes.

Switzerland is currently in talks with the EU to link up with the EU Emissions Trading Scheme (EU-ETS).

## ENERGY EFFICIENCY

Most end-use efficiency measures are encapsulated in the SwissEnergy Programme, with three focuses: buildings and the public sector, industry and appliances, transport.

## BUILDING AND THE PUBLIC SECTOR

According to the Constitution, building codes are explicitly a cantonal responsibility. Therefore, SwissEnergy has devoted much effort to harmonising cantonal regulations. By 2003, 20 cantons (home to 80% of the population) had introduced harmonised model building codes. SwissEnergy also promotes the high-efficiency "Minergie" standards. Earlier goals to require individualised heat and hot water metering in existing buildings (in addition to new buildings, for which individualised metering is obligatory by law) were abandoned in the face of widespread opposition, including in eight cantons that already require it (and that hold 33% of the population). Instead, energy policy aims at tightening those norms with higher political acceptability, such as a new obligation that no more than 80% of heating and hot water demand in new buildings be generated from non-renewable sources. Eleven cantons with 63% of the population have already introduced this policy.

Another important programme is the promotion of sustainable energy policy at the municipal level by means of the "EnergyCity" *(Energiestadt, Cité de l'énergie)* label, which has been awarded to 122 cities in Switzerland, where some 37% of the population live. EnergyCity is internationally known as the European Energy Award. It requires cities to adopt at least 50% (for the silver award) or 75% (for the gold award) of 80 energy efficiency measures and is subject to re-evaluation at four-year intervals.

## INDUSTRY AND APPLIANCES

Voluntary agreements with industry and service companies (or groups of companies) are co-ordinated by the private sector's energy agency, EnAW *(Energie-Agentur der Wirtschaft, Agence de l'énergie pour l'économie)*. Companies that enter into these agreements will be exempted from the impending $CO_2$ tax if they sufficiently curb their energy consumption and $CO_2$ emissions. In April 2004, EnAW signed a covenant with the Department of Environment, Transport, Energy and Communications (DETEC) on behalf of about 600 enterprises grouped into 45 voluntary agreements. The covenant commits the companies, which in total cover about 2.57 Mt $CO_2$ (25% of total industry $CO_2$ emissions), to increase energy efficiency by 8.8% and to cut emissions by 345 kt $CO_2$ by 2010. This corresponds to a 12.6% decline in emissions as compared to 1990 and a 6.9% decline in emissions as compared to 2000. More voluntary agreements are being finalised so as to ultimately cover 40% of industry emissions.

In a separate agreement signed in February 2003, the Swiss cement industry committed to reducing its fuel-induced emissions by 44.2% (by 575 kt $CO_2$, not including emissions from non-energy sources) by 2010 as compared to 1990 levels.

In the appliance sector, major efforts have been directed at enforcing labelling of home appliances, which was introduced in 2002. EU and Swiss practices were realigned with the introduction of A+ and A++ labels for refrigerators and freezers starting in 2005. Steps are currently under way to join the EnergyStar programme for office equipment and consumer electronics. A voluntary labelling scheme for coffee machines is being considered.

## TRANSPORT

In February 2002, an agreement was reached with the Swiss automobile import association to improve the average fuel efficiency of new vehicles from 8.40 litres/100 km in 2000 to 6.40 litres/100 km in 2008. By 2004, the average fuel efficiency was 7.82 litres/100 km, *i.e.* behind schedule. Car labelling in line with EU regulations started in 2003.

Several SwissEnergy programmes aim at changing mobility patterns and driving behaviour. The most successful have been efficient driving courses, which are now compulsory for acquiring a driver's licence.

Very important, although not part of SwissEnergy, is the heavy-duty vehicle tax, which was introduced in 2001 and raised at the beginning of 2005. The tax is calculated on distance and load. Two-thirds of annual revenues, which now total some CHF 1.1 billion, are allocated to construction of rail infrastructure to achieve a modal shift. The effects of the tax (as well as raised truck load limitations) are compelling. Road freight transport decreased by 9% in 2001–2003 after decade-long uninterrupted growth. Transit through the Alps decreased by 8%.

There are planned reforms on transport fuel and car taxation, discussed in the General Energy Policy section above.

## RENEWABLES

The SwissEnergy Programme sets two renewables generation targets: the share of electricity generated from non-hydro renewables is to increase from 1.3% in 2000 to 2.3% in 2010 (an increase of 500 GWh) and the share of heat generated from renewables is to increase by 3 percentage points (an increase of 3 000 GWh).

By the end of 2004, the fourth year of the SwissEnergy programme, electricity generated from new renewables amounted to 997 GWh (1.57% of total generation). This represents an increase of 149 GWh over four years, *i.e.* only 30% of the full ten-year target. By far the largest source was combustible renewables and waste, which made up 83% of new renewables, followed by biomass (15%). Wind power production is slated to almost double, to 10 GWh, with the expansion of the country's largest wind farm in the autumn of 2004.

A wind master plan was released in 2004, identifying 28 sites with the aim of producing up to 50 GWh by 2010. Solar contributes a mere 1.7% of new renewable electricity, but the completion of the country's largest solar plant (850 kW) on the roof of the Berne sports stadium in 2004 underscores the source's untapped potential.

In the heat sector, however, developments were on track to meet the 2010 target, with 8 424 GWh produced from new renewables (an increase of 1 153 GWh over 2000), with biomass providing the lion's share (49%), followed by combustible renewables and waste (27%) and ambient heat and heat pumps (18%).

Additional policy measures have been adopted to promote renewables. In November 2004, the Energy Ordinance was amended so that electricity bills will need to detail the origin and source of electricity starting in 2006. This should facilitate consumer choices at a time when ever more utilities offer various electricity mixes. Another amendment to the Energy Ordinance adjusts allocation of the minimal CHF 0.15/kWh feed-in tariff, which cantons must implement, to the high-voltage grid, instead of hitherto to local suppliers, so that extra costs are spread to all consumers. This will ease the burden on suppliers with a disproportionately large concentration of small hydro.

The planned tax reform for transport fuels (see the General Energy Policy section) should contribute to bioethanol reaching a transport fuels market share of 5.75% by 2020. Market penetration of biogas will be buoyed by mixing up to 10% of biogas to compressed natural gas (see the Natural Gas section below).

Furthermore, as part of the proposed electricity market liberalisation package, the Energy Law is to be amended to include renewable electricity targets for 2030. The share of renewables (including hydro) in net electricity consumption (generation divided by consumption net of losses and exports) is to rise from 67% to 77% by 2030. Five years after enactment of the law, the Federal Council may adopt prescriptive measures such as cost-based feed-in tariffs or compulsory quotas, if voluntary industry action fails to deliver results. Voluntary action is to focus on tenders for new capacity. The renewables issue is highly controversial in the ongoing parliamentary debate.

Sales of green electricity soared thirteenfold in 2003 to 2.5 TWh (4.6% of consumption), mainly because the public utility of the canton of Geneva entered the market. Over 98% of green electricity sales are of hydropower. Roughly half of Switzerland's 900 utilities offer green power. Some 340 000 consumers cover part of their demand with green power. Sales of green power under the more stringent "naturemade star" label are increasing, too, reaching 0.3 TWh (0.54% of consumption) in late 2004.

Heat pump sales boomed to record highs in 2003 and 2004 with growth rates of 15–20% annually, partly because of high oil prices. In 2004, heat pumps reached a 23% market share of all heating installations.

CHF 40 million of financing (mainly by the Basle authorities) has been secured for the next phase of a geothermal deep heat mining project. Two or three exploratory wells are to be drilled to some 5 000 metres by 2007 to appraise the geothermal potential of a site near Basle. If successful, a CHP plant with a capacity of 3 $MW_e$ and 20 $MW_{th}$ will be built at an additional cost of CHF 40 million.

## OIL

Oil demand decreased in 2004 by 1.3% to 11.06 Mt according to industry figures. Consumption of transport fuels declined by 0.5%, with both gasoline (which fell by 1.8%) and aviation fuel (which fell by 5.7%, mainly because of the downsizing of the Swiss airline fleet) plummeting. In contrast, the trend towards diesel accelerated, rising by 7.5%. About 30% of new vehicles and 8.4% of the total vehicle fleet were running on diesel at the end of 2004. Heating fuel demand decreased by 2.5%, mainly because of lost market share to biomass, natural gas and heat pumps as a result of high oil prices. Switzerland has relatively high per capita oil consumption (1.78 toe) by central European standards, because a large share of oil demand (23%) is for heating purposes.

## NATURAL GAS

Year after year, natural gas has been steadily winning market share, reaching 9.4% of TPES in 2003. Gas sales increased by 5.7% in 2003 and 3.2% in 2004 to a new record of 35.059 TWh. The gas industry wants to achieve 23% of TPES – a highly ambitious goal – in the coming 10–15 years by means of grid densification and expansion to compete mainly in the heat sector, but also in the power sector (see the Electricity section) and by supplying the growing natural gas vehicles fleet.

Plans to liberalise the natural gas sector were shelved after the Electricity Market Law was defeated by referendum in 2002. For several reasons, Switzerland considers gas sector reform a lesser priority than electricity sector reform. Based on the Pipeline Law, which allows for third-party access (TPA) to high-pressure pipelines, the gas industry has already drawn up rules for negotiated TPA. Transit capacity was boosted in 2002 when the capacity of the Transitgas pipeline from France and Germany to Italy was doubled to 16 bcm per year. To ensure the fair provision of TPA, the law identifies the Swiss Federal Office of Energy as a dispute settlement body. Further factors that make gas sector reform less pressing are the relative immaturity of the sector and the small number of large (*i.e.* potentially contestable) customers. Though large customers are charged prices about 30% above the EU average, gas prices for households – in contrast to the situation in electricity – are relatively competitive by EU standards, because gas competes mainly against fuel oil for heat generation and taxation of gas for household use is lower than in most EU countries.

The target of the gas industry association VSG *(Verband der Schweizerischen Gasindustrie)* is to have 100 natural gas vehicle filling stations operational by 2006 (there were 62 stations by spring 2005) in return for legislative efforts to differentiate fuel taxes according to environmental impacts (see General Energy Policy section). This should help reach a target of 50 000 natural gas vehicles by 2010. VSG and the biogas association agreed in 2003 to admix up to 10% biogas into the gas network.

## ELECTRICITY

In 2004, electricity generation amounted to 63.5 TWh, a 2.7% decrease over 2003. Hydropower accounted for 55.3% of production (3.6% less than in 2003), and nuclear power for 40%.

Demand rose to a new record 56.2 TWh in 2004, up 1.9% from 2003 and 7.3% above 2000 levels. The SwissEnergy 5% cap on electricity demand growth over the decade has thus been breached.

For decades, Switzerland has been a net electricity exporter over the whole calendar year. In recent years, however, demand has increasingly shifted towards the winter season and thereby led to increased imports. Owing to rising demand and reduced hydropower production during the hydrological year 2004 (1 October 2003–30 September 2004), Switzerland became a (small) net importer for the first time since 1971/72. For calendar year 2004, exports dwindled to 0.7 TWh – a massive decline compared with 3.1 TWh in 2003 and 10.4 TWh in 2001.

Current construction and upgrades will increase total generating capacity only marginally from 17 352 MW to 17 540 MW by 2010. Major new capacity could stem from plans to de-mothball and retrofit the Chavalon plant by installing a 357 MW combined-cycle gas turbine. Additional generation – but not actually new capacity – is expected in 2009 with completion of repairs on the 1 200 MW Cleuson-Dixence-Bieudron hydropower plant, which has not produced power since a water pipeline broke in 2000. Several major pump storage expansions of existing hydropower complexes are under way or in an advanced planning stage: Linth-Limmern (+860 MW), Oberhasli-Grimsel (+1 100 MW), Emosson (at the French border, jointly with EDF; +600 MW).

Cross-border flows of electricity have increased considerably in recent years as a result of growing international electricity trade, particularly to Italy. Existing cross-border net transfer capacity is:

- 4 350 MW (3 200 MW in winter) from France.
- 4 000 MW from/to Germany in summer (3 000 MW from Germany in winter).
- 1 200 MW from Austria, where 700 MW capacity were added in 2002.
- 3 120 MW to Italy.

The commissioning in early 2005 of the 1 300 MW San Fiorano-Robbia interconnection will ease chronic bottlenecks with Italy. Several additional interconnections with Italy, including a 400 kV DC merchant line, are at the planning or permitting stage The interconnections with France and Germany are occasionally congested in times of high load and strong loop flows.

A new legal reform package for the electricity sector was sent to Parliament in December 2004 after more than a year of preparation and public consultation in the aftermath of the demise of the Electricity Market Law (EML) by popular referendum in September 2002. The package includes an amendment to the Electricity Law and a new Law on Electric Power Supply (LEPS).

The amendment to the Electricity Law provides for EU-compatible cross-border electricity trade, with TPA to be offered by the newly created transmission system operator Swissgrid under regulation by a new Electricity Commission (ElCom). The amendment to the Electricity Law is a temporary solution until the new LEPS enters into force, which is scheduled for 2007. The LEPS calls for a two-phase liberalisation of the electricity sector. Upon enactment of the law, all commercial customers will become eligible, to be followed five years later by full opening of the market. Households will be given the choice to either remain captive to their incumbent utility or to be eligible to choose their own suppliers. ElCom's powers will be extended to regulate not only cross-border trade, as foreseen by the amendment to the Electricity Law, but also the domestic market. Distribution companies will be unbundled at the accounting level, as legal unbundling would be too burdensome for most of them, as they are small utilities. Legal unbundling of the transmission network will have taken place previously by amendment of the Electricity Law and the setting up of Swissgrid, the TSO.

To allay concerns about public service dismantlement, which caused the failure of the EML, the LEPS reinforces electricity companies' obligations regarding security of supply and empowers the Federal Council to take remedial action if security of supply is threatened. Both the promulgation of the LEPS and the subsequent full market opening are subject to optional referendums, which should enhance the political acceptability of the law. To rally ecological and mountain constituencies, the LEPS introduces targets for renewable energies (see the Renewables section), and mandates that hydropower capacity be sustained.

Preparation of a new reform package began after several domestic and international developments. In March 2001, the Competition Commission ruled, and the Supreme Court affirmed in June 2003 that negotiated TPA could be enforced. This ruling was also upheld by the Federal Council in March 2004. However, electricity companies were not granted the right to TPA automatically, but needed to secure it case by case through lawsuits. Many companies refrained from filing protracted and costly lawsuits and urged for matters to be clarified by a new law. Furthermore, the question of whether cantonal monopolies could deny TPA by invoking public-service obligations was not resolved. Finally, Switzerland's pivotal position in the EU electricity market requires EU-compatible regulation of electricity trade. The blackout in Italy in September 2003, following the consecutive tripping of two main transmission lines in Switzerland, underscored the need for improved co-operation between European transmission system operators under common rules and standards.

Notwithstanding legal uncertainty, the electricity sector geared up for competition by granting sizable price discounts to large customers, by consolidating and by setting up a joint company, ETRANS, to operate the transmission network. ETRANS is currently being constituted as a TSO called Swissgrid. In March 2005, Switzerland's Competition Commission imposed certain conditions on the establishment of Swissgrid. In May, Swisselectric, the association of large utilities and the main shareholders of Swissgrid, appealed against some of these conditions. The appeal is now pending and the formal establishment of Swissgrid is unlikely in 2005.

By the summer of 2005, the draft legal reform package was examined by the Energy Commission of the National Council (the lower house), which decided to split it into three items for debate in the National Council in the autumn of 2005:

- An amended Electricity Law to regulate electricity transit.
- The LEPS to address domestic market opening, with the major change to fully open the market in one step (skipping the transition period during which the market would be opened for commercial consumers only).
- Measures to deal with the promotion of renewables separately, and to skip the 5-year phase for voluntary action. To reach a target of 5.4 TWh by 2030 (including 2–2.5 TWh of hydro), cost-based feed-in tariffs for biomass, wind, geothermal and solar are to be financed through a grid levy, which will be capped at CHF 0.003/kWh and which will provide CHF 165 million (by comparison, current feed-in tariffs provide CHF 28 million). New hydropower capacity (mainly retrofits and upgrades) and possibly demand-side measures are to be tendered.

## NUCLEAR

In May 2003, two popular initiatives – one to extend a moratorium on the construction of nuclear plants that lapsed in 2000, the other to phase out nuclear energy altogether – were rejected by majorities of 58.4% and 66.3%, respectively.

After two years of parliamentary debate, a new Nuclear Energy Law (NEL) was adopted in March 2003 and entered into force in February 2005, along with a new main Nuclear Energy Ordinance (NEO). The NEL keeps the nuclear option open, addresses key issues related to radioactive waste management and clearly empowers the Federal Council to authorise construction, operation and decommissioning of nuclear installations. Controversies on reprocessing were circumvented with a temporary ban (until 2016) on exports of spent nuclear fuels. The NEL requires the monitoring of long-term geological disposal (combining elements of both final disposal and reversibility), creates a funding system for decommissioning and waste-management costs, simplifies licensing procedures, mandates the participation of the public and affected parties in licensing procedures, including host and adjacent cantons and countries, and provides for the possibility of filing court appeals against important licence decisions, except framework licences for new nuclear installations, which must be approved by Parliament.

Efforts to identify sites for final disposal are ongoing. As part of the Swiss waste management programme, the project *Entsorgungsnachweis* (disposal feasibility) aims at demonstrating the feasibility and availability of a safe repository. The Federal Council will issue a decision in 2006 on how to proceed. The NEO stipulates that a *Sachplan*, or master plan, defining a site selection procedure, which will be binding for the authorities, be drawn up. Disposal remains the prime responsibility of the nuclear waste producers, who will have to submit a disposal programme to the Federal Council.

Decommissioning of the three oldest nuclear power plants Beznau I, II and Mühleberg with a combined capacity of 1 085 MW (one-third of the country's total nuclear capacity) is expected around 2020. Furthermore, drawing rights for some 2 500 MW of French nuclear capacity will need to be renewed. Replacement of this capacity will be one of the major challenges of Swiss energy policy in the coming years and has prompted the review of long-term energy perspectives. Some power industry representatives floated the idea of building a new nuclear power plant, triggering a vehement debate.

## RESEARCH, DEVELOPMENT AND DEMONSTRATION

In November 2003, the Federal Council adopted the sixth Swiss Federal Energy Research Master Plan for the Years 2004–2007. Emphasis is on applications-oriented research, flanked by pilot and demonstration projects. The master plan focuses on four areas:

- *Rational use of energy,* particularly in the buildings and transportation sectors. A substantial savings potential exists in optimising combustion processes and in increasing the efficiency of storage and consumption of electricity. Also important are the optimal co-generation of heat and power, as well as the use of ambient heat (heat pumps).
- *Renewable energy.* Examples of project areas include solar thermal systems, photovoltaics and biomass (with priority given to wood). Other project areas include geothermal energy, wind power and small hydro plants, as well as longer-term research in the area of solar chemistry (including hydrogen).

- *Nuclear energy.* Security and disposal of radioactive waste are the main research topics in the fission area. Research on fusion is also carried out.
- *Energy policies and economics.*

In 2003 public funding for energy R&D amounted to CHF 183 million, which represents a 9.6% increase since 2000. Further slight increases are budgeted for 2004 and 2005. The target of the master plan is to reach CHF 213 million by 2007. In 2003, the breakdown by funding areas was: 32.2% for rational use of energy, 29.5% for renewables, 28.8% for nuclear energy and 9.5% for energy policies and economics. Nearly 41% of funding was directly linked with international projects, mainly within IEA Implementing Agreements and within the EU Framework Programmes. A bilateral treaty with the EU has enabled Swiss researchers to seek financing directly from the EU since 2004.

PART 2.3

# ENERGY BALANCES AND KEY STATISTICAL DATA OF IEA COUNTRIES

AUSTRALIA

AUSTRIA

BELGIUM

CANADA

CZECH REPUBLIC

DENMARK

FINLAND

FRANCE

GERMANY

GREECE

HUNGARY

IRELAND

ITALY

JAPAN

KOREA

LUXEMBOURG

NETHERLANDS

NEW ZEALAND

NORWAY

PORTUGAL

SPAIN

SWEDEN

SWITZERLAND

TURKEY

UNITED KINGDOM

UNITED STATES

# AUSTRALIA

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **68.0** | **157.7** | **254.5** | **253.5** | **350.0** | **396.2** | **..** |
| Coal[1] | | 40.3 | 106.3 | 184.3 | 185.0 | 245.0 | 264.9 | .. |
| Oil | | 19.8 | 29.0 | 33.0 | 30.7 | 30.6 | 32.7 | .. |
| Gas | | 3.4 | 17.1 | 30.3 | 31.3 | 65.0 | 89.0 | .. |
| Comb. Renewables & Waste[2] | | 3.5 | 4.0 | 5.4 | 5.0 | 7.5 | 7.6 | .. |
| Nuclear | | – | – | – | – | – | – | .. |
| Hydro | | 1.0 | 1.2 | 1.4 | 1.4 | 1.5 | 1.5 | .. |
| Geothermal | | – | – | – | – | – | – | .. |
| Solar/Wind/Other[3] | – | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | .. | |
| **TOTAL NET IMPORTS[4]** | | **-10.3** | **-65.7** | **-139.4** | **-139.5** | **-203.9** | **-216.8** | **..** |
| Coal1 | Exports | 17.6 | 67.7 | 131.6 | 135.5 | 188.8 | 198.1 | .. |
| | Imports | – | – | – | – | – | – | .. |
| | Net Imports | -17.6 | -67.7 | -131.6 | -135.5 | -188.8 | -198.1 | .. |
| Oil | Exports | 3.4 | 9.3 | 26.2 | 22.1 | 19.7 | 13.7 | .. |
| | Imports | 12.5 | 14.2 | 28.0 | 28.0 | 37.4 | 41.2 | .. |
| | Bunkers | 1.8 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | .. |
| | Net Imports | 7.4 | 4.3 | 1.1 | 5.1 | 16.8 | 26.7 | .. |
| Gas | Exports | – | 2.3 | 8.9 | 9.1 | 32.0 | 45.3 | .. |
| | Imports | – | – | – | – | – | – | .. |
| | Net Imports | – | -2.3 | -8.9 | -9.1 | -32.0 | -45.3 | .. |
| Electricity | Exports | – | – | – | – | – | – | .. |
| | Imports | – | – | – | – | – | – | .. |
| | Net Imports | – | – | – | – | – | – | .. |
| **TOTAL STOCK CHANGES** | | **-0.1** | **-4.5** | **-3.2** | **-1.4** | **0.4** | **–** | **..** |
| **TOTAL SUPPLY (TPES)** | | **57.6** | **87.5** | **111.9** | **112.6** | **146.5** | **179.5** | **..** |
| Coal[1] | | 22.6 | 35.0 | 49.0 | 48.0 | 56.2 | 66.8 | .. |
| Oil | | 27.1 | 32.5 | 34.6 | 35.9 | 47.9 | 59.3 | .. |
| Gas | | 3.4 | 14.8 | 21.4 | 22.2 | 33.0 | 43.7 | .. |
| Comb. Renewables & Waste[2] | | 3.5 | 4.0 | 5.4 | 5.0 | 7.5 | 7.6 | .. |
| Nuclear | | – | – | – | – | – | – | .. |
| Hydro | | 1.0 | 1.2 | 1.4 | 1.4 | 1.5 | 1.5 | .. |
| Geothermal | | – | – | – | – | – | – | .. |
| Solar/Wind/Other[3] | | – | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | .. |
| Electricity Trade[5] | | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *39.2* | *39.9* | *43.8* | *42.6* | *38.4* | *37.2* | .. |
| *Oil* | | *47.1* | *37.2* | *30.9* | *31.9* | *32.7* | *33.1* | .. |
| *Gas* | | *5.9* | *16.9* | *19.2* | *19.7* | *22.5* | *24.3* | .. |
| *Comb. Renewables & Waste* | | *6.1* | *4.5* | *4.8* | *4.4* | *5.1* | *4.3* | .. |
| *Nuclear* | | – | – | – | – | – | – | .. |
| *Hydro* | | *1.7* | *1.4* | *1.2* | *1.2* | *1.1* | *0.9* | .. |
| *Geothermal* | | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | | – | *0.1* | *0.1* | *0.1* | *0.2* | *0.3* | .. |
| *Electricity Trade* | | – | – | – | – | – | – | .. |

0 is negligible, – is nil, .. is not available

Please note: All data except GDP and population refer to the fiscal year July to June

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **40.0** | **58.1** | **70.9** | **72.3** | **89.2** | **111.1** | **..** |
| Coal[1] | 4.9 | 4.3 | 2.9 | 2.7 | 2.6 | 2.7 | .. |
| Oil | 24.7 | 30.5 | 36.1 | 37.3 | 44.5 | 55.7 | .. |
| Gas | 2.4 | 8.8 | 11.0 | 11.5 | 17.8 | 22.8 | .. |
| Comb. Renewables & Waste[2] | 3.5 | 3.3 | 4.6 | 4.3 | 3.8 | 4.4 | .. |
| Geothermal | – | – | – | – | – | – | .. |
| Solar/Wind/Other | – | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | .. |
| Electricity | 4.5 | 11.1 | 16.3 | 16.4 | 20.3 | 25.4 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *12.3* | *7.4* | *4.0* | *3.8* | *2.9* | *2.4* | .. |
| *Oil* | *61.7* | *52.6* | *50.9* | *51.7* | *49.9* | *50.2* | .. |
| *Gas* | *5.9* | *15.2* | *15.5* | *15.9* | *20.0* | *20.5* | .. |
| *Comb. Renewables & Waste* | *8.7* | *5.6* | *6.4* | *5.9* | *4.3* | *3.9* | .. |
| *Geothermal* | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | – | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* | .. |
| *Electricity* | *11.3* | *19.1* | *23.0* | *22.6* | *22.8* | *22.9* | .. |
| *Heat* | – | – | – | – | – | – | .. |
| **TOTAL INDUSTRY[6]** | **17.6** | **23.1** | **25.7** | **25.8** | **36.6** | **45.4** | **..** |
| Coal[1] | 4.6 | 4.1 | 2.7 | 2.6 | 2.5 | 2.5 | .. |
| Oil | 7.7 | 6.3 | 5.9 | 6.0 | 9.9 | 13.0 | .. |
| Gas | 1.8 | 6.1 | 7.1 | 7.5 | 12.1 | 15.5 | .. |
| Comb. Renewables & Waste[2] | 1.5 | 1.5 | 2.5 | 2.4 | 2.3 | 2.8 | .. |
| Geothermal | – | – | – | – | – | – | .. |
| Solar/Wind/Other | – | – | – | – | – | – | .. |
| Electricity | 2.0 | 5.1 | 7.4 | 7.3 | 9.8 | 11.7 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *26.4* | *17.6* | *10.7* | *10.1* | *6.9* | *5.6* | .. |
| *Oil* | *43.8* | *27.4* | *22.8* | *23.2* | *27.1* | *28.5* | .. |
| *Gas* | *10.0* | *26.5* | *27.5* | *29.2* | *33.1* | *34.0* | .. |
| *Comb. Renewables & Waste* | *8.5* | *6.4* | *9.9* | *9.2* | *6.2* | *6.1* | .. |
| *Geothermal* | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | – | – | – | – | – | – | .. |
| *Electricity* | *11.3* | *22.0* | *29.0* | *28.3* | *26.7* | *25.8* | .. |
| *Heat* | – | – | – | – | – | – | .. |
| **TRANSPORT[7]** | **13.5** | **22.7** | **28.3** | **29.2** | **34.7** | **42.9** | **..** |
| **TOTAL OTHER SECTORS[8]** | **8.9** | **12.3** | **17.0** | **17.3** | **17.9** | **22.7** | **..** |
| Coal[1] | 0.3 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | .. |
| Oil | 3.5 | 1.8 | 2.5 | 2.7 | 1.0 | 1.2 | .. |
| Gas | 0.6 | 2.7 | 3.6 | 3.7 | 4.9 | 6.3 | .. |
| Comb. Renewables & Waste[2] | 2.0 | 1.8 | 2.0 | 1.9 | 1.6 | 1.6 | .. |
| Geothermal | – | – | – | – | – | – | .. |
| Solar/Wind/Other | – | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | .. |
| Electricity | 2.5 | 5.9 | 8.7 | 8.9 | 10.3 | 13.5 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.2* | *1.1* | *0.4* | *0.3* | *0.1* | *0.1* | .. |
| *Oil* | *39.7* | *14.2* | *14.6* | *15.8* | *5.7* | *5.5* | .. |
| *Gas* | *7.0* | *21.8* | *21.3* | *21.2* | *27.5* | *27.6* | .. |
| *Comb. Renewables & Waste* | *22.5* | *14.4* | *11.8* | *10.8* | *8.7* | *7.0* | .. |
| *Geothermal* | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | – | *0.7* | *0.5* | *0.5* | *0.4* | *0.5* | .. |
| *Electricity* | *27.7* | *47.7* | *51.3* | *51.3* | *57.6* | *59.4* | .. |
| *Heat* | – | – | – | – | – | – | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **16.0** | **35.1** | **55.3** | **54.3** | **65.8** | **79.1** | .. |
| **OUTPUT (Mtoe)** | **5.5** | **13.3** | **19.5** | **19.6** | **23.6** | **29.6** | .. |
| (TWh gross) | 64.4 | 154.3 | 226.2 | 227.9 | 274.6 | 343.9 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *74.9* | *77.1* | *76.9* | *77.2* | *71.9* | *71.1* | .. |
| *Oil* | *2.6* | *2.7* | *1.7* | *1.0* | *0.9* | *0.7* | .. |
| *Gas* | *4.3* | *10.6* | *13.6* | *13.8* | *17.5* | *20.2* | .. |
| *Comb. Renewables & Waste* | *0.5* | *0.4* | *0.7* | *0.6* | *2.1* | *1.6* | .. |
| *Nuclear* | – | – | – | – | – | – | .. |
| *Hydro* | *17.7* | *9.2* | *7.0* | *7.0* | *6.5* | *5.2* | .. |
| *Geothermal* | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | – | – | *0.2* | *0.3* | *1.2* | *1.2* | .. |
| **TOTAL LOSSES** | **17.8** | **29.3** | **46.5** | **46.1** | **57.2** | **68.4** | .. |
| *of which:* | | | | | | | |
| Electricity and Heat Generation[10] | 10.5 | 21.7 | 35.9 | 34.7 | 42.2 | 49.5 | .. |
| Other Transformation | 5.5 | 0.6 | 2.3 | 2.7 | 5.2 | 6.2 | .. |
| Own Use and Losses[11] | 1.7 | 7.0 | 8.3 | 8.6 | 9.9 | 12.7 | .. |
| Statistical Differences | -0.1 | 0.2 | -5.6 | -5.7 | – | – | .. |

## INDICATORS

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 168.30 | 273.23 | 415.49 | 431.16 | 546.56 | 753.67 | .. |
| Population (millions) | 13.61 | 17.18 | 19.76 | 20.01 | 21.33 | 23.19 | .. |
| TPES/GDP[12] | 0.34 | 0.32 | 0.27 | 0.26 | 0.27 | 0.24 | .. |
| Energy Production/TPES | 1.18 | 1.80 | 2.27 | 2.25 | 2.39 | 2.21 | .. |
| Per Capita TPES[13] | 4.23 | 5.10 | 5.66 | 5.63 | 6.87 | 7.74 | .. |
| Oil Supply/GDP[12] | 0.16 | 0.12 | 0.08 | 0.08 | 0.09 | 0.08 | .. |
| TFC/GDP[12] | 0.24 | 0.21 | 0.17 | 0.17 | 0.16 | 0.15 | .. |
| Per Capita TFC[13] | 2.94 | 3.38 | 3.59 | 3.61 | 4.18 | 4.79 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 157.9 | 259.7 | 346.6 | 347.1 | 414.3 | 510.1 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 7.3 | 6.3 | 8.6 | 9.2 | 9.4 | 9.5 | .. |

## GROWTH RATES (% per year)

| | 73–79 | 79–90 | 90–02 | 02–03 | 03–10 | 10–20 | 20–30 |
|---|---|---|---|---|---|---|---|
| TPES | 3.0 | 2.2 | 2.1 | 0.7 | 3.8 | 2.1 | .. |
| Coal | 1.5 | 3.2 | 2.9 | -2.0 | 2.3 | 1.7 | .. |
| Oil | 2.9 | 0.1 | 0.5 | 3.9 | 4.2 | 2.2 | .. |
| Gas | 12.7 | 7.1 | 3.1 | 3.3 | 5.9 | 2.8 | .. |
| Comb. Renewables & Waste | 0.1 | 1.0 | 2.6 | -6.6 | 5.9 | 0.2 | .. |
| Nuclear | – | – | – | – | – | – | .. |
| Hydro | 5.1 | -0.7 | 1.0 | 1.2 | 1.6 | -0.1 | .. |
| Geothermal | – | – | – | – | – | – | .. |
| Solar/Wind/Other | – | 17.3 | 3.3 | 26.1 | 13.1 | 2.4 | .. |
| TFC | 2.5 | 2.1 | 1.7 | 1.9 | 3.1 | 2.2 | .. |
| Electricity Consumption | 6.3 | 5.0 | 3.3 | 0.2 | 3.1 | 2.3 | .. |
| Energy Production | 3.9 | 5.7 | 4.1 | -0.4 | 4.7 | 1.2 | .. |
| Net Oil Imports | 4.2 | -6.9 | -10.9 | 379.1 | 18.5 | 4.7 | .. |
| GDP | 2.6 | 3.0 | 3.6 | 3.8 | 3.4 | 3.3 | .. |
| Growth in the TPES/GDP Ratio | 0.4 | -0.8 | -1.4 | -3.0 | 0.4 | -1.2 | .. |
| Growth in the TFC/GDP Ratio | -0.1 | -0.9 | -1.8 | -1.8 | -0.4 | -1.0 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **7.9** | **8.1** | **10.0** | **10.0** | **10.4** | **11.6** | **..** |
| Coal[1] | | 1.0 | 0.6 | 0.3 | 0.3 | 0.0 | 0.0 | .. |
| Oil | | 2.7 | 1.2 | 1.1 | 1.0 | 1.0 | 1.1 | .. |
| Gas | | 2.0 | 1.1 | 1.6 | 1.8 | 1.8 | 2.1 | .. |
| Comb. Renewables & Waste[2] | | 0.7 | 2.4 | 3.4 | 3.7 | 3.8 | 4.2 | .. |
| Nuclear | | - | - | - | - | - | - | .. |
| Hydro | | 1.6 | 2.7 | 3.4 | 3.1 | 3.5 | 3.7 | .. |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | .. |
| **TOTAL NET IMPORTS[4]** | | **14.0** | **17.2** | **21.2** | **23.1** | **22.0** | **23.9** | **..** |
| Coal[1] | Exports | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| | Imports | 3.1 | 3.2 | 3.5 | 3.3 | 3.0 | 2.1 | .. |
| | Net Imports | 3.0 | 3.2 | 3.5 | 3.3 | 3.0 | 2.1 | .. |
| Oil | Exports | 0.1 | 0.6 | 1.5 | 1.5 | 1.6 | 1.8 | .. |
| | Imports | 9.9 | 10.2 | 14.1 | 14.8 | 13.4 | 15.1 | .. |
| | Bunkers | - | - | - | - | - | - | .. |
| | Net Imports | 9.7 | 9.6 | 12.6 | 13.3 | 11.8 | 13.2 | .. |
| Gas | Exports | - | - | 0.5 | 0.9 | 0.0 | 0.0 | .. |
| | Imports | 1.3 | 4.4 | 5.6 | 6.8 | 7.1 | 8.4 | .. |
| | Net Imports | 1.3 | 4.4 | 5.1 | 5.9 | 7.1 | 8.4 | .. |
| Electricity | Exports | 0.4 | 0.6 | 1.3 | 1.2 | 1.3 | 1.3 | .. |
| | Imports | 0.3 | 0.6 | 1.3 | 1.6 | 1.4 | 1.5 | .. |
| | Net Imports | -0.1 | -0.0 | 0.1 | 0.5 | 0.1 | 0.1 | .. |
| **TOTAL STOCK CHANGES** | | **-0.3** | **-0.3** | **-0.0** | **0.1** | **-0.2** | **-0.6** | **..** |
| **TOTAL SUPPLY (TPES)** | | **21.7** | **25.0** | **31.1** | **33.2** | **32.3** | **34.9** | **..** |
| Coal[1] | | 3.9 | 4.1 | 3.8 | 4.0 | 3.0 | 2.1 | .. |
| Oil | | 12.3 | 10.6 | 13.3 | 14.2 | 12.5 | 14.1 | .. |
| Gas | | 3.3 | 5.2 | 7.0 | 7.6 | 9.0 | 10.3 | .. |
| Comb. Renewables & Waste[2] | | 0.7 | 2.5 | 3.4 | 3.7 | 3.8 | 4.2 | .. |
| Nuclear | | - | - | - | - | - | - | .. |
| Hydro | | 1.6 | 2.7 | 3.4 | 3.1 | 3.5 | 3.7 | .. |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | .. |
| Electricity Trade[5] | | -0.1 | -0.0 | 0.1 | 0.5 | 0.1 | 0.1 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *17.9* | *16.4* | *12.2* | *12.0* | *9.2* | *6.0* | .. |
| *Oil* | | *56.7* | *42.3* | *42.8* | *42.9* | *38.9* | *40.3* | .. |
| *Gas* | | *15.3* | *20.7* | *22.4* | *22.8* | *28.0* | *29.5* | .. |
| *Comb. Renewables & Waste* | | *3.3* | *9.9* | *11.0* | *11.0* | *11.8* | *12.1* | .. |
| *Nuclear* | | - | - | - | - | - | - | .. |
| *Hydro* | | *7.5* | *10.8* | *11.0* | *9.4* | *10.8* | *10.6* | .. |
| *Geothermal* | | - | - | *0.1* | *0.1* | *0.1* | *0.1* | .. |
| *Solar/Wind/Other* | | - | *0.1* | *0.3* | *0.3* | *0.8* | *1.1* | .. |
| *Electricity Trade* | | *-0.6* | *-0.2* | *0.2* | *1.5* | *0.4* | *0.4* | .. |

0 is negligible. - is nil, .. is not available

All forecasts are based on the 2002 submission

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **16.8** | **20.1** | **26.3** | **28.1** | **26.9** | **29.0** | **..** |
| Coal[1] | 2.0 | 1.5 | 1.1 | 1.0 | 0.9 | 0.7 | .. |
| Oil | 10.2 | 9.2 | 12.2 | 13.1 | 11.2 | 12.1 | .. |
| Gas | 1.8 | 3.1 | 4.5 | 4.6 | 5.6 | 5.8 | .. |
| Comb. Renewables & Waste[2] | 0.7 | 2.2 | 2.5 | 2.7 | 2.6 | 2.8 | .. |
| Geothermal | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Solar/Wind/Other | - | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | .. |
| Electricity | 2.2 | 3.6 | 4.7 | 5.2 | 5.2 | 5.9 | .. |
| Heat | - | 0.6 | 1.2 | 1.3 | 1.2 | 1.5 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *11.8* | *7.2* | *4.1* | *3.7* | *3.4* | *2.5* | .. |
| *Oil* | *60.4* | *45.6* | *46.3* | *46.7* | *41.7* | *41.8* | .. |
| *Gas* | *10.7* | *15.2* | *17.2* | *16.4* | *21.0* | *20.1* | .. |
| *Comb. Renewables & Waste* | *4.1* | *10.8* | *9.6* | *9.6* | *9.8* | *9.6* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | *0.1* | *0.3* | *0.3* | *0.5* | *0.5* | .. |
| *Electricity* | *12.9* | *18.1* | *18.0* | *18.6* | *19.2* | *20.4* | .. |
| *Heat* | - | *3.0* | *4.5* | *4.6* | *4.5* | *5.1* | .. |
| **TOTAL INDUSTRY[6]** | **6.5** | **7.1** | **8.8** | **9.3** | **8.7** | **8.9** | **..** |
| Coal[1] | 0.7 | 0.7 | 0.9 | 0.9 | 0.7 | 0.6 | .. |
| Oil | 3.3 | 2.2 | 2.7 | 2.9 | 2.0 | 2.3 | .. |
| Gas | 1.3 | 2.0 | 2.4 | 2.4 | 3.0 | 2.8 | .. |
| Comb. Renewables & Waste[2] | 0.0 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 1.0 | 1.5 | 1.8 | 2.1 | 2.1 | 2.3 | .. |
| Heat | - | 0.1 | 0.2 | 0.2 | - | 0.0 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *11.5* | *10.0* | *9.9* | *9.4* | *8.4* | *7.0* | .. |
| *Oil* | *51.7* | *30.4* | *30.4* | *31.5* | *23.0* | *25.5* | .. |
| *Gas* | *20.2* | *28.0* | *27.7* | *25.5* | *34.9* | *32.0* | .. |
| *Comb. Renewables & Waste* | *0.5* | *8.6* | *9.0* | *8.6* | *9.2* | *9.6* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *16.1* | *21.9* | *20.8* | *22.7* | *24.5* | *25.8* | .. |
| *Heat* | - | *1.1* | *2.1* | *2.3* | - | - | .. |
| **TRANSPORT[7]** | **4.0** | **4.7** | **7.3** | **7.8** | **7.3** | **8.1** | **..** |
| **TOTAL OTHER SECTORS[8]** | **6.3** | **8.3** | **10.1** | **11.0** | **10.9** | **12.0** | **..** |
| Coal[1] | 1.1 | 0.8 | 0.2 | 0.2 | 0.2 | 0.1 | .. |
| Oil | 3.1 | 2.6 | 2.7 | 2.9 | 2.6 | 2.5 | .. |
| Gas | 0.5 | 1.0 | 1.9 | 2.0 | 2.4 | 2.7 | .. |
| Comb. Renewables & Waste[2] | 0.7 | 1.6 | 1.7 | 1.9 | 1.8 | 1.9 | .. |
| Geothermal | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Solar/Wind/Other | - | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | .. |
| Electricity | 1.0 | 1.9 | 2.6 | 2.8 | 2.6 | 3.2 | .. |
| Heat | - | 0.5 | 1.0 | 1.1 | 1.2 | 1.5 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *17.9* | *9.0* | *1.9* | *1.6* | *1.7* | *0.9* | .. |
| *Oil* | *48.6* | *31.7* | *26.2* | *26.5* | *23.5* | *20.7* | .. |
| *Gas* | *7.6* | *11.7* | *18.3* | *18.5* | *21.7* | *22.6* | .. |
| *Comb. Renewables & Waste* | *10.3* | *18.7* | *17.0* | *17.1* | *16.6* | *16.0* | .. |
| *Geothermal* | - | - | *0.1* | *0.1* | *0.1* | - | .. |
| *Solar/Wind/Other* | - | *0.2* | *0.7* | *0.7* | *1.1* | *1.1* | .. |
| *Electricity* | *15.6* | *22.3* | *25.9* | *25.8* | *24.2* | *26.4* | .. |
| *Heat* | - | *6.4* | *9.9* | *9.8* | *11.1* | *12.2* | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **4.9** | **7.2** | **8.6** | **9.2** | **9.3** | **10.7** | .. |
| **OUTPUT (Mtoe)** | **2.7** | **4.2** | **5.2** | **5.3** | **5.7** | **6.6** | .. |
| (TWh gross) | 30.9 | 49.3 | 60.4 | 61.2 | 66.7 | 76.5 | .. |
| *Output Shares (%)* | | | | | | | |
| *Coal* | *10.3* | *14.2* | *12.7* | *15.4* | *8.0* | *3.7* | .. |
| *Oil* | *14.1* | *3.8* | *2.2* | *2.9* | *5.2* | *8.7* | .. |
| *Gas* | *14.3* | *15.7* | *15.6* | *18.3* | *18.4* | *22.4* | .. |
| *Comb. Renewables & Waste* | *0.7* | *2.4* | *3.1* | *3.3* | *4.7* | *5.0* | .. |
| *Nuclear* | - | - | - | - | - | - | .. |
| *Hydro* | *60.6* | *63.9* | *66.1* | *59.4* | *61.0* | *56.5* | .. |
| *Geothermal* | - | - | *0.0* | *0.0* | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.3* | *0.6* | *2.5* | *3.6* | .. |
| **TOTAL LOSSES** | **4.7** | **4.9** | **4.7** | **4.9** | **5.4** | **6.0** | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 2.2 | 2.3 | 2.2 | 2.6 | 2.2 | 2.5 | .. |
| Other Transformation | 1.3 | 0.7 | 1.0 | 0.7 | 0.8 | 0.7 | .. |
| Own Use and Losses[11] | 1.2 | 1.9 | 1.6 | 1.6 | 2.4 | 2.8 | .. |
| **Statistical Differences** | **0.1** | **-0.0** | **0.2** | **0.2** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 98.59 | 150.67 | 197.51 | 199.00 | 228.59 | 278.65 | .. |
| Population (millions) | 7.56 | 7.68 | 8.05 | 8.10 | 8.20 | 8.28 | .. |
| TPES/GDP[12] | 0.22 | 0.17 | 0.16 | 0.17 | 0.14 | 0.13 | .. |
| Energy Production/TPES | 0.37 | 0.32 | 0.32 | 0.30 | 0.32 | 0.33 | .. |
| Per Capita TPES[13] | 2.87 | 3.26 | 3.87 | 4.10 | 3.94 | 4.22 | .. |
| Oil Supply/GDP[12] | 0.12 | 0.07 | 0.07 | 0.07 | 0.05 | 0.05 | .. |
| TFC/GDP[12] | 0.17 | 0.13 | 0.13 | 0.14 | 0.12 | 0.10 | .. |
| Per Capita TFC[13] | 2.23 | 2.62 | 3.26 | 3.47 | 3.28 | 3.50 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 54.3 | 57.4 | 69.2 | 74.7 | 66.4 | 70.7 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.3 | 0.9 | 1.5 | 1.3 | 1.3 | 1.3 | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.7 | 0.4 | 1.8 | 6.6 | -0.4 | 0.8 | .. |
| Coal | -1.1 | 1.1 | -0.6 | 4.7 | -4.1 | -3.4 | .. |
| Oil | 0.8 | -1.8 | 1.9 | 6.9 | -1.8 | 1.2 | .. |
| Gas | 4.6 | 1.7 | 2.5 | 8.1 | 2.6 | 1.3 | .. |
| Comb. Renewables & Waste | 6.3 | 8.2 | 2.7 | 7.5 | 0.6 | 1.0 | .. |
| Nuclear | - | - | - | - | - | - | .. |
| Hydro | 6.7 | 1.2 | 2.0 | -9.0 | 1.6 | 0.6 | .. |
| Geothermal | - | - | 14.0 | 10.3 | - | - | .. |
| Solar/Wind/Other | - | - | 15.8 | 27.6 | 13.3 | 3.5 | .. |
| TFC | 2.2 | 0.5 | 2.2 | 6.9 | -0.6 | 0.7 | .. |
| Electricity Consumption | 3.9 | 2.6 | 2.2 | 10.4 | -0.2 | 1.4 | .. |
| Energy Production | 0.2 | 0.1 | 1.7 | 0.7 | 0.6 | 1.1 | .. |
| Net Oil Imports | 2.7 | -1.6 | 2.3 | 5.9 | -1.7 | 1.2 | .. |
| GDP | 3.0 | 2.3 | 2.3 | 0.8 | 2.0 | 2.0 | .. |
| Growth in the TPES/GDP Ratio | -1.2 | -1.8 | -0.4 | 5.8 | -2.3 | -1.2 | .. |
| Growth in the TFC/GDP Ratio | -0.8 | -1.8 | -0.0 | 6.1 | -2.6 | -1.2 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

| SUPPLY | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **6.5** | **13.1** | **13.3** | **13.4** | **13.7** | **11.2** | **2.4** |
| Coal[1] | | 6.4 | 1.2 | 0.1 | 0.1 | .. | .. | .. |
| Oil | | - | - | - | - | - | - | - |
| Gas | | 0.0 | 0.0 | - | - | - | - | - |
| Comb. Renewables & Waste[2] | | 0.0 | 0.7 | 0.8 | 1.0 | 1.6 | 1.9 | 2.1 |
| Nuclear | | 0.0 | 11.1 | 12.3 | 12.3 | 12.1 | 9.2 | - |
| Hydro | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Solar/Wind/Other[3] | | - | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| **TOTAL NET IMPORTS[4]** | | **39.8** | **36.0** | **42.5** | **45.7** | **47.8** | **51.9** | **59.0** |
| Coal1 | Exports | 0.8 | 1.1 | 1.4 | 0.7 | .. | .. | .. |
| | Imports | 5.3 | 10.8 | 6.8 | 6.5 | .. | .. | .. |
| | Net Imports | 4.6 | 9.7 | 5.4 | 5.8 | 4.2 | 3.1 | 10.0 |
| Oil | Exports | 15.1 | 19.2 | 23.3 | 23.8 | .. | .. | .. |
| | Imports | 46.4 | 41.7 | 52.7 | 55.8 | .. | .. | .. |
| | Bunkers | 3.1 | 4.1 | 6.9 | 6.9 | 5.8 | 6.2 | 6.7 |
| | Net Imports | 28.2 | 18.4 | 22.6 | 25.0 | 23.2 | 24.0 | 24.1 |
| Gas | Exports | - | - | - | - | - | - | - |
| | Imports | 7.1 | 8.2 | 13.6 | 14.2 | 20.0 | 24.4 | 24.6 |
| | Net Imports | 7.1 | 8.2 | 13.6 | 14.2 | 20.0 | 24.4 | 24.6 |
| Electricity | Exports | 0.2 | 0.7 | 0.8 | 0.7 | .. | .. | .. |
| | Imports | 0.1 | 0.4 | 1.4 | 1.3 | .. | .. | .. |
| | Net Imports | -0.1 | -0.3 | 0.7 | 0.6 | 0.4 | 0.4 | 0.4 |
| **TOTAL STOCK CHANGES** | | **-0.0** | **0.1** | **0.8** | **-0.0** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **46.3** | **49.1** | **56.5** | **59.2** | **61.5** | **63.1** | **61.4** |
| Coal[1] | | 11.2 | 10.7 | 6.3 | 5.9 | 4.2 | 3.1 | 10.0 |
| Oil | | 28.0 | 18.7 | 22.9 | 24.8 | 23.2 | 24.0 | 24.1 |
| Gas | | 7.1 | 8.2 | 13.4 | 14.4 | 20.0 | 24.4 | 24.6 |
| Comb. Renewables & Waste[2] | | 0.0 | 0.7 | 0.9 | 1.2 | 1.6 | 1.9 | 2.1 |
| Nuclear | | 0.0 | 11.1 | 12.3 | 12.3 | 12.1 | 9.2 | - |
| Hydro | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Solar/Wind/Other[3] | | - | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| Electricity Trade[5] | | -0.1 | -0.3 | 0.7 | 0.6 | 0.4 | 0.4 | 0.4 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *24.1* | *21.7* | *11.2* | *10.0* | *6.8* | *5.0* | *16.2* |
| *Oil* | | *60.5* | *38.2* | *40.5* | *41.8* | *37.7* | *38.0* | *39.1* |
| *Gas* | | *15.4* | *16.6* | *23.7* | *24.3* | *32.6* | *38.6* | *40.1* |
| *Comb. Renewables & Waste* | | - | *1.4* | *1.6* | *2.0* | *2.6* | *3.0* | *3.4* |
| *Nuclear* | | - | *22.7* | *21.8* | *20.9* | *19.6* | *14.6* | - |
| *Hydro* | | - | - | *0.1* | - | *0.1* | *0.1* | *0.1* |
| *Geothermal* | | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | | - | - | - | - | *0.1* | *0.1* | *0.5* |
| *Electricity Trade* | | *-0.1* | *-0.7* | *1.2* | *0.9* | *0.6* | *0.6* | *0.6.* |

0 is negligible. - is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **34.6** | **33.2** | **40.9** | **42.7** | **45.4** | **47.8** | **49.1** |
| Coal[1] | 5.7 | 3.5 | 1.8 | 1.8 | 1.7 | 1.4 | 1.2 |
| Oil | 21.0 | 17.3 | 21.2 | 22.6 | 21.6 | 22.4 | 22.4 |
| Gas | 4.6 | 6.8 | 10.4 | 10.5 | 12.7 | 13.2 | 13.6 |
| Comb. Renewables & Waste[2] | - | 0.3 | 0.4 | 0.4 | 0.7 | 0.9 | 1.0 |
| Geothermal | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Electricity | 2.9 | 5.0 | 6.7 | 6.9 | 7.7 | 8.8 | 9.6 |
| Heat | 0.3 | 0.2 | 0.5 | 0.5 | 0.9 | 1.1 | 1.2 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *16.5* | *10.6* | *4.3* | *4.2* | *3.6* | *2.8* | *2.4* |
| *Oil* | *60.7* | *52.2* | *51.7* | *52.9* | *47.6* | *46.8* | *45.7* |
| *Gas* | *13.3* | *20.5* | *25.4* | *24.6* | *28.1* | *27.6* | *27.7* |
| *Comb. Renewables & Waste* | - | *1.0* | *0.9* | *1.1* | *1.6* | *1.9* | *2.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | *0.1* | *0.2* |
| *Electricity* | *8.5* | *15.0* | *16.5* | *16.1* | *17.1* | *18.4* | *19.5* |
| *Heat* | *0.9* | *0.7* | *1.2* | *1.2* | *2.0* | *2.4* | *2.5* |
| **TOTAL INDUSTRY[6]** | **16.8** | **13.6** | **17.2** | **17.0** | **20.7** | **21.5** | **21.2** |
| Coal[1] | 3.5 | 3.0 | 1.6 | 1.6 | 1.6 | 1.3 | 1.2 |
| Oil | 7.9 | 4.3 | 6.4 | 6.0 | 7.1 | 7.5 | 7.5 |
| Gas | 3.2 | 3.3 | 5.3 | 5.2 | 6.8 | 6.9 | 6.8 |
| Comb. Renewables & Waste[2] | - | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 1.9 | 2.6 | 3.3 | 3.4 | 4.1 | 4.4 | 4.3 |
| Heat | 0.3 | 0.2 | 0.4 | 0.4 | 0.9 | 1.1 | 1.1 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *21.1* | *22.2* | *9.0* | *9.7* | *7.8* | *6.3* | *5.4* |
| *Oil* | *46.8* | *31.8* | *37.0* | *35.2* | *34.5* | *35.1* | *35.6* |
| *Gas* | *18.7* | *24.3* | *30.9* | *30.8* | *32.8* | *32.1* | *32.3* |
| *Comb. Renewables & Waste* | - | *1.0* | *1.2* | *1.5* | *0.9* | *1.0* | *1.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *11.5* | *19.3* | *19.4* | *20.2* | *19.9* | *20.6* | *20.3* |
| *Heat* | *1.9* | *1.4* | *2.4* | *2.6* | *4.1* | *4.9* | *5.4* |
| **TRANSPORT[7]** | **5.0** | **7.9** | **9.8** | **10.4** | **10.7** | **11.6** | **12.3** |
| **TOTAL OTHER SECTORS[8]** | **12.7** | **11.7** | **13.9** | **15.3** | **14.0** | **14.7** | **15.6** |
| Coal[1] | 2.2 | 0.5 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| Oil | 8.1 | 5.2 | 5.1 | 6.3 | 4.2 | 3.9 | 3.5 |
| Gas | 1.5 | 3.5 | 5.1 | 5.3 | 6.0 | 6.3 | 6.8 |
| Comb. Renewables & Waste[2] | - | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| Geothermal | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Electricity | 0.9 | 2.3 | 3.3 | 3.3 | 3.5 | 4.2 | 5.1 |
| Heat | - | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *17.0* | *4.5* | *1.5* | *1.0* | *0.2* | *0.1* | - |
| *Oil* | *64.2* | *44.5* | *36.8* | *41.3* | *30.4* | *26.6* | *22.2* |
| *Gas* | *11.4* | *30.0* | *36.6* | *34.5* | *42.6* | *42.7* | *43.2* |
| *Comb. Renewables & Waste* | - | *1.6* | *1.1* | *1.3* | *1.2* | *1.1* | *0.9* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | *0.1* | *0.2* | *0.4* |
| *Electricity* | *7.4* | *19.2* | *23.6* | *21.5* | *25.0* | *28.9* | *32.9* |
| *Heat* | - | *0.3* | *0.4* | *0.4* | *0.5* | *0.5* | *0.4* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **10.0** | **17.7** | **19.1** | **19.9** | **21.2** | **21.7** | **19.7** |
| **OUTPUT (Mtoe)** | **3.5** | **6.0** | **7.0** | **7.2** | **8.3** | **9.5** | **10.3** |
| (TWh gross) | 40.6 | 70.3 | 80.9 | 83.6 | 96.5 | 110.0 | 120.0 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *21.7* | *28.2* | *15.6* | *13.9* | *4.5* | *1.8* | *37.4* |
| *Oil* | *53.7* | *1.9* | *1.2* | *1.2* | *0.2* | *0.0* | *0.0* |
| *Gas* | *23.7* | *7.7* | *22.1* | *25.9* | *43.9* | *62.9* | *58.1* |
| *Comb. Renewables & Waste* | *0.3* | *1.0* | *2.1* | *1.9* | *2.5* | *2.3* | *2.0* |
| *Nuclear* | *0.2* | *60.8* | *58.5* | *56.7* | *47.9* | *32.2* | - |
| *Hydro* | *0.4* | *0.4* | *0.4* | *0.3* | *0.5* | *0.4* | *0.4* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | *0.0* | *0.1* | *0.1* | *0.5* | *0.5* | *2.1* |
| **TOTAL LOSSES** | **12.6** | **16.2** | **16.1** | **16.8** | **16.2** | **15.3** | **12.3** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 6.2 | 11.4 | 11.6 | 12.2 | 11.9 | 11.0 | 8.1 |
| Other Transformation | 5.0 | 2.1 | 1.6 | 1.7 | 1.6 | 1.5 | 1.4 |
| Own Use and Losses[11] | 1.4 | 2.7 | 2.9 | 2.9 | 2.7 | 2.8 | 2.9 |
| **Statistical Differences** | **-0.9** | **-0.3** | **-0.5** | **-0.3** | - | - | - |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD)[12] | 5.70 | 184.36 | 232.14 | 235.06 | 283.45 | 337.81 | 397.09 |
| Population (millions) | 9.73 | 9.97 | 10.33 | 10.37 | 10.51 | 10.70 | 10.88 |
| TPES/GDP[12] | 0.37 | 0.27 | 0.24 | 0.25 | 0.22 | 0.19 | 0.15 |
| Energy Production/TPES | 0.14 | 0.27 | 0.23 | 0.23 | 0.22 | 0.18 | 0.04 |
| Per Capita TPES[13] | 4.76 | 4.93 | 5.47 | 5.70 | 5.85 | 5.90 | 5.65 |
| Oil Supply/GDP[12] | 0.22 | 0.10 | 0.10 | 0.11 | 0.08 | 0.07 | 0.06 |
| TFC/GDP[12] | 0.27 | 0.18 | 0.18 | 0.18 | 0.16 | 0.14 | 0.12 |
| Per Capita TFC[13] | 3.55 | 3.33 | 3.96 | 4.11 | 4.32 | 4.46 | 4.51 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 133.6 | 108.5 | 112.5 | 120.1 | 123.0 | 131.0 | 158.5 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 11.3 | 16.0 | 25.7 | 26.6 | 23.0 | 24.4 | 26.0 |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | 1.0 | -0.0 | 1.2 | 4.6 | 0.6 | 0.3 | -0.3 |
| Coal | 0.3 | -0.6 | -4.3 | -6.5 | -4.8 | -2.8 | 12.3 |
| Oil | -1.5 | -2.8 | 1.7 | 8.1 | -0.9 | 0.3 | 0.0 |
| Gas | 4.5 | -1.2 | 4.2 | 7.7 | 4.8 | 2.0 | 0.1 |
| Comb. Renewables & Waste | 41.7 | 22.8 | 2.3 | 26.5 | 4.5 | 1.8 | 0.9 |
| Nuclear | 130.2 | 12.8 | 0.9 | 0.0 | -0.3 | -2.6 | - |
| Hydro | 4.9 | 1.3 | 2.5 | -32.3 | 10.0 | - | - |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | 17.6 | 42.9 | 27.2 | 3.6 | 14.0 |
| TFC | 0.5 | -0.6 | 1.8 | 4.3 | 0.9 | 0.5 | 0.3 |
| Electricity Consumption | 4.2 | 2.6 | 2.5 | 1.6 | 1.8 | 1.3 | 0.8 |
| Energy Production | 2.7 | 5.0 | 0.1 | 1.5 | 0.3 | -2.0 | -14.3 |
| Net Oil Imports | -0.8 | -3.4 | 1.7 | 10.8 | -1.1 | 0.3 | 0.0 |
| GDP | 2.4 | 2.2 | 1.9 | 1.3 | 2.7 | 1.8 | 1.6 |
| Growth in the TPES/GDP Ratio | -1.3 | -2.2 | -0.7 | 3.3 | -2.1 | -1.5 | -1.9 |
| Growth in the TFC/GDP Ratio | -1.9 | -2.8 | -0.2 | 3.0 | -1.8 | -1.2 | -1.3. |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **198.0** | **273.7** | **384.1** | **385.3** | **593.9** | **607.1** | **..** |
| Coal[1] | | 11.7 | 37.9 | 32.6 | 30.2 | 39.9 | 38.7 | .. |
| Oil | | 96.3 | 94.1 | 136.5 | 144.2 | 263.2 | 220.4 | .. |
| Gas | | 61.4 | 88.6 | 153.5 | 150.6 | 216.2 | 271.1 | .. |
| Comb. Renewables & Waste[2] | | 7.8 | 8.2 | 11.6 | 11.6 | 17.0 | 19.0 | .. |
| Nuclear | | 4.1 | 19.4 | 19.7 | 19.5 | 23.9 | 22.7 | .. |
| Hydro | | 16.7 | 25.5 | 30.1 | 29.0 | 33.3 | 34.6 | .. |
| Geothermal | | - | - | - | - | 0.4 | 0.4 | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | .. |
| **TOTAL NET IMPORTS[4]** | | **-36.6** | **-60.6** | **-137.5** | **-129.6** | **-286.4** | **-256.6** | **..** |
| Coal[1] | Exports | 7.6 | 21.4 | 16.0 | 16.9 | 23.1 | 23.1 | .. |
| | Imports | 10.5 | 9.5 | 13.2 | 13.3 | 8.7 | 2.1 | .. |
| | Net Imports | 2.8 | -11.9 | -2.8 | -3.5 | -14.4 | -21.0 | .. |
| Oil | Exports | 63.1 | 49.7 | 102.5 | 106.3 | 219.1 | 171.6 | .. |
| | Imports | 48.8 | 34.5 | 53.4 | 57.0 | 54.2 | 60.0 | .. |
| | Bunkers | 1.1 | 0.9 | 1.1 | 0.9 | 0.7 | 0.8 | .. |
| | Net Imports | -15.4 | -16.1 | -50.2 | -50.2 | -165.6 | -112.4 | .. |
| Gas | Exports | 23.1 | 33.0 | 88.2 | 83.3 | 105.4 | 122.8 | .. |
| | Imports | 0.3 | 0.5 | 5.4 | 7.9 | 1.0 | 1.0 | .. |
| | Net Imports | -22.8 | -32.5 | -82.8 | -75.4 | -104.4 | -121.7 | .. |
| Electricity | Exports | 1.4 | 1.6 | 3.1 | 2.7 | 5.4 | 4.7 | .. |
| | Imports | 0.2 | 1.5 | 1.4 | 2.1 | 3.4 | 3.3 | .. |
| | Net Imports | -1.2 | -0.0 | -1.7 | -0.6 | -2.0 | -1.4 | .. |
| **TOTAL STOCK CHANGES** | | **-1.6** | **-4.0** | **2.7** | **4.9** | **-** | **-** | **..** |
| **TOTAL SUPPLY (TPES)** | | **159.8** | **209.1** | **249.2** | **260.6** | **307.5** | **350.5** | **..** |
| Coal[1] | | 15.3 | 24.3 | 29.7 | 30.0 | 25.5 | 17.7 | .. |
| Oil | | 79.9 | 77.1 | 86.1 | 91.7 | 97.6 | 108.0 | .. |
| Gas | | 37.3 | 54.7 | 73.6 | 79.2 | 111.8 | 149.4 | .. |
| Comb. Renewables & Waste[2] | | 7.8 | 8.2 | 11.7 | 11.7 | 17.0 | 19.0 | .. |
| Nuclear | | 4.1 | 19.4 | 19.7 | 19.5 | 23.4 | 22.1 | .. |
| Hydro | | 16.7 | 25.5 | 30.1 | 29.0 | 33.3 | 34.6 | .. |
| Geothermal | | - | - | - | - | 0.4 | 0.4 | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | .. |
| Electricity Trade[5] | | -1.2 | -0.0 | -1.7 | -0.6 | -2.0 | -1.4 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *9.5* | *11.6* | *11.9* | *11.5* | *8.3* | *5.1* | .. |
| *Oil* | | *50.0* | *36.9* | *34.5* | *35.2* | *31.7* | *30.8* | .. |
| *Gas* | | *23.3* | *26.2* | *29.5* | *30.4* | *36.4* | *42.6* | .. |
| *Comb. Renewables & Waste* | | *4.9* | *3.9* | *4.7* | *4.5* | *5.5* | *5.4* | .. |
| *Nuclear* | | *2.5* | *9.3* | *7.9* | *7.5* | *7.6* | *6.3* | .. |
| *Hydro* | | *10.5* | *12.2* | *12.1* | *11.1* | *10.8* | *9.9* | .. |
| *Geothermal* | | - | - | - | - | *0.1* | *0.1* | .. |
| *Solar/Wind/Other* | | - | - | - | - | - | - | .. |
| *Electricity Trade* | | *-0.8* | - | *-0.7* | *-0.2* | *-0.7* | *-0.4* | .. |

0 is negligible. - is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **132.1** | **160.8** | **190.2** | **197.5** | **219.8** | **248.1** | **..** |
| Coal[1] | 5.2 | 3.1 | 3.1 | 3.2 | 2.9 | 2.2 | .. |
| Oil | 76.5 | 70.6 | 82.7 | 87.5 | 86.8 | 98.2 | .. |
| Gas | 23.7 | 43.3 | 51.9 | 53.0 | 63.5 | 72.4 | .. |
| Comb. Renewables & Waste[2] | 7.6 | 7.3 | 9.6 | 9.6 | 15.6 | 17.5 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 18.9 | 36.0 | 42.1 | 43.3 | 50.3 | 57.0 | .. |
| Heat | 0.1 | 0.6 | 0.8 | 0.9 | 0.7 | 0.9 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *4.0* | *1.9* | *1.6* | *1.6* | *1.3* | *0.9* | .. |
| *Oil* | *57.9* | *43.9* | *43.5* | *44.3* | *39.5* | *39.6* | .. |
| *Gas* | *18.0* | *26.9* | *27.3* | *26.8* | *28.9* | *29.2* | .. |
| *Comb. Renewables & Waste* | *5.8* | *4.5* | *5.0* | *4.8* | *7.1* | *7.0* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *14.3* | *22.4* | *22.1* | *21.9* | *22.9* | *23.0* | .. |
| *Heat* | *0.1* | *0.4* | *0.4* | *0.4* | *0.3* | *0.3* | .. |
| **TOTAL INDUSTRY[6]** | **52.8** | **62.7** | **72.9** | **76.6** | **95.7** | **107.9** | **..** |
| Coal[1] | 4.7 | 3.0 | 3.1 | 3.2 | 2.8 | 2.2 | .. |
| Oil | 21.4 | 18.7 | 22.0 | 24.2 | 24.9 | 27.6 | .. |
| Gas | 11.9 | 20.2 | 21.9 | 22.9 | 31.2 | 36.2 | .. |
| Comb. Renewables & Waste[2] | 5.7 | 5.7 | 7.6 | 7.6 | 13.6 | 15.3 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 9.1 | 14.4 | 17.5 | 17.8 | 22.4 | 25.8 | .. |
| Heat | 0.1 | 0.6 | 0.8 | 0.9 | 0.7 | 0.9 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *8.9* | *4.8* | *4.2* | *4.2* | *3.0* | *2.0* | .. |
| *Oil* | *40.4* | *29.8* | *30.2* | *31.6* | *26.0* | *25.6* | .. |
| *Gas* | *22.5* | *32.3* | *30.0* | *29.9* | *32.6* | *33.6* | .. |
| *Comb. Renewables & Waste* | *10.8* | *9.0* | *10.4* | *9.9* | *14.2* | *14.2* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *17.2* | *23.1* | *24.0* | *23.3* | *23.4* | *23.9* | .. |
| *Heat* | *0.2* | *1.0* | *1.2* | *1.1* | *0.8* | *0.8* | .. |
| **TRANSPORT[7]** | **34.2** | **44.2** | **53.6** | **54.1** | **64.5** | **75.4** | **..** |
| **TOTAL OTHER SECTORS[8]** | **45.1** | **54.0** | **63.6** | **66.8** | **59.7** | **64.8** | **..** |
| Coal[1] | 0.4 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | .. |
| Oil | 21.3 | 10.9 | 12.2 | 13.6 | 6.5 | 6.9 | .. |
| Gas | 11.9 | 20.2 | 25.4 | 26.2 | 24.5 | 25.7 | .. |
| Comb. Renewables & Waste[2] | 1.9 | 1.6 | 1.8 | 1.8 | 2.0 | 2.2 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 9.5 | 21.2 | 24.2 | 25.1 | 26.7 | 30.0 | .. |
| Heat | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *0.9* | *0.1* | - | - | *0.1* | *0.1* | .. |
| *Oil* | *47.4* | *20.2* | *19.2* | *20.4* | *10.8* | *10.7* | .. |
| *Gas* | *26.3* | *37.4* | *39.8* | *39.2* | *41.0* | *39.6* | .. |
| *Comb. Renewables & Waste* | *4.2* | *3.0* | *2.9* | *2.8* | *3.3* | *3.3* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *21.2* | *39.3* | *38.1* | *37.6* | *44.7* | *46.2* | .. |
| *Heat* | - | - | - | - | - | - | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **36.1** | **71.2** | **88.5** | **88.3** | **97.6** | **103.1** | **..** |
| **OUTPUT (Mtoe)** | **23.2** | **41.4** | **51.7** | **50.5** | **60.5** | **67.4** | **..** |
| (TWh gross) | 270.1 | 481.9 | 601.0 | 586.9 | 703.6 | 783.5 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *12.9* | *17.1* | *19.5* | *19.3* | *14.2* | *10.5* | .. |
| *Oil* | *3.4* | *3.4* | *2.4* | *3.0* | *2.1* | *1.9* | .. |
| *Gas* | *6.0* | *2.0* | *5.6* | *5.8* | *13.7* | *23.2* | .. |
| *Comb. Renewables & Waste* | - | *0.8* | *1.5* | *1.6* | *2.1* | *2.1* | .. |
| *Nuclear* | *5.6* | *15.1* | *12.6* | *12.8* | *12.7* | *10.8* | .. |
| *Hydro* | *72.1* | *61.6* | *58.3* | *57.5* | *55.0* | *51.3* | .. |
| *Geothermal* | - | - | - | - | *0.1* | *0.1* | .. |
| *Solar/Wind/Other* | - | *0.0* | *0.1* | *0.1* | *0.1* | *0.1* | .. |
| **TOTAL LOSSES** | **31.2** | **49.2** | **62.1** | **61.5** | **87.7** | **102.3** | **..** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 12.8 | 29.1 | 36.0 | 36.9 | 36.3 | 34.8 | .. |
| Other Transformation | 1.9 | -1.3 | -5.2 | -7.0 | -5.0 | -2.7 | .. |
| Own Use and Losses[11] | 16.5 | 21.4 | 31.3 | 31.6 | 56.3 | 70.2 | .. |
| **Statistical Differences** | **-3.5** | **-0.9** | **-3.0** | **1.6** | **-** | **-** | **..** |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 323.09 | 535.63 | 752.10 | 767.13 | 897.65 | 1110.43 | .. |
| Population (millions) | 22.49 | 27.70 | 31.36 | 31.63 | 33.20 | 35.30 | .. |
| TPES/GDP[12] | 0.49 | 0.39 | 0.33 | 0.34 | 0.34 | 0.32 | .. |
| Energy Production/TPES | 1.24 | 1.31 | 1.54 | 1.48 | 1.93 | 1.73 | .. |
| Per Capita TPES[13] | 7.11 | 7.55 | 7.95 | 8.24 | 9.26 | 9.93 | .. |
| Oil Supply/GDP[12] | 0.25 | 0.14 | 0.11 | 0.12 | 0.11 | 0.10 | .. |
| TFC/GDP[12] | 0.41 | 0.30 | 0.25 | 0.26 | 0.24 | 0.22 | .. |
| Per Capita TFC[13] | 5.87 | 5.81 | 6.06 | 6.24 | 6.62 | 7.03 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 376.3 | 430.2 | 531.7 | 553.3 | 619.6 | 697.9 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 5.2 | 5.6 | 6.4 | 4.9 | 4.5 | 4.6 | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 3.0 | 0.8 | 1.5 | 4.6 | 2.4 | 1.3 | .. |
| Coal | 4.4 | 1.9 | 1.7 | 1.0 | -2.3 | -3.6 | .. |
| Oil | 2.4 | -1.6 | 0.9 | 6.5 | 0.9 | 1.0 | .. |
| Gas | 2.7 | 2.1 | 2.5 | 7.6 | 5.1 | 2.9 | .. |
| Comb. Renewables & Waste | -1.6 | 1.2 | 3.0 | 0.3 | 5.5 | 1.2 | .. |
| Nuclear | 15.7 | 6.4 | 0.1 | -0.8 | 2.6 | -0.6 | .. |
| Hydro | 3.8 | 1.8 | 1.4 | -3.7 | 2.0 | 0.4 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | 28.4 | 87.5 | -3.1 | - | .. |
| TFC | 2.6 | 0.4 | 1.4 | 3.9 | 1.5 | 1.2 | .. |
| Electricity Consumption | 4.7 | 3.4 | 1.3 | 3.0 | 2.1 | 1.3 | .. |
| Energy Production | 1.0 | 2.4 | 2.9 | 0.3 | 6.4 | 0.2 | .. |
| Net Oil Imports | - | - | 9.9 | -0.1 | 18.6 | -3.8 | .. |
| GDP | 3.6 | 2.7 | 2.9 | 2.0 | 2.3 | 2.2 | .. |
| Growth in the TPES/GDP Ratio | -0.6 | -1.8 | -1.4 | 2.5 | 0.1 | -0.8 | .. |
| Growth in the TFC/GDP Ratio | -1.0 | -2.2 | -1.4 | 1.8 | -0.7 | -0.9 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **38.51** | **38.49** | **30.70** | **33.00** | **25.68** | **21.50** | **19.41** |
| Coal[1] | | 38.01 | 34.71 | 24.21 | 24.33 | 17.00 | 12.00 | 9.60 |
| Oil | | 0.04 | 0.18 | 0.41 | 0.47 | 0.40 | 0.40 | 0.40 |
| Gas | | 0.36 | 0.20 | 0.12 | 0.13 | 0.10 | 0.30 | 0.30 |
| Comb. Renewables & Waste[2] | | – | – | 0.86 | 1.21 | 1.30 | 1.90 | 2.20 |
| Nuclear | | – | 3.28 | 4.88 | 6.74 | 6.70 | 6.70 | 6.70 |
| Hydro | | 0.09 | 0.12 | 0.21 | 0.12 | 0.16 | 0.17 | 0.17 |
| Geothermal | | – | – | – | – | – | – | – |
| Solar/Wind/Other[3] | | – | – | – | – | 0.02 | 0.03 | 0.04 |
| **TOTAL NET IMPORTS[4]** | | **6.99** | **7.63** | **11.07** | **11.07** | **16.40** | **22.50** | **24.20** |
| Coal1 | Exports | 2.56 | 7.26 | 4.96 | 4.90 | 4.10 | 1.10 | 0.90 |
| | Imports | 0.15 | 1.57 | 1.13 | 1.29 | 1.20 | 1.40 | 1.60 |
| | Net Imports | -2.41 | -5.69 | -3.83 | -3.61 | -2.90 | 0.30 | 0.70 |
| Oil | Exports | 0.04 | 6.56 | 1.42 | 1.28 | 1.60 | 1.60 | 1.70 |
| | Imports | 8.91 | 15.16 | 9.42 | 9.70 | 10.20 | 10.60 | 11.00 |
| | Bunkers | – | – | – | – | – | – | – |
| | Net Imports | 8.87 | 8.60 | 7.99 | 8.42 | 8.60 | 9.00 | 9.30 |
| Gas | Exports | 0.01 | – | 0.00 | 0.04 | – | – | – |
| | Imports | 0.73 | 4.78 | 7.92 | 7.74 | 11.00 | 13.00 | 14.00 |
| | Net Imports | 0.72 | 4.78 | 7.92 | 7.70 | 11.00 | 13.00 | 14.00 |
| Electricity | Exports | 0.44 | 0.76 | 1.80 | 2.26 | 0.70 | 0.40 | 0.60 |
| | Imports | 0.25 | 0.70 | 0.82 | 0.87 | 0.40 | 0.60 | 0.80 |
| | Net Imports | -0.19 | -0.06 | -0.98 | -1.40 | -0.30 | 0.20 | 0.20 |
| **TOTAL STOCK CHANGES** | | **-0.08** | **1.25** | **-0.02** | **0.05** | **–** | **–** | **–** |
| **TOTAL SUPPLY (TPES)** | | **45.42** | **47.38** | **41.74** | **44.12** | **42.08** | **44.00** | **43.61** |
| Coal[1] | | 35.59 | 29.84 | 20.51 | 20.87 | 14.10 | 12.30 | 10.30 |
| Oil | | 8.91 | 8.94 | 8.53 | 8.77 | 9.00 | 9.40 | 9.70 |
| Gas | | 1.01 | 5.26 | 7.76 | 7.84 | 11.10 | 13.30 | 14.30 |
| Comb. Renewables & Waste[2] | | – | – | 0.84 | 1.17 | 1.30 | 1.90 | 2.20 |
| Nuclear | | – | 3.28 | 4.88 | 6.74 | 6.70 | 6.70 | 6.70 |
| Hydro | | 0.09 | 0.12 | 0.21 | 0.12 | 0.16 | 0.17 | 0.17 |
| Geothermal | | – | – | – | – | – | – | – |
| Solar/Wind/Other[3] | | – | – | – | – | 0.02 | 0.03 | 0.04 |
| Electricity Trade[5] | | -0.19 | -0.06 | -0.98 | -1.39 | -0.30 | 0.20 | 0.20 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *78.4* | *63.0* | *49.1* | *47.3* | *33.5* | *28.0* | *23.6* |
| *Oil* | | *19.6* | *18.9* | *20.4* | *19.9* | *21.4* | *21.4* | *22.2* |
| *Gas* | | *2.2* | *11.1* | *18.6* | *17.8* | *26.4* | *30.2* | *32.8* |
| *Comb. Renewables & Waste* | | – | – | *2.0* | *2.6* | *3.1* | *4.3* | *5.0* |
| *Nuclear* | | – | *6.9* | *11.7* | *15.3* | *15.9* | *15.2* | *15.4* |
| *Hydro* | | *0.2* | *0.3* | *0.5* | *0.3* | *0.4* | *0.4* | *0.4* |
| *Geothermal* | | – | – | – | – | – | – | – |
| *Solar/Wind/Other* | | – | – | – | – | – | *0.1* | *0.1* |
| *Electricity Trade* | | *-0.4* | *-0.1* | *-2.3* | *-3.2* | *-0.7* | *0.5* | *0.5* |

0 is negligible, – is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **31.66** | **35.30** | **24.89** | **26.53** | **28.58** | **30.44** | **31.04** |
| Coal[1] | 19.25 | 17.43 | 3.46 | 3.80 | 2.70 | 2.30 | 1.60 |
| Oil | 8.06 | 8.09 | 7.80 | 8.39 | 8.30 | 8.40 | 8.70 |
| Gas | 1.81 | 4.19 | 6.19 | 6.32 | 8.70 | 9.70 | 10.70 |
| Comb. Renewables & Waste[2] | – | – | 0.43 | 0.87 | 0.70 | 1.00 | 1.20 |
| Geothermal | – | – | – | – | – | – | – |
| Solar/Wind/Other | – | – | – | – | 0.01 | 0.02 | 0.02 |
| Electricity | 2.54 | 4.14 | 4.37 | 4.51 | 4.87 | 5.67 | 5.52 |
| Heat | – | 1.45 | 2.64 | 2.65 | 3.30 | 3.35 | 3.30 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *60.8* | *49.4* | *13.9* | *14.3* | *9.4* | *7.6* | *5.2* |
| *Oil* | *25.5* | *22.9* | *31.3* | *31.6* | *29.0* | *27.6* | *28.0* |
| *Gas* | *5.7* | *11.9* | *24.9* | *23.8* | *30.4* | *31.9* | *34.5* |
| *Comb. Renewables & Waste* | – | – | *1.7* | *3.3* | *2.4* | *3.3* | *3.9* |
| *Geothermal* | – | – | – | – | – | – | – |
| *Solar/Wind/Other* | – | – | – | – | – | – | *0.1* |
| *Electricity* | *8.0* | *11.7* | *17.6* | *17.0* | *17.0* | *18.6* | *17.8* |
| *Heat* | – | *4.1* | *10.6* | *10.0* | *11.5* | *11.0* | *10.6* |
| **TOTAL INDUSTRY[6]** | **18.80** | **18.63** | **10.61** | **10.58** | **12.52** | **13.12** | **13.02** |
| Coal[1] | 11.44 | 10.06 | 2.65 | 2.77 | 1.80 | 1.60 | 1.10 |
| Oil | 5.30 | 4.23 | 2.54 | 2.47 | 3.40 | 3.30 | 3.40 |
| Gas | 0.46 | 2.02 | 2.58 | 2.52 | 4.20 | 4.70 | 5.10 |
| Comb. Renewables & Waste[2] | – | – | 0.32 | 0.27 | 0.10 | 0.30 | 0.30 |
| Geothermal | – | – | – | – | – | – | – |
| Solar/Wind/Other | – | – | – | – | – | – | – |
| Electricity | 1.61 | 2.32 | 1.77 | 1.77 | 1.72 | 1.87 | 1.82 |
| Heat | – | – | 0.75 | 0.78 | 1.30 | 1.35 | 1.30 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *60.8* | *54.0* | *24.9* | *26.2* | *14.4* | *12.2* | *8.5* |
| *Oil* | *28.2* | *22.7* | *24.0* | *23.3* | *27.2* | *25.2* | *26.1* |
| *Gas* | *2.4* | *10.9* | *24.3* | *23.8* | *33.5* | *35.8* | *39.2* |
| *Comb. Renewables & Waste* | – | – | *3.0* | *2.6* | *0.8* | *2.3* | *2.3* |
| *Geothermal* | – | – | – | – | – | – | – |
| *Solar/Wind/Other* | – | – | – | – | – | – | – |
| *Electricity* | *8.6* | *12.4* | *16.7* | *16.7* | *13.7* | *14.3* | *14.0* |
| *Heat* | – | – | *7.1* | *7.4* | *10.4* | *10.3* | *10.0* |
| **TRANSPORT[7]** | **2.45** | **2.86** | **5.31** | **5.97** | **5.10** | **5.40** | **5.60** |
| **TOTAL OTHER SECTORS[8]** | **10.42** | **13.81** | **8.97** | **9.98** | **10.96** | **11.92** | **12.42** |
| Coal[1] | 7.70 | 7.37 | 0.81 | 1.03 | 0.90 | 0.70 | 0.50 |
| Oil | 0.60 | 1.27 | 0.19 | 0.20 | 0.60 | 0.70 | 0.70 |
| Gas | 1.35 | 2.17 | 3.58 | 3.76 | 4.30 | 4.60 | 5.20 |
| Comb. Renewables & Waste[2] | – | – | 0.08 | 0.57 | 0.60 | 0.70 | 0.90 |
| Geothermal | – | – | – | – | – | – | – |
| Solar/Wind/Other | – | – | – | – | 0.01 | 0.02 | 0.02 |
| Electricity | 0.76 | 1.56 | 2.42 | 2.55 | 2.55 | 3.20 | 3.10 |
| Heat | – | 1.45 | 1.89 | 1.87 | 2.00 | 2.00 | 2.00 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *73.9* | *53.3* | *9.1* | *10.3* | *8.2* | *5.9* | *4.0* |
| *Oil* | *5.8* | *9.2* | *2.1* | *2.0* | *5.5* | *5.9* | *5.6* |
| *Gas* | *13.0* | *15.7* | *39.9* | *37.7* | *39.2* | *38.6* | *41.9* |
| *Comb. Renewables & Waste* | – | – | *0.9* | *5.7* | *5.5* | *5.9* | *7.2* |
| *Geothermal* | – | – | – | – | – | – | – |
| *Solar/Wind/Other* | – | – | – | – | *0.1* | *0.1* | *0.2* |
| *Electricity* | *7.3* | *11.3* | *27.0* | *25.6* | *23.3* | *26.9* | *25.0* |
| *Heat* | – | *10.5* | *21.0* | *18.7* | *18.2* | *16.8* | *16.1* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **9.70** | **16.54** | **21.80** | **23.29** | **21.07** | **21.58** | **20.49** |
| **OUTPUT (Mtoe)** | **3.54** | **5.38** | **6.54** | **7.12** | **6.07** | **6.37** | **6.32** |
| (TWh gross) | 41.17 | 62.56 | 76.00 | 82.82 | 70.59 | 74.05 | 73.47 |
| *Output Shares (%)* | | | | | | | |
| *Coal* | *85.1* | *71.8* | *66.8* | *62.3* | *47.5* | *40.5* | *39.3* |
| *Oil* | *11.3* | *4.8* | *0.5* | *0.4* | *2.0* | *2.6* | *2.7* |
| *Gas* | *0.9* | *1.0* | *3.9* | *3.7* | *9.9* | *17.1* | *17.3* |
| *Comb. Renewables & Waste* | – | – | *0.9* | *0.6* | *1.3* | *2.3* | *2.9* |
| *Nuclear* | – | *20.1* | *24.7* | *31.2* | *36.7* | *34.9* | *35.2* |
| *Hydro* | *2.6* | *2.3* | *3.3* | *1.7* | *2.6* | *2.6* | *2.6* |
| *Geothermal* | – | – | – | – | – | – | – |
| *Solar/Wind/Other* | – | – | *0.0* | *0.0* | *0.0* | *0.0* | *0.1* |
| **TOTAL LOSSES** | **15.07** | **13.44** | **15.80** | **16.90** | **13.50** | **13.56** | **12.57** |
| *of which:* | | | | | | | |
| Electricity and Heat Generation[10] | 6.16 | 9.34 | 11.87 | 12.65 | 11.22 | 11.36 | 10.37 |
| Other Transformation | 7.34 | 1.62 | 1.08 | 1.32 | 0.40 | 0.20 | 0.10 |
| Own Use and Losses[11] | 1.57 | 2.48 | 2.85 | 2.93 | 1.88 | 2.00 | 2.10 |
| Statistical Differences | -1.31 | -1.36 | 1.06 | 0.69 | – | – | – |

## INDICATORS

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 40.36 | 54.39 | 58.03 | 60.18 | 84.68 | 137.94 | 224.69 |
| Population (millions) | 9.92 | 10.36 | 10.20 | 10.20 | 10.20 | 10.10 | 10.10 |
| TPES/GDP12 | 1.13 | 0.87 | 0.72 | 0.73 | 0.50 | 0.32 | 0.19 |
| Energy Production/TPES | 0.85 | 0.81 | 0.74 | 0.75 | 0.61 | 0.49 | 0.45 |
| Per Capita TPES[13] | 4.58 | 4.57 | 4.09 | 4.32 | 4.13 | 4.36 | 4.32 |
| Oil Supply/GDP[12] | 0.22 | 0.16 | 0.15 | 0.15 | 0.11 | 0.07 | 0.04 |
| TFC/GDP[12] | 0.78 | 0.65 | 0.43 | 0.44 | 0.34 | 0.22 | 0.14 |
| Per Capita TFC[13] | 3.19 | 3.41 | 2.44 | 2.60 | 2.80 | 3.01 | 3.07 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 147.3 | 153.8 | 114.7 | 117.0 | 102.7 | 102.4 | 97.9 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.7 | 0.7 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 |

## GROWTH RATES (% per year)

| | 73–79 | 79–90 | 90–02 | 02–03 | 03–10 | 10–20 | 20–30 |
|---|---|---|---|---|---|---|---|
| TPES | 1.2 | -0.2 | -1.0 | 5.7 | -0.7 | 0.4 | -0.1 |
| Coal | -0.3 | -1.4 | -3.1 | 1.8 | -5.4 | -1.4 | -1.8 |
| Oil | 4.2 | -2.2 | -0.4 | 2.9 | 0.4 | 0.4 | 0.3 |
| Gas | 14.3 | 8.0 | 3.3 | 1.0 | 5.1 | 1.8 | 0.7 |
| Comb. Renewables & Waste | – | – | – | 39.8 | 1.5 | 3.9 | 1.5 |
| Nuclear | – | – | 3.4 | 38.1 | -0.1 | – | – |
| Hydro | 13.3 | -4.1 | 4.7 | -44.4 | 4.3 | 0.3 | – |
| Geothermal | – | – | – | – | – | – | – |
| Solar/Wind/Other | – | – | – | – | – | 4.1 | 2.9 |
| TFC | 2.8 | -0.5 | -2.9 | 6.6 | 1.1 | 0.6 | 0.2 |
| Electricity Consumption | 3.4 | 2.6 | 0.4 | 3.1 | 1.1 | 1.5 | -0.3 |
| Energy Production | 2.0 | -1.1 | -1.9 | 7.5 | -3.5 | -1.8 | -1.0 |
| Net Oil Imports | 3.9 | -2.4 | -0.6 | 5.4 | 0.3 | 0.5 | 0.3 |
| GDP | 2.5 | 1.4 | 0.5 | 3.7 | 5.0 | 5.0 | 5.0 |
| Growth in the TPES/GDP Ratio | -1.3 | -1.6 | -1.6 | 1.9 | -5.4 | -4.3 | -4.8 |
| Growth in the TFC/GDP Ratio | 0.3 | -1.9 | -3.4 | 2.8 | -3.7 | -4.2 | -4.6 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **0.43** | **10.00** | **28.69** | **28.50** | **33.79** | **22.25** | **21.59** |
| Coal[1] | | - | - | - | - | - | - | - |
| Oil | | 0.07 | 6.03 | 18.63 | 18.63 | 19.96 | 13.29 | 12.36 |
| Gas | | - | 2.77 | 7.60 | 7.20 | 10.17 | 4.81 | 4.69 |
| Comb. Renewables & Waste[2] | | 0.35 | 1.14 | 1.94 | 2.09 | 2.77 | 3.06 | 3.13 |
| Nuclear | | - | - | - | - | - | - | - |
| Hydro | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Geothermal | | - | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | - |
| Solar/Wind/Other[3] | | - | 0.06 | 0.51 | 0.57 | 0.86 | 1.06 | 1.41 |
| **TOTAL NET IMPORTS[4]** | | **19.85** | **7.69** | **-9.75** | **-7.93** | **-11.44** | **1.16** | **2.71** |
| Coal[1] | Exports | 0.04 | 0.03 | 0.10 | 0.09 | - | - | - |
| | Imports | 1.91 | 6.25 | 3.80 | 5.66 | 4.23 | 2.71 | 1.77 |
| | Net Imports | 1.87 | 6.22 | 3.70 | 5.57 | 4.23 | 2.71 | 1.77 |
| Oil | Exports | 2.89 | 5.84 | 17.97 | 17.80 | 9.95 | 2.53 | 1.09 |
| | Imports | 21.58 | 8.58 | 8.55 | 8.50 | - | - | - |
| | Bunkers | 0.69 | 0.96 | 0.94 | 0.99 | 0.99 | 0.99 | 0.99 |
| | Net Imports | 18.00 | 1.79 | -10.36 | -10.29 | -10.93 | -3.52 | -2.08 |
| Gas | Exports | - | 0.93 | 2.98 | 2.59 | 4.59 | - | - |
| | Imports | - | - | - | - | - | 2.15 | 3.50 |
| | Net Imports | - | -0.93 | -2.98 | -2.59 | -4.59 | 2.15 | 3.50 |
| Electricity | Exports | 0.11 | 0.42 | 0.95 | 1.34 | 0.16 | 0.18 | 0.48 |
| | Imports | 0.09 | 1.03 | 0.77 | 0.60 | - | - | - |
| | Net Imports | -0.02 | 0.61 | -0.18 | -0.74 | -0.16 | -0.18 | -0.48 |
| **TOTAL STOCK CHANGES** | | **-0.44** | **0.17** | **0.76** | **0.18** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **19.83** | **17.85** | **19.70** | **20.76** | **22.34** | **23.41** | **24.29** |
| Coal[1] | | 1.93 | 6.09 | 4.19 | 5.67 | 4.23 | 2.71 | 1.77 |
| Oil | | 17.57 | 8.13 | 8.54 | 8.37 | 9.03 | 9.78 | 10.28 |
| Gas | | - | 1.82 | 4.63 | 4.66 | 5.59 | 6.96 | 8.19 |
| Comb. Renewables & Waste[2] | | 0.35 | 1.14 | 2.01 | 2.21 | 2.77 | 3.06 | 3.13 |
| Nuclear | | - | - | - | - | - | - | - |
| Hydro | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Geothermal | | - | 0.00 | 0.00 | 0.00 | 0.03 | 0.02 | - |
| Solar/Wind/Other[3] | | - | 0.06 | 0.51 | 0.57 | 0.86 | 1.06 | 1.41 |
| Electricity Trade[5] | | -0.02 | 0.61 | -0.18 | -0.74 | -0.16 | -0.18 | -0.48 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *9.7* | *34.1* | *21.3* | *27.3* | *18.9* | *11.6* | *7.3* |
| *Oil* | | *88.6* | *45.6* | *43.3* | *40.3* | *40.4* | *41.8* | *42.3* |
| *Gas* | | - | *10.2* | *23.5* | *22.4* | *25.0* | *29.7* | *33.7* |
| *Comb. Renewables & Waste* | | *1.8* | *6.4* | *10.2* | *10.7* | *12.4* | *13.1* | *12.9* |
| *Nuclear* | | - | - | - | - | - | - | - |
| *Hydro* | | - | - | - | - | - | - | - |
| *Geothermal* | | - | - | - | - | *0.1* | *0.1* | - |
| *Solar/Wind/Other* | | - | *0.3* | *2.6* | *2.8* | *3.8* | *4.5* | *5.8* |
| *Electricity Trade* | | *-0.1* | *3.4* | *-0.9* | *-3.5* | *-0.7* | *-0.8* | *-2.0* |

0 is negligible. - is nil, .. is not available

Please note: TPES for a given year strongly depends on the amount of net import of electricity. which may vary substantially from year to year. For forecast years, electricity exports may be lower when the $CO_2$ quota system is taken into account.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **16.26** | **13.87** | **15.12** | **15.32** | **17.08** | **18.20** | **19.08** |
| Coal[1] | 0.34 | 0.40 | 0.22 | 0.21 | 0.23 | 0.27 | 0.29 |
| Oil | 14.26 | 7.56 | 7.32 | 7.42 | 8.03 | 8.64 | 9.16 |
| Gas | 0.12 | 1.16 | 1.66 | 1.71 | 1.95 | 1.97 | 2.00 |
| Comb. Renewables & Waste[2] | 0.16 | 0.56 | 0.71 | 0.72 | 0.86 | 0.91 | 0.96 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Electricity | 1.39 | 2.44 | 2.80 | 2.79 | 3.15 | 3.59 | 3.90 |
| Heat | - | 1.76 | 2.41 | 2.46 | 2.85 | 2.82 | 2.77 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.1* | *2.9* | *1.5* | *1.4* | *1.4* | *1.5* | *1.5* |
| *Oil* | *87.7* | *54.5* | *48.4* | *48.5* | *47.0* | *47.5* | *48.0* |
| *Gas* | *0.7* | *8.3* | *11.0* | *11.2* | *11.4* | *10.8* | *10.5* |
| *Comb. Renewables & Waste* | *1.0* | *4.1* | *4.7* | *4.7* | *5.0* | *5.0* | *5.0* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.1* | - | *0.1* |
| *Electricity* | *8.5* | *17.6* | *18.5* | *18.2* | *18.5* | *19.7* | *20.5* |
| *Heat* | - | *12.7* | *15.9* | *16.1* | *16.7* | *15.5* | *14.5* |
| **TOTAL INDUSTRY[6]** | **4.10** | **3.00** | **3.18** | **3.15** | **3.51** | **3.83** | **4.08** |
| Coal[1] | 0.21 | 0.32 | 0.20 | 0.17 | 0.19 | 0.22 | 0.24 |
| Oil | 3.41 | 1.23 | 1.04 | 1.05 | 1.13 | 1.22 | 1.29 |
| Gas | 0.02 | 0.54 | 0.76 | 0.77 | 0.87 | 0.90 | 0.93 |
| Comb. Renewables & Waste[2] | 0.06 | 0.11 | 0.16 | 0.16 | 0.18 | 0.19 | 0.19 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 0.40 | 0.73 | 0.86 | 0.84 | 0.94 | 1.09 | 1.22 |
| Heat | - | 0.07 | 0.17 | 0.17 | 0.21 | 0.22 | 0.22 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.2* | *10.7* | *6.3* | *5.5* | *5.4* | *5.7* | *5.8* |
| *Oil* | *83.3* | *40.9* | *32.8* | *33.2* | *32.2* | *31.9* | *31.6* |
| *Gas* | *0.4* | *17.9* | *23.9* | *24.3* | *24.8* | *23.5* | *22.8* |
| *Comb. Renewables & Waste* | *1.4* | *3.8* | *4.9* | *5.1* | *5.0* | *4.9* | *4.6* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *9.7* | *24.2* | *26.9* | *26.6* | *26.7* | *28.4* | *29.8* |
| *Heat* | - | *2.5* | *5.3* | *5.3* | *5.9* | *5.8* | *5.4* |
| **TRANSPORT[7]** | **3.52** | **4.11** | **4.84** | **5.02** | **5.53** | **6.08** | **6.54** |
| **TOTAL OTHER SECTORS[8]** | **8.65** | **6.77** | **7.10** | **7.15** | **8.04** | **8.29** | **8.46** |
| Coal[1] | 0.13 | 0.08 | 0.02 | 0.03 | 0.04 | 0.05 | 0.05 |
| Oil | 7.34 | 2.24 | 1.47 | 1.39 | 1.39 | 1.36 | 1.34 |
| Gas | 0.10 | 0.62 | 0.91 | 0.95 | 1.08 | 1.07 | 1.07 |
| Comb. Renewables & Waste[2] | 0.10 | 0.45 | 0.55 | 0.56 | 0.68 | 0.73 | 0.77 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Electricity | 0.98 | 1.70 | 1.91 | 1.92 | 2.20 | 2.48 | 2.67 |
| Heat | - | 1.68 | 2.24 | 2.30 | 2.64 | 2.60 | 2.55 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.4* | *1.2* | *0.3* | *0.5* | *0.5* | *0.6* | *0.6* |
| *Oil* | *84.9* | *33.1* | *20.7* | *19.4* | *17.3* | *16.5* | *15.9* |
| *Gas* | *1.2* | *9.2* | *12.7* | *13.2* | *13.5* | *13.0* | *12.6* |
| *Comb. Renewables & Waste* | *1.2* | *6.7* | *7.7* | *7.8* | *8.5* | *8.7* | *9.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* |
| Electricity | 11.3 | 25.1 | 26.9 | 26.8 | 27.3 | 29.9 | 31.5 |
| *Heat* | - | *24.9* | *31.5* | *32.1* | *32.8* | *31.3* | *30.1* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **4.60** | **7.08** | **9.06** | **10.44** | **9.29** | **9.59** | **10.16** |
| **OUTPUT (Mtoe)** | **1.64** | **2.23** | **3.38** | **3.98** | **3.55** | **4.04** | **4.68** |
| (TWh gross) | 19.12 | 25.98 | 39.32 | 46.26 | 41.26 | 46.96 | 54.42 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *35.8* | *90.3* | *46.4* | *54.7* | *45.0* | *27.0* | *15.4* |
| *Oil* | *64.1* | *3.7* | *10.2* | *5.1* | *2.5* | *2.9* | *1.8* |
| *Gas* | - | *2.7* | *24.4* | *21.2* | *19.0* | *33.4* | *42.2* |
| *Comb. Renewables & Waste* | - | *0.8* | *6.4* | *6.8* | *12.3* | *13.5* | *13.3* |
| *Nuclear* | - | - | - | - | - | - | - |
| *Hydro* | *0.1* | *0.1* | *0.1* | *0.0* | *0.1* | *0.1* | *0.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | *2.3* | *12.5* | *12.2* | *21.0* | *23.3* | *27.3* |
| **TOTAL LOSSES** | **3.66** | **4.02** | **4.57** | **5.42** | **5.26** | **5.21** | **5.21** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 2.96 | 2.64 | 2.62 | 3.36 | 2.16 | 2.01 | 1.99 |
| Other Transformation | 0.44 | -0.03 | -0.07 | -0.00 | 0.08 | 0.08 | 0.08 |
| Own Use and Losses[11] | 0.26 | 1.41 | 2.01 | 2.07 | 3.02 | 3.12 | 3.14 |
| **Statistical Differences** | **-0.08** | **-0.05** | **0.02** | **0.01** | - | - | - |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 98.76 | 125.72 | 162.32 | 163.04 | 185.88 | 214.87 | 236.64 |
| Population (millions) | 5.02 | 5.14 | 5.38 | 5.39 | 5.43 | 5.41 | 5.38 |
| TPES/GDP[12] | 0.20 | 0.14 | 0.12 | 0.13 | 0.12 | 0.11 | 0.10 |
| Energy Production/TPES | 0.02 | 0.56 | 1.46 | 1.37 | 1.51 | 0.95 | 0.89 |
| Per Capita TPES[13] | 3.95 | 3.47 | 3.66 | 3.85 | 4.12 | 4.33 | 4.51 |
| Oil Supply/GDP[12] | 0.18 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.04 |
| TFC/GDP[12] | 0.16 | 0.11 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 |
| Per Capita TFC[13] | 3.24 | 2.70 | 2.81 | 2.84 | 3.15 | 3.37 | 3.55 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 56.6 | 50.7 | 51.2 | 56.2 | 54.8 | 54.3 | 55.0 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 4.5 | 4.8 | 5.1 | 5.3 | 5.3 | 5.3 | 5.3 |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | 1.2 | -1.6 | 0.8 | 5.3 | 1.1 | 0.5 | 0.4 |
| Coal | 14.4 | 3.1 | -3.1 | 35.3 | -4.1 | -4.4 | -4.2 |
| Oil | -1.4 | -6.1 | 0.4 | -1.9 | 1.1 | 0.8 | 0.5 |
| Gas | - | - | 8.1 | 0.7 | 2.6 | 2.2 | 1.6 |
| Comb. Renewables & Waste | 6.9 | 7.3 | 4.9 | 10.0 | 3.2 | 1.0 | 0.2 |
| Nuclear | - | - | - | - | - | - | - |
| Hydro | - | - | 3.4 | -33.3 | 6.0 | - | - |
| Geothermal | - | - | 5.9 | - | 31.4 | -1.6 | - |
| Solar/Wind/Other | - | 44.0 | 20.4 | 11.6 | 6.1 | 2.1 | 2.9 |
| TFC | 0.7 | -1.8 | 0.7 | 1.3 | 1.6 | 0.6 | 0.5 |
| Electricity Consumption | 4.9 | 2.5 | 1.2 | -0.3 | 1.8 | 1.3 | 0.9 |
| Energy Production | 14.7 | 23.6 | 9.2 | -0.7 | 2.5 | -4.1 | -0.3 |
| Net Oil Imports | -2.6 | -17.8 | - | -0.7 | 0.9 | - | -5.1 |
| GDP | 1.5 | 1.4 | 2.2 | 0.4 | 1.9 | 1.5 | 1.0 |
| Growth in the TPES/GDP Ratio | -0.3 | -2.9 | -1.3 | 4.9 | -0.8 | -1.0 | -0.6 |
| Growth in the TFC/GDP Ratio | -0.9 | -3.1 | -1.4 | 0.9 | -0.3 | -0.8 | -0.5 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **4.9** | **12.1** | **16.1** | **16.0** | **18.2** | **19.8** | **..** |
| Coal[1] | | - | - | - | - | - | - | .. |
| Peat | | 0.1 | 1.8 | 2.2 | 1.8 | 1.8 | 2.0 | .. |
| Oil | | - | - | 0.1 | 0.1 | - | - | .. |
| Gas | | - | - | - | - | - | - | .. |
| Comb. Renewables & Waste[2] | | 3.9 | 4.3 | 7.1 | 7.3 | 7.1 | 7.5 | .. |
| Nuclear | | - | 5.0 | 5.8 | 5.9 | 8.1 | 9.0 | .. |
| Hydro | | 0.9 | 0.9 | 0.9 | 0.8 | 1.1 | 1.2 | .. |
| Geothermal | | - | - | - | - | - | - | .. |
| Solar/Wind/Other[3] | | - | - | 0.0 | 0.0 | 0.0 | 0.1 | .. |
| **TOTAL NET IMPORTS[4]** | | **16.6** | **17.7** | **18.5** | **22.1** | **19.9** | **20.8** | **..** |
| Coal[1] | Exports | 0.0 | 0.0 | - | - | .. | .. | .. |
| | Imports | 2.4 | 4.4 | 4.0 | 6.6 | 4.3 | 5.2 | .. |
| | Net Imports | 2.4 | 4.4 | 4.0 | 6.6 | 4.3 | 5.2 | .. |
| Peat | Exports | - | - | 0.0 | 0.0 | .. | .. | .. |
| | Imports | - | - | - | - | - | - | .. |
| | Net Imports | - | - | -0.0 | -0.0 | .. | .. | .. |
| Oil | Exports | 0.2 | 1.7 | 5.5 | 5.7 | .. | .. | .. |
| | Imports | 14.0 | 12.5 | 16.0 | 17.3 | 9.2 | 8.9 | .. |
| | Bunkers | 0.1 | 0.6 | 0.6 | 0.6 | .. | .. | .. |
| | Net Imports | 13.8 | 10.2 | 9.8 | 10.9 | 9.2 | 8.9 | .. |
| Gas | Exports | - | - | - | - | - | - | .. |
| | Imports | - | 2.2 | 3.7 | 4.1 | 4.8 | 5.2 | .. |
| | Net Imports | - | 2.2 | 3.7 | 4.1 | 4.8 | 5.2 | .. |
| Electricity | Exports | 0.0 | 0.0 | 0.1 | 0.6 | 0.4 | 0.7 | .. |
| | Imports | 0.4 | 0.9 | 1.2 | 1.0 | 1.1 | 1.1 | .. |
| | Net Imports | 0.4 | 0.9 | 1.0 | 0.4 | 0.7 | 0.4 | .. |
| **TOTAL STOCK CHANGES** | | **-0.1** | **-0.6** | **1.1** | **-0.5** | **-** | **-** | **..** |
| **TOTAL SUPPLY (TPES)** | | **21.3** | **29.2** | **35.6** | **37.6** | **37.7** | **39.9** | **..** |
| Coal[1] | | 2.5 | 4.1 | 4.5 | 5.9 | 4.3 | 5.2 | .. |
| Peat | | 0.0 | 1.2 | 2.1 | 2.4 | 1.8 | 2.0 | .. |
| Oil | | 13.6 | 10.3 | 10.5 | 10.7 | 9.2 | 8.9 | .. |
| Gas | | - | 2.2 | 3.7 | 4.1 | 4.8 | 5.2 | .. |
| Comb. Renewables & Waste[2] | | 3.9 | 4.6 | 7.1 | 7.3 | 7.5 | 7.9 | .. |
| Nuclear | | - | 5.0 | 5.8 | 5.9 | 8.1 | 9.0 | .. |
| Hydro | | 0.9 | 0.9 | 0.9 | 0.8 | 1.1 | 1.2 | .. |
| Geothermal | | - | - | - | - | - | - | .. |
| Solar/Wind/Other[3] | | - | - | 0.0 | 0.0 | 0.0 | 0.1 | .. |
| Electricity Trade[5] | | 0.4 | 0.9 | 1.0 | 0.4 | 0.7 | 0.4 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *11.8* | *14.1* | *12.5* | *15.7* | *11.4* | *13.0* | .. |
| *Peat* | | *0.2* | *4.2* | *5.9* | *6.3* | *4.8* | *5.0* | .. |
| *Oil* | | *63.6* | *35.1* | *29.5* | *28.6* | *24.5* | *22.4* | .. |
| *Gas* | | - | *7.5* | *10.3* | *10.9* | *12.8* | *13.0* | .. |
| *Comb. Renewables & Waste* | | *18.5* | *15.6* | *19.9* | *19.5* | *20.0* | *19.8* | .. |
| *Nuclear* | | - | *17.2* | *16.3* | *15.8* | *21.5* | *22.6* | .. |
| *Hydro* | | *4.2* | *3.2* | *2.6* | *2.2* | *3.0* | *3.0* | .. |
| *Geothermal* | | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | | - | - | - | - | *0.1* | *0.2* | .. |
| *Electricity Trade* | | *1.7* | *3.1* | *2.9* | *1.1* | *1.8* | *1.1* | .. |

0 is negligible. - is nil, .. is not available - Please note: Finland is preparing a new Energy and Climate strategy which will include additional policy measures in order to meet the Finnish Kyoto targets. New scenarios are also under preparation.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **19.4** | **22.7** | **26.2** | **26.2** | **28.8** | **29.9** | **..** |
| Coal[1] | 1.0 | 1.2 | 0.8 | 0.8 | 1.0 | 1.1 | .. |
| Peat | 0.0 | 0.4 | 0.4 | 0.1 | 0.4 | 0.4 | .. |
| Oil | 11.5 | 9.7 | 8.9 | 9.0 | 8.9 | 8.6 | .. |
| Gas | 0.0 | 1.0 | 1.0 | 0.8 | 2.0 | 2.1 | .. |
| Comb. Renewables & Waste[2] | 3.9 | 3.5 | 5.0 | 4.8 | 5.7 | 5.9 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 2.3 | 5.1 | 6.9 | 7.0 | 7.9 | 8.7 | .. |
| Heat | 0.6 | 1.9 | 3.2 | 3.8 | 2.8 | 3.1 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.3* | *5.1* | *3.1* | *3.0* | *3.5* | *3.5* | .. |
| *Peat* | *0.1* | *1.8* | *1.4* | *0.5* | *1.4* | *1.4* | .. |
| *Oil* | *59.2* | *42.5* | *34.2* | *34.3* | *30.9* | *28.9* | .. |
| *Gas* | *0.1* | *4.3* | *3.9* | *3.1* | *7.0* | *6.9* | .. |
| *Comb. Renewables & Waste* | *20.3* | *15.5* | *19.0* | *18.2* | *19.8* | *19.7* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *11.9* | *22.3* | *26.2* | *26.5* | *27.5* | *29.1* | .. |
| *Heat* | *3.1* | *8.4* | *12.3* | *14.4* | *9.8* | *10.3* | .. |
| **TOTAL INDUSTRY[6]** | **7.6** | **10.5** | **12.7** | **12.6** | **15.4** | **16.2** | **..** |
| Coal[1] | 0.9 | 1.2 | 0.8 | 0.8 | 1.0 | 1.1 | .. |
| Peat | 0.0 | 0.4 | 0.3 | 0.1 | 0.4 | 0.4 | .. |
| Oil | 5.0 | 2.6 | 2.2 | 2.3 | 2.7 | 2.7 | .. |
| Gas | 0.0 | 0.9 | 0.9 | 0.7 | 1.9 | 2.0 | .. |
| Comb. Renewables & Waste[2] | - | 2.5 | 3.8 | 3.6 | 4.5 | 4.7 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 1.6 | 2.8 | 3.8 | 3.8 | 4.5 | 5.1 | .. |
| Heat | 0.1 | 0.2 | 0.9 | 1.3 | 0.3 | 0.3 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *12.1* | *11.0* | *6.3* | *6.2* | *6.6* | *6.5* | .. |
| *Peat* | *0.2* | *3.6* | *2.7* | *0.9* | *2.5* | *2.6* | .. |
| *Oil* | *66.2* | *24.7* | *17.2* | *18.1* | *17.7* | *16.3* | .. |
| *Gas* | *0.1* | *9.0* | *7.4* | *5.7* | *12.6* | *12.1* | .. |
| *Comb. Renewables & Waste* | - | *23.4* | *30.0* | *28.5* | *29.3* | *28.9* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *20.4* | *26.6* | *29.7* | *30.1* | *29.5* | *31.6* | .. |
| *Heat* | *1.0* | *1.7* | *6.8* | *10.4* | *1.8* | *2.0* | .. |
| **TRANSPORT[7]** | **2.6** | **4.4** | **4.7** | **4.8** | **4.5** | **4.4** | **..** |
| **TOTAL OTHER SECTORS[8]** | **9.3** | **7.9** | **8.9** | **8.8** | **9.0** | **9.2** | **..** |
| Coal[1] | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Peat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .. |
| Oil | 3.9 | 2.7 | 2.2 | 2.0 | 1.8 | 1.7 | .. |
| Gas | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | .. |
| Comb. Renewables & Waste[2] | 3.9 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 0.8 | 2.2 | 3.0 | 3.1 | 3.3 | 3.5 | .. |
| Heat | 0.5 | 1.7 | 2.3 | 2.5 | 2.6 | 2.7 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.1* | *0.1* | - | - | - | - | .. |
| *Peat* | *0.1* | *0.2* | *0.3* | *0.3* | *0.1* | *0.1* | .. |
| *Oil* | *42.3* | *35.0* | *24.6* | *22.9* | *20.4* | *18.2* | .. |
| *Gas* | - | *0.5* | *0.8* | *0.8* | *0.7* | *0.6* | .. |
| *Comb. Renewables & Waste* | *42.6* | *13.6* | *13.4* | *13.2* | *13.2* | *13.0* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *8.2* | *28.5* | *34.4* | *34.9* | *37.1* | *38.2* | .. |
| *Heat* | *5.7* | *22.1* | *26.5* | *27.9* | *28.4* | *29.8* | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **3.5** | **11.9** | **16.6** | **19.8** | **18.9** | **21.4** | **..** |
| **OUTPUT (Mtoe)** | **2.2** | **4.7** | **6.4** | **7.2** | **7.5** | **8.6** | **..** |
| (TWh gross) | 26.1 | 54.4 | 74.9 | 84.2 | 87.5 | 99.7 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *18.7* | *18.5* | *17.7* | *23.1* | *13.1* | *15.4* | .. |
| *Peat* | *9.4* | *14.6* | *8.6* | *8.7* | *5.7* | *5.6* | .. |
| *Oil* | *31.6* | *3.1* | *0.8* | *1.1* | *0.8* | *0.7* | .. |
| *Gas* | - | *8.6* | *15.1* | *16.6* | *16.5* | *16.5* | .. |
| *Comb. Renewables & Waste* | - | - | *13.5* | *12.1* | *12.6* | *12.4* | .. |
| *Nuclear* | - | *35.3* | *29.8* | *27.0* | *35.6* | *34.7* | .. |
| *Hydro* | *40.3* | *20.0* | *14.4* | *11.4* | *15.1* | *13.8* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.5* | *1.1* | .. |
| **TOTAL LOSSES** | **2.0** | **7.1** | **9.3** | **11.2** | **8.9** | **10.0** | **..** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 0.6 | 5.1 | 6.7 | 8.4 | 8.3 | 9.5 | .. |
| Other Transformation | 0.5 | 0.6 | 0.8 | 0.9 | .. | .. | .. |
| Own Use and Losses[11] | 0.9 | 1.4 | 1.7 | 1.9 | 0.5 | 0.6 | .. |
| **Statistical Differences** | **-0.07** | **-0.70** | **0.18** | **0.16** | **-** | **-** | **..** |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 60.63 | 99.57 | 123.94 | 126.45 | 152.25 | 191.76 | .. |
| Population (millions) | 4.67 | 4.99 | 5.20 | 5.21 | 5.27 | 5.32 | .. |
| TPES/GDP[12] | 0.35 | 0.29 | 0.29 | 0.30 | 0.25 | 0.21 | .. |
| Energy Production/TPES | 0.23 | 0.41 | 0.45 | 0.43 | 0.48 | 0.50 | .. |
| Per Capita TPES[13] | 4.57 | 5.85 | 6.85 | 7.20 | 7.15 | 7.50 | .. |
| Oil Supply/GDP[12] | 0.22 | 0.10 | 0.08 | 0.08 | 0.06 | 0.05 | .. |
| TFC/GDP[12] | 0.32 | 0.23 | 0.21 | 0.21 | 0.19 | 0.16 | .. |
| Per Capita TFC[13] | 4.16 | 4.56 | 5.03 | 5.03 | 5.47 | 5.61 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 48.4 | 55.0 | 63.9 | 72.6 | 63.0 | 67.2 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.5 | 2.8 | 3.1 | 3.1 | 1.1 | 1.1 | .. |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | 2.3 | 1.6 | 1.7 | 5.4 | 0.0 | 0.6 | .. |
| Coal | 7.4 | 0.6 | 0.7 | 31.8 | -4.3 | 1.8 | .. |
| Peat | 48.1 | 10.6 | 4.7 | 11.1 | -3.5 | 1.0 | .. |
| Oil | -0.5 | -2.3 | 0.2 | 2.3 | -2.2 | -0.3 | .. |
| Gas | - | 9.4 | 4.5 | 10.9 | 2.4 | 0.7 | .. |
| Comb. Renewables & Waste | -2.4 | 2.7 | 3.7 | 3.3 | 0.4 | 0.5 | .. |
| Nuclear | - | 10.0 | 1.2 | 2.0 | 4.6 | 1.1 | .. |
| Hydro | 0.6 | -0.0 | -0.1 | -11.0 | 4.7 | 0.4 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | 33.3 | 25.8 | 9.4 | .. |
| TFC | 0.4 | 1.2 | 1.2 | 0.3 | 1.3 | 0.4 | .. |
| Electricity Consumption | 4.7 | 4.7 | 2.5 | 1.5 | 1.9 | 0.9 | .. |
| Energy Production | 4.7 | 5.9 | 2.4 | -0.7 | 1.9 | 0.8 | .. |
| Net Oil Imports | 1.1 | -3.3 | -0.4 | 11.6 | -2.4 | -0.3 | .. |
| GDP | 2.5 | 3.2 | 1.8 | 2.0 | 2.7 | 2.3 | .. |
| Growth in the TPES/GDP Ratio | -0.2 | -1.6 | -0.2 | 3.3 | -2.6 | -1.7 | .. |
| Growth in the TFC/GDP Ratio | -2.0 | -2.0 | -0.6 | -1.7 | -1.3 | -1.9 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION | | 44.2 | 111.9 | 134.5 | 136.3 | 142.0 | 146.0 | 138.7 |
| Coal[1] | | 18.0 | 8.2 | 1.3 | 1.4 | 0.5 | 0.4 | - |
| Oil | | 2.1 | 3.5 | 1.5 | 1.4 | - | - | - |
| Gas | | 6.3 | 2.5 | 1.4 | 1.3 | - | - | - |
| Comb. Renewables & Waste[2] | | 9.8 | 11.0 | 11.1 | 12.0 | 14.7 | 18.5 | 22.5 |
| Nuclear | | 3.8 | 81.9 | 113.8 | 114.9 | 120.3 | 117.8 | 106.6 |
| Hydro | | 4.1 | 4.6 | 5.2 | 5.1 | 5.9 | 5.9 | 5.9 |
| Geothermal | | 0.0 | 0.1 | 0.1 | 0.1 | .. | .. | .. |
| Solar/Wind/Other[3] | | 0.0 | 0.1 | 0.1 | 0.1 | 0.6 | 3.3 | 3.7 |
| **TOTAL NET IMPORTS[4]** | | **142.8** | **117.1** | **133.5** | **134.6** | **156.8** | **173.9** | **198.9** |
| Coal[1] | Exports | 1.3 | 0.6 | 0.3 | 0.3 | - | - | - |
| | Imports | 10.8 | 13.7 | 12.9 | 12.1 | 9.8 | 11.2 | 21.4 |
| | Net Imports | 9.5 | 13.0 | 12.6 | 11.8 | 9.8 | 11.2 | 21.4 |
| Oil | Exports | 13.7 | 14.8 | 19.5 | 22.9 | 13.3 | 14.6 | 16.1 |
| | Imports | 145.1 | 100.9 | 112.9 | 116.7 | 120.3 | 124.3 | 126.6 |
| | Bunkers | 5.3 | 2.5 | 2.6 | 2.8 | 3.0 | 3.0 | 3.0 |
| | Net Imports | 126.0 | 83.6 | 90.8 | 91.0 | 104.0 | 106.7 | 107.5 |
| Gas | Exports | 0.1 | 0.3 | 0.8 | 0.8 | - | - | - |
| | Imports | 7.6 | 24.7 | 37.5 | 38.4 | 47.3 | 59.0 | 70.0 |
| | Net Imports | 7.6 | 24.4 | 36.7 | 37.6 | 47.3 | 59.0 | 70.0 |
| Electricity | Exports | 0.6 | 4.5 | 6.9 | 6.2 | 4.3 | 3.0 | - |
| | Imports | 0.4 | 0.6 | 0.3 | 0.5 | - | - | - |
| | Net Imports | -0.2 | -3.9 | -6.6 | -5.7 | -4.3 | -3.0 | - |
| **TOTAL STOCK CHANGES** | | **-2.4** | **-1.7** | **-2.0** | **0.3** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **184.7** | **227.3** | **266.0** | **271.3** | **298.8** | **319.9** | **337.6** |
| Coal[1] | | 29.2 | 20.2 | 13.6 | 14.4 | 10.3 | 11.6 | 21.4 |
| Oil | | 124.3 | 87.3 | 91.3 | 91.0 | 104.0 | 106.7 | 107.5 |
| Gas | | 13.6 | 26.0 | 37.5 | 39.4 | 47.3 | 59.0 | 70.0 |
| Comb. Renewables & Waste[2] | | 9.8 | 11.0 | 11.1 | 11.9 | 14.7 | 18.5 | 22.5 |
| Nuclear | | 3.8 | 81.9 | 113.8 | 114.9 | 120.3 | 117.8 | 106.6 |
| Hydro | | 4.1 | 4.6 | 5.2 | 5.1 | 5.9 | 5.9 | 5.9 |
| Geothermal | | 0.0 | 0.1 | 0.1 | 0.1 | .. | .. | .. |
| Solar/Wind/Other[3] | | 0.0 | 0.1 | 0.1 | 0.1 | 0.6 | 3.3 | 3.7 |
| Electricity Trade[5] | | -0.2 | -3.9 | -6.6 | -5.7 | -4.3 | -3.0 | - |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *15.8* | *8.9* | *5.1* | *5.3* | *3.4* | *3.6* | *6.3* |
| *Oil* | | *67.3* | *38.4* | *34.3* | *33.6* | *34.8* | *33.4* | *31.8* |
| *Gas* | | *7.3* | *11.5* | *14.1* | *14.5* | *15.8* | *18.4* | *20.7* |
| *Comb. Renewables & Waste* | | *5.3* | *4.8* | *4.2* | *4.4* | *4.9* | *5.8* | *6.7* |
| *Nuclear* | | *2.1* | *36.0* | *42.8* | *42.4* | *40.3* | *36.8* | *31.6* |
| *Hydro* | | *2.2* | *2.0* | *2.0* | *1.9* | *2.0* | *1.9* | *1.8* |
| *Geothermal* | | - | - | - | - | .. | .. | .. |
| *Solar/Wind/Other* | | - | - | - | - | *0.2* | *1.0* | *1.1* |
| *Electricity Trade* | | *-0.1* | *-1.7* | *-2.5* | *-2.1* | *-1.4* | *-0.9* | - |

0 is negligible. - is nil, .. is not available.

Please note: All forecasts are based on the 2003 submission. Forecast data for Solar/Wind/Other include Geothermal.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **145.6** | **147.1** | **169.3** | **173.1** | **196.1** | **213.3** | **228.2** |
| Coal[1] | 13.1 | 7.5 | 3.6 | 3.6 | 7.2 | 6.9 | 7.2 |
| Oil | 99.4 | 79.5 | 88.3 | 88.6 | 95.1 | 97.3 | 97.8 |
| Gas | 11.2 | 23.9 | 33.8 | 35.2 | 40.9 | 46.7 | 51.1 |
| Comb. Renewables & Waste[2] | 8.9 | 9.6 | 9.0 | 9.8 | 13.9 | 16.1 | 19.6 |
| Geothermal | 0.0 | 0.1 | 0.1 | 0.1 | .. | .. | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | - | - |
| Electricity | 12.8 | 26.0 | 33.8 | 35.1 | 39.0 | 46.3 | 52.5 |
| Heat | 0.3 | 0.5 | 0.6 | 0.7 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *9.0* | *5.1* | *2.1* | *2.1* | *3.7* | *3.2* | *3.2* |
| *Oil* | *68.3* | *54.0* | *52.2* | *51.2* | *48.5* | *45.6* | *42.8* |
| *Gas* | *7.7* | *16.3* | *20.0* | *20.3* | *20.9* | *21.9* | *22.4* |
| *Comb. Renewables & Waste* | *6.1* | *6.5* | *5.3* | *5.7* | *7.1* | *7.6* | *8.6* |
| *Geothermal* | - | *0.1* | *0.1* | *0.1* | .. | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *8.8* | *17.7* | *20.0* | *20.3* | *19.9* | *21.7* | *23.0* |
| *Heat* | *0.2* | *0.3* | *0.4* | *0.4* | .. | .. | .. |
| **TOTAL INDUSTRY[6]** | **56.6** | **46.1** | **50.4** | **50.0** | **62.2** | **67.3** | **71.8** |
| Coal[1] | 7.2 | 5.9 | 3.2 | 3.2 | 5.6 | 5.1 | 5.0 |
| Oil | 35.3 | 18.0 | 19.1 | 19.2 | 22.2 | 22.1 | 22.6 |
| Gas | 5.8 | 11.1 | 15.4 | 14.9 | 16.3 | 18.5 | 20.0 |
| Comb. Renewables & Waste[2] | 1.2 | 1.3 | 1.3 | 1.3 | 4.8 | 6.0 | 6.5 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 7.2 | 9.9 | 11.5 | 11.4 | 13.3 | 15.6 | 17.7 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *12.7* | *12.7* | *6.3* | *6.3* | *9.0* | *7.6* | *7.0* |
| *Oil* | *62.3* | *38.9* | *37.8* | *38.4* | *35.7* | *32.9* | *31.5* |
| *Gas* | *10.2* | *24.1* | *30.5* | *29.7* | *26.2* | *27.5* | *27.9* |
| *Comb. Renewables & Waste* | *2.1* | *2.9* | *2.6* | *2.7* | *7.7* | *8.9* | *9.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *12.8* | *21.4* | *22.7* | *22.9* | *21.4* | *23.2* | *24.7* |
| *Heat* | - | - | - | - | - | - | - |
| **TRANSPORT[7]** | **27.1** | **42.8** | **52.9** | **52.4** | **56.4** | **62.2** | **68.3** |
| **TOTAL OTHER SECTORS[8]** | **61.9** | **58.1** | **66.0** | **70.6** | **77.5** | **83.9** | **88.1** |
| Coal[1] | 5.8 | 1.7 | 0.4 | 0.4 | 1.6 | 1.8 | 2.2 |
| Oil | 37.6 | 19.5 | 17.7 | 18.3 | 18.1 | 15.4 | 10.4 |
| Gas | 5.4 | 12.8 | 18.4 | 20.3 | 24.6 | 28.2 | 31.1 |
| Comb. Renewables & Waste[2] | 7.7 | 8.2 | 7.4 | 8.2 | 8.5 | 9.0 | 11.1 |
| Geothermal | 0.0 | 0.1 | 0.1 | 0.1 | .. | .. | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | - | - |
| Electricity | 5.0 | 15.3 | 21.3 | 22.7 | 24.7 | 29.5 | 33.3 |
| Heat | 0.3 | 0.5 | 0.6 | 0.7 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *9.4* | *2.9* | *0.6* | *0.6* | *2.1* | *2.1* | *2.5* |
| *Oil* | *60.8* | *33.5* | *26.8* | *25.9* | *23.4* | *18.4* | *11.8* |
| *Gas* | *8.7* | *22.1* | *27.8* | *28.7* | *31.7* | *33.6* | *35.3* |
| *Comb. Renewables & Waste* | *12.5* | *14.1* | *11.3* | *11.6* | *11.0* | *10.7* | *12.6* |
| *Geothermal* | - | *0.2* | *0.2* | *0.2* | .. | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *8.1* | *26.4* | *32.3* | *32.1* | *31.9* | *35.2* | *37.8* |
| *Heat* | *0.4* | *0.8* | *0.9* | *0.9* | .. | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **36.8** | **98.6** | **131.7** | **134.0** | **138.3** | **147.9** | **153.2** |
| **OUTPUT (Mtoe)** | **15.7** | **35.9** | **47.6** | **48.3** | **51.0** | **57.0** | **60.9** |
| (TWh gross) | 182.5 | 417.8 | 553.9 | 561.7 | 593.0 | 663.2 | 708.3 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *19.4* | *8.5* | *5.0* | *5.3* | *1.9* | *2.8* | *8.7* |
| *Oil* | *40.2* | *2.1* | *1.3* | *1.5* | *0.9* | *0.3* | *0.2* |
| *Gas* | *5.5* | *0.7* | *2.9* | *3.1* | *6.0* | *11.3* | *16.2* |
| *Comb. Renewables & Waste* | *0.4* | *0.5* | *0.8* | *0.9* | *0.5* | *1.2* | *1.4* |
| *Nuclear* | *8.1* | *75.2* | *78.9* | *78.5* | *77.8* | *68.1* | *57.8* |
| *Hydro* | *26.1* | *12.9* | *10.9* | *10.5* | *11.6* | *10.4* | *9.8* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | *0.3* | *0.1* | *0.1* | *0.2* | *1.2* | *5.8* | *6.1* |
| **TOTAL LOSSES** | **39.3** | **75.7** | **96.8** | **99.0** | **102.7** | **106.5** | **109.4** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 20.8 | 62.2 | 83.5 | 85.1 | 87.3 | 90.9 | 92.3 |
| Other Transformation | 6.4 | 1.6 | 0.5 | 0.4 | 0.3 | 0.4 | 0.4 |
| Own Use and Losses[11] | 12.0 | 11.9 | 12.8 | 13.5 | 15.1 | 15.2 | 16.7 |
| **Statistical Differences** | **-0.2** | **4.5** | **-0.1** | **-0.8** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 709.68 | 1087.46 | 1351.65 | 1357.97 | 1592.28 | 1998.83 | 2509.18 |
| Population (millions) | 53.30 | 58.17 | 61.24 | 61.54 | 61.10 | 62.70 | 63.90 |
| TPES/GDP[12] | 0.26 | 0.21 | 0.20 | 0.20 | 0.19 | 0.16 | 0.13 |
| Energy Production/TPES | 0.24 | 0.49 | 0.51 | 0.50 | 0.48 | 0.46 | 0.41 |
| Per Capita TPES[13] | 3.46 | 3.91 | 4.34 | 4.41 | 4.89 | 5.10 | 5.28 |
| Oil Supply/GDP[12] | 0.18 | 0.08 | 0.07 | 0.07 | 0.07 | 0.05 | 0.04 |
| TFC/GDP[12] | 0.21 | 0.14 | 0.13 | 0.13 | 0.12 | 0.11 | 0.09 |
| Per Capita TFC[13] | 2.73 | 2.53 | 2.76 | 2.81 | 3.21 | 3.40 | 3.57 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 489.0 | 355.3 | 380.3 | 389.6 | 422.9 | 462.9 | 528.4 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 22.7 | 17.7 | 23.0 | 24.5 | 25.0 | 25.0 | 25.0 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 0.8 | 1.5 | 1.3 | 2.0 | 1.4 | 0.7 | 0.5 |
| Coal | 1.7 | -4.2 | -3.3 | 5.8 | -4.6 | 1.2 | 6.3 |
| Oil | -1.4 | -2.4 | 0.4 | -0.2 | 1.9 | 0.3 | 0.1 |
| Gas | 7.4 | 2.0 | 3.1 | 5.1 | 2.7 | 2.2 | 1.7 |
| Comb. Renewables & Waste | -0.5 | 1.4 | 0.0 | 8.1 | 3.0 | 2.3 | 2.0 |
| Nuclear | 18.1 | 20.6 | 2.8 | 1.0 | 0.7 | -0.2 | -1.0 |
| Hydro | 5.7 | -1.9 | 1.0 | -2.4 | 2.2 | 0.0 | - |
| Geothermal | 46.8 | 24.4 | 1.3 | 0.8 | .. | .. | .. |
| Solar/Wind/Other | -1.8 | 4.5 | 1.9 | 9.1 | 30.3 | 18.3 | 1.2 |
| TFC | 0.5 | -0.2 | 1.2 | 2.2 | 1.8 | 0.8 | 0.7 |
| Electricity Consumption | 5.4 | 3.7 | 2.2 | 3.8 | 1.5 | 1.7 | 1.3 |
| Energy Production | 1.3 | 8.0 | 1.5 | 1.3 | 0.6 | 0.3 | -0.5 |
| Net Oil Imports | -1.4 | -2.9 | 0.7 | 0.2 | 1.9 | 0.3 | 0.1 |
| GDP | 2.8 | 2.4 | 1.8 | 0.5 | 2.3 | 2.3 | 2.3 |
| Growth in the TPES/GDP Ratio | -1.9 | -0.9 | -0.5 | 1.5 | -0.9 | -1.6 | -1.7 |
| Growth in the TFC/GDP Ratio | -2.2 | -2.5 | -0.6 | 1.7 | -0.5 | -1.4 | -1.6 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **171.7** | **186.2** | **134.9** | **134.5** | **123.4** | **94.9** | **86.9** |
| Coal[1] | | 141.4 | 121.8 | 58.8 | 57.9 | 51.5 | 45.2 | 41.8 |
| Oil | | 6.8 | 4.7 | 4.2 | 4.4 | 3.0 | 1.8 | 0.6 |
| Gas | | 16.4 | 13.5 | 16.0 | 15.9 | 15.3 | 13.8 | 11.4 |
| Comb. Renewables & Waste[2] | | 2.5 | 4.8 | 9.3 | 9.7 | 13.2 | 15.8 | 17.2 |
| Nuclear | | 3.2 | 39.8 | 43.0 | 43.0 | 33.9 | 8.3 | - |
| Hydro | | 1.3 | 1.5 | 2.0 | 1.7 | 2.0 | 2.1 | 2.1 |
| Geothermal | | - | 0.0 | 0.1 | 0.1 | 0.2 | 1.1 | 4.3 |
| Solar/Wind/Other[3] | | - | 0.0 | 1.5 | 1.9 | 4.3 | 6.7 | 9.5 |
| **TOTAL NET IMPORTS[4]** | | **167.3** | **165.4** | **207.8** | **211.2** | **214.0** | **213.8** | **200.2** |
| Coal[1] | Exports | 18.3 | 8.2 | 0.6 | 0.6 | - | - | - |
| | Imports | 15.2 | 11.5 | 25.5 | 25.7 | 23.9 | 24.8 | 13.8 |
| | Net Imports | -3.1 | 3.3 | 24.8 | 25.1 | 23.9 | 24.8 | 13.8 |
| Oil | Exports | 9.9 | 10.2 | 20.2 | 19.8 | 3.7 | 3.9 | 2.8 |
| | Imports | 171.1 | 132.9 | 144.7 | 146.1 | 131.6 | 124.2 | 116.8 |
| | Bunkers | 4.1 | 2.5 | 2.4 | 2.6 | 3.0 | 3.6 | 4.4 |
| | Net Imports | 157.1 | 120.2 | 122.1 | 123.7 | 124.9 | 116.7 | 109.5 |
| Gas | Exports | 0.1 | 0.9 | 5.8 | 6.1 | - | - | - |
| | Imports | 12.4 | 42.7 | 65.8 | 68.5 | 67.2 | 72.4 | 77.2 |
| | Net Imports | 12.3 | 41.7 | 60.1 | 62.4 | 67.2 | 72.4 | 77.2 |
| Electricity | Exports | 0.7 | 2.6 | 3.3 | 4.1 | 3.8 | 3.8 | 4.0 |
| | Imports | 1.7 | 2.7 | 4.2 | 4.0 | 1.8 | 3.7 | 3.8 |
| | Net Imports | 1.0 | 0.1 | 0.9 | -0.0 | -2.0 | -0.1 | -0.2 |
| **TOTAL STOCK CHANGES** | | **-1.1** | **4.7** | **3.3** | **1.4** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **337.9** | **356.2** | **346.0** | **347.1** | **337.4** | **308.6** | **287.2** |
| Coal[1] | | 139.4 | 128.5 | 84.8 | 85.1 | 75.4 | 69.9 | 55.5 |
| Oil | | 161.9 | 126.5 | 128.8 | 126.5 | 127.9 | 118.5 | 110.1 |
| Gas | | 28.7 | 55.0 | 75.5 | 79.2 | 82.6 | 86.3 | 88.5 |
| Comb. Renewables & Waste[2] | | 2.5 | 4.8 | 9.3 | 9.7 | 13.2 | 15.8 | 17.2 |
| Nuclear | | 3.2 | 39.8 | 43.0 | 43.0 | 33.9 | 8.3 | - |
| Hydro | | 1.3 | 1.5 | 2.0 | 1.7 | 2.0 | 2.1 | 2.1 |
| Geothermal | | - | 0.0 | 0.1 | 0.1 | 0.2 | 1.1 | 4.3 |
| Solar/Wind/Other[3] | | - | 0.0 | 1.5 | 1.9 | 4.3 | 6.7 | 9.5 |
| Electricity Trade[5] | | 1.0 | 0.1 | 0.9 | -0.0 | -2.0 | -0.1 | -0.2 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *41.2* | *36.1* | *24.5* | *24.5* | *22.3* | *22.7* | *19.3* |
| *Oil* | | *47.9* | *35.5* | *37.2* | *36.4* | *37.9* | *38.4* | *38.4* |
| *Gas* | | *8.5* | *15.4* | *21.8* | *22.8* | *24.5* | *27.9* | *30.8* |
| *Comb. Renewables & Waste* | | *0.7* | *1.3* | *2.7* | *2.8* | *3.9* | *5.1* | *6.0* |
| *Nuclear* | | *0.9* | *11.2* | *12.4* | *12.4* | *10.0* | *2.7* | - |
| *Hydro* | | *0.4* | *0.4* | *0.6* | *0.5* | *0.6* | *0.7* | *0.7* |
| *Geothermal* | | - | - | - | - | *0.1* | *0.4* | *1.5* |
| *Solar/Wind/Other* | | - | - | *0.4* | *0.5* | *1.3* | *2.2* | *3.3* |
| *Electricity Trade* | | *0.3* | - | *0.2* | - | *-0.6* | - | *-0.1* |

0 is negligible. - is nil, .. is not available

Please note: Forecasts are based on studies by the Institute of Energy Economics at the University of Cologne (EWI) and Prognos AG/Baselof. They are not official forecasts of the German Government.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **246.6** | **247.3** | **241.2** | **245.7** | **248.7** | **240.1** | **229.8** |
| Coal[1] | 53.1 | 37.3 | 9.1 | 9.3 | 12.3 | 10.7 | 10.0 |
| Oil | 138.2 | 117.7 | 120.7 | 117.6 | 117.8 | 109.4 | 101.9 |
| Gas | 21.1 | 41.0 | 56.0 | 61.0 | 59.0 | 58.3 | 56.2 |
| Comb. Renewables & Waste[2] | 1.7 | 3.0 | 5.4 | 5.1 | 6.1 | 8.0 | 9.2 |
| Geothermal | - | 0.0 | 0.1 | 0.1 | - | - | - |
| Solar/Wind/Other | - | 0.0 | 0.2 | 0.2 | 0.5 | 0.9 | 1.1 |
| Electricity | 26.9 | 39.1 | 42.9 | 43.8 | 45.3 | 45.8 | 45.3 |
| Heat | 5.5 | 9.1 | 6.8 | 8.4 | 7.6 | 7.1 | 6.3 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *21.5* | *15.1* | *3.8* | *3.8* | *5.0* | *4.5* | *4.3* |
| *Oil* | *56.0* | *47.6* | *50.0* | *47.9* | *47.4* | *45.6* | *44.3* |
| *Gas* | *8.6* | *16.6* | *23.2* | *24.8* | *23.7* | *24.3* | *24.4* |
| *Comb. Renewables & Waste* | *0.7* | *1.2* | *2.2* | *2.1* | *2.5* | *3.3* | *4.0* |
| *Geothermal* | - | - | *0.1* | - | - | - | - |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.2* | *0.4* | *0.5* |
| Electricity | 10.9 | 15.8 | 17.8 | 17.8 | 18.2 | 19.1 | 19.7 |
| *Heat* | *2.2* | *3.7* | *2.8* | *3.4* | *3.1* | *2.9* | *2.7* |
| **TOTAL INDUSTRY[6]** | **105.9** | **89.5** | **78.1** | **77.7** | **81.4** | **81.1** | **79.6** |
| Coal[1] | 28.7 | 20.7 | 8.0 | 8.2 | 11.9 | 10.5 | 9.8 |
| Oil | 46.9 | 27.3 | 27.6 | 27.1 | 27.5 | 28.0 | 27.0 |
| Gas | 13.3 | 19.7 | 20.8 | 21.3 | 21.2 | 21.6 | 21.3 |
| Comb. Renewables & Waste[2] | 0.0 | 0.8 | 0.8 | - | 0.5 | 0.5 | 0.6 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | 0.0 | 0.0 | 0.1 |
| Electricity | 15.3 | 18.6 | 20.1 | 19.9 | 19.0 | 19.4 | 19.9 |
| Heat | 1.6 | 2.4 | 0.9 | 1.1 | 1.3 | 1.2 | 1.0 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *27.1* | *23.1* | *10.2* | *10.6* | *14.6* | *13.0* | *12.3* |
| *Oil* | *44.3* | *30.5* | *35.4* | *34.9* | *33.8* | *34.5* | *33.9* |
| *Gas* | *12.6* | *22.0* | *26.6* | *27.5* | *26.1* | *26.6* | *26.8* |
| *Comb. Renewables & Waste* | - | *0.9* | *1.0* | - | *0.6* | *0.6* | *0.8* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | *0.1* | *0.1* |
| *Electricity* | *14.5* | *20.8* | *25.7* | *25.6* | *23.3* | *23.9* | *24.9* |
| *Heat* | *1.5* | *2.7* | *1.2* | *1.4* | *1.6* | *1.4* | *1.2* |
| **TRANSPORT[7]** | **39.7** | **60.0** | **65.6** | **63.7** | **64.1** | **62.6** | **61.5** |
| **TOTAL OTHER SECTORS[8]** | **101.0** | **97.8** | **97.5** | **104.3** | **103.1** | **96.4** | **88.7** |
| Coal[1] | 22.7 | 16.6 | 1.1 | 1.1 | 0.4 | 0.2 | 0.2 |
| Oil | 54.2 | 31.6 | 29.4 | 28.8 | 29.2 | 24.7 | 21.4 |
| Gas | 7.8 | 21.3 | 35.3 | 39.7 | 37.7 | 36.0 | 33.3 |
| Comb. Renewables & Waste[2] | 1.7 | 2.2 | 4.1 | 4.5 | 4.1 | 4.1 | 4.0 |
| Geothermal | - | 0.0 | 0.1 | 0.1 | - | - | - |
| Solar/Wind/Other | - | 0.0 | 0.2 | 0.2 | 0.5 | 0.8 | 1.0 |
| Electricity | 10.7 | 19.3 | 21.4 | 22.5 | 24.9 | 24.7 | 23.6 |
| Heat | 3.9 | 6.7 | 5.9 | 7.3 | 6.3 | 5.9 | 5.3 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *22.5* | *16.9* | *1.1* | *1.0* | *0.4* | *0.2* | *0.2* |
| *Oil* | *53.6* | *32.3* | *30.1* | *27.7* | *28.3* | *25.6* | *24.1* |
| *Gas* | *7.7* | *21.8* | *36.2* | *38.0* | *36.6* | *37.3* | *37.5* |
| *Comb. Renewables & Waste* | *1.7* | *2.2* | *4.2* | *4.4* | *4.0* | *4.2* | *4.5* |
| *Geothermal* | - | - | *0.1* | *0.1* | - | - | - |
| *Solar/Wind/Other* | - | - | *0.2* | *0.2* | *0.5* | *0.8* | *1.1* |
| *Electricity* | *10.6* | *19.8* | *22.0* | *21.6* | *24.1* | *25.6* | *26.6* |
| *Heat* | *3.9* | *6.9* | *6.1* | *7.0* | *6.1* | *6.1* | *6.0* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **98.6** | **141.2** | **136.9** | **141.6** | **133.3** | **112.2** | **100.6** |
| **OUTPUT (Mtoe)** | **32.2** | **47.1** | **48.8** | **51.1** | **53.5** | **51.6** | **50.7** |
| (TWh gross) | 374.4 | 547.7 | 566.9 | 594.3 | 622.5 | 600.0 | 589.5 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *69.0* | *58.8* | *51.4* | *52.9* | *47.0* | *48.6* | *39.4* |
| *Oil* | *12.0* | *1.9* | *0.8* | *0.8* | *0.7* | *0.7* | *0.6* |
| *Gas* | *10.9* | *7.4* | *9.5* | *9.8* | *16.3* | *24.7* | *33.1* |
| *Comb. Renewables & Waste* | *0.8* | *0.9* | *2.3* | *2.2* | *4.2* | *4.9* | *5.4* |
| *Nuclear* | *3.2* | *27.8* | *29.1* | *27.8* | *20.9* | *5.3* | - |
| *Hydro* | *4.1* | *3.2* | *4.1* | *3.2* | *3.7* | *4.2* | *4.2* |
| *Geothermal* | - | - | - | - | *0.0* | *0.2* | *0.9* |
| *Solar/Wind/Other* | - | *0.0* | *2.8* | *3.2* | *7.1* | *11.4* | *16.5* |
| **TOTAL LOSSES** | **90.7** | **112.0** | **103.1** | **104.4** | **88.7** | **68.5** | **57.3** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 60.0 | 83.4 | 80.6 | 81.2 | 71.0 | 52.5 | 42.8 |
| Other Transformation | 7.0 | 8.0 | 5.6 | 5.5 | 1.4 | 1.4 | 1.3 |
| Own Use and Losses[11] | 23.7 | 20.5 | 16.8 | 17.7 | 16.3 | 14.7 | 13.3 |
| **Statistical Differences** | **0.5** | **-3.0** | **1.8** | **-3.0** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 1053.96 | 1545.84 | 1887.47 | 1885.19 | 2092.27 | 2452.19 | 2790.28 |
| Population (millions) | 78.96 | 79.36 | 82.48 | 82.52 | 82.40 | 81.30 | 79.30 |
| TPES/GDP[12] | 0.32 | 0.23 | 0.18 | 0.18 | 0.16 | 0.13 | 0.10 |
| Energy Production/TPES | 0.51 | 0.52 | 0.39 | 0.39 | 0.37 | 0.31 | 0.30 |
| Per Capita TPES[13] | 4.28 | 4.49 | 4.19 | 4.21 | 4.09 | 3.80 | 3.62 |
| Oil Supply/GDP[12] | 0.15 | 0.08 | 0.07 | 0.07 | 0.06 | 0.05 | 0.04 |
| TFC/GDP[12] | 0.23 | 0.16 | 0.13 | 0.13 | 0.12 | 0.10 | 0.08 |
| Per Capita TFC[13] | 3.12 | 3.12 | 2.92 | 2.98 | 3.02 | 2.95 | 2.90 |
| Energy-related $CO_2$ | | | | | | | |
| Emissions (Mt $CO_2$)[14] | 1058.7 | 966.4 | 841.2 | 854.3 | 814.4 | 775.9 | 701.5 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 21.8 | 22.1 | 28.5 | 29.6 | 30.8 | 32.9 | 35.4 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.5 | -0.3 | -0.2 | 0.3 | -0.4 | -0.9 | -0.7 |
| Coal | -0.2 | -0.6 | -3.4 | 0.3 | -1.7 | -0.7 | -2.3 |
| Oil | -0.1 | -2.2 | 0.2 | -1.8 | 0.2 | -0.8 | -0.7 |
| Gas | 10.2 | 0.6 | 2.7 | 4.8 | 0.6 | 0.4 | 0.3 |
| Comb. Renewables & Waste | 6.2 | 2.7 | 5.7 | 3.9 | 4.5 | 1.8 | 0.9 |
| Nuclear | 27.5 | 10.3 | 0.6 | 0.1 | -3.4 | -13.1 | - |
| Hydro | 3.2 | -0.5 | 2.4 | -16.7 | 2.6 | 0.8 | 0.0 |
| Geothermal | - | - | 27.4 | 10.2 | 4.7 | 19.1 | 14.5 |
| Solar/Wind/Other | - | - | 45.6 | 20.3 | 12.8 | 4.5 | 3.4 |
| TFC | 1.2 | -0.6 | -0.2 | 1.9 | 0.2 | -0.3 | -0.4 |
| Electricity Consumption | 3.8 | 1.4 | 0.8 | 2.1 | 0.5 | 0.1 | -0.1 |
| Energy Production | 1.0 | 0.2 | -2.6 | -0.3 | -1.2 | -2.6 | -0.9 |
| Net Oil Imports | 0.2 | -2.5 | 0.1 | 1.3 | 0.1 | -0.7 | -0.6 |
| GDP | 2.4 | 2.2 | 1.7 | -0.1 | 1.5 | 1.6 | 1.3 |
| Growth in the TPES/GDP Ratio | -0.9 | -2.5 | -1.9 | 0.4 | -1.9 | -2.4 | -2.0 |
| Growth in the TFC/GDP Ratio | -1.1 | -2.8 | -1.9 | 2.0 | -1.3 | -1.9 | -1.7 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **2.33** | **9.20** | **10.23** | **9.92** | **11.14** | **..** | **..** |
| Coal[1] | | 1.69 | 7.12 | 8.58 | 8.18 | 8.82 | .. | .. |
| Oil | | - | 0.84 | 0.17 | 0.13 | 0.30 | .. | .. |
| Gas | | - | 0.14 | 0.04 | 0.03 | 0.04 | .. | .. |
| Comb. Renewables & Waste[2] | | 0.45 | 0.89 | 1.03 | 0.98 | 1.14 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.19 | 0.15 | 0.24 | 0.41 | 0.33 | .. | .. |
| Geothermal | | - | 0.00 | 0.00 | 0.00 | 0.11 | .. | .. |
| Solar/Wind/Other[3] | | - | 0.06 | 0.16 | 0.19 | 0.40 | .. | .. |
| **TOTAL NET IMPORTS[4]** | **11.12** | **12.74** | **19.86** | **19.08** | **29.40** | **..** | **..** | |
| Coal[1] | Exports | 0.02 | - | 0.02 | 0.07 | - | .. | .. |
| | Imports | 0.47 | 0.92 | 0.65 | 0.49 | 0.76 | .. | .. |
| | Net Imports | 0.45 | 0.92 | 0.63 | 0.42 | 0.76 | .. | .. |
| Oil | Exports | 4.95 | 7.56 | 4.28 | 6.04 | 6.00 | .. | .. |
| | Imports | 16.51 | 21.87 | 24.64 | 25.72 | 31.22 | .. | .. |
| | Bunkers | 0.89 | 2.55 | 3.13 | 3.20 | 3.60 | .. | .. |
| | Net Imports | 10.67 | 11.76 | 17.23 | 16.48 | 21.62 | .. | .. |
| Gas | Exports | - | - | - | - | - | .. | .. |
| | Imports | - | - | 1.75 | 2.00 | 7.02 | .. | .. |
| | Net Imports | - | - | 1.75 | 2.00 | 7.02 | .. | .. |
| Electricity | Exports | 0.00 | 0.05 | 0.15 | 0.18 | - | .. | .. |
| | Imports | 0.01 | 0.11 | 0.40 | 0.36 | - | .. | .. |
| | Net Imports | 0.00 | 0.06 | 0.25 | 0.18 | - | .. | .. |
| **TOTAL STOCK CHANGES** | | **-1.10** | **0.24** | **-1.07** | **0.89** | **-** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **12.36** | **22.18** | **29.03** | **29.89** | **40.54** | **..** | **..** |
| Coal[1] | | 2.10 | 8.07 | 8.97 | 8.91 | 9.58 | .. | .. |
| Oil | | 9.61 | 12.81 | 16.57 | 17.19 | 21.92 | .. | .. |
| Gas | | - | 0.14 | 1.80 | 2.03 | 7.06 | .. | .. |
| Comb. Renewables & Waste[2] | | 0.45 | 0.89 | 1.03 | 0.98 | 1.14 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.19 | 0.15 | 0.24 | 0.41 | 0.33 | .. | .. |
| Geothermal | | - | 0.00 | 0.00 | 0.00 | 0.11 | .. | .. |
| Solar/Wind/Other[3] | | - | 0.06 | 0.16 | 0.19 | 0.40 | .. | .. |
| Electricity Trade[5] | | 0.00 | 0.06 | 0.25 | 0.18 | - | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *17.0* | *36.4* | *30.9* | *29.8* | *23.6* | .. | .. |
| *Oil* | | *77.7* | *57.8* | *57.1* | *57.5* | *54.1* | .. | .. |
| *Gas* | | - | *0.6* | *6.2* | *6.8* | *17.4* | .. | .. |
| *Comb. Renewables & Waste* | | *3.6* | *4.0* | *3.6* | *3.3* | *2.8* | .. | .. |
| *Nuclear* | | - | - | - | - | - | .. | .. |
| *Hydro* | | *1.5* | *0.7* | *0.8* | *1.4* | *0.8* | .. | .. |
| *Geothermal* | | - | - | - | - | *0.3* | .. | .. |
| *Solar/Wind/Other* | | - | *0.3* | *0.5* | *0.6* | *1.0* | .. | .. |
| *Electricity Trade* | | - | *0.3* | *0.9* | *0.6* | - | .. | .. |

0 is negligible. - is nil, .. is not available
Please note: All forecasts are based on the 2001 submisson.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **9.21** | **15.47** | **20.49** | **21.59** | **29.53** | **..** | **..** |
| Coal[1] | 0.52 | 1.20 | 0.70 | 0.60 | 0.76 | .. | .. |
| Oil | 7.15 | 10.75 | 14.29 | 15.26 | 19.87 | .. | .. |
| Gas | 0.00 | 0.11 | 0.42 | 0.51 | 1.88 | .. | .. |
| Comb. Renewables & Waste[2] | 0.45 | 0.89 | 0.95 | 0.91 | 1.08 | .. | .. |
| Geothermal | - | 0.00 | 0.00 | 0.00 | - | .. | .. |
| Solar/Wind/Other | - | 0.06 | 0.10 | 0.11 | 0.14 | .. | .. |
| Electricity | 1.09 | 2.45 | 4.01 | 4.18 | 5.79 | .. | .. |
| Heat | - | - | 0.03 | 0.02 | 0.03 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.6* | *7.8* | *3.4* | *2.8* | *2.6* | .. | .. |
| *Oil* | *77.6* | *69.5* | *69.7* | *70.7* | *67.3* | .. | .. |
| *Gas* | - | *0.7* | *2.0* | *2.4* | *6.4* | .. | .. |
| *Comb. Renewables & Waste* | *4.9* | *5.8* | *4.6* | *4.2* | *3.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | *0.4* | *0.5* | *0.5* | *0.5* | .. | .. |
| *Electricity* | *11.9* | *15.8* | *19.5* | *19.4* | *19.6* | .. | .. |
| *Heat* | - | - | *0.1* | *0.1* | *0.1* | .. | .. |
| **TOTAL INDUSTRY[6]** | **3.49** | **4.70** | **5.20** | **5.15** | **7.32** | **..** | **..** |
| Coal[1] | 0.46 | 1.18 | 0.69 | 0.60 | 0.72 | .. | .. |
| Oil | 2.39 | 2.18 | 2.67 | 2.69 | 3.54 | .. | .. |
| Gas | - | 0.10 | 0.38 | 0.45 | 0.99 | .. | .. |
| Comb. Renewables & Waste[2] | - | 0.19 | 0.24 | 0.20 | 0.25 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 0.63 | 1.04 | 1.22 | 1.22 | 1.82 | .. | .. |
| Heat | - | - | - | - | - | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *13.1* | *25.0* | *13.3* | *11.6* | *9.8* | .. | .. |
| *Oil* | *68.7* | *46.5* | *51.4* | *52.1* | *48.4* | .. | .. |
| *Gas* | - | *2.2* | *7.3* | *8.8* | *13.5* | .. | .. |
| *Comb. Renewables & Waste* | - | *4.1* | *4.6* | *3.9* | *3.4* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *18.2* | *22.2* | *23.4* | *23.6* | *24.8* | .. | .. |
| *Heat* | - | - | - | - | - | .. | .. |
| **TRANSPORT[7]** | **2.70** | **5.95** | **7.63** | **7.98** | **11.44** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **3.03** | **4.82** | **7.66** | **8.46** | **10.78** | **..** | **..** |
| Coal[1] | 0.04 | 0.03 | 0.01 | 0.01 | 0.04 | .. | .. |
| Oil | 2.08 | 2.63 | 4.02 | 4.63 | 4.98 | .. | .. |
| Gas | 0.00 | 0.01 | 0.03 | 0.05 | 0.86 | .. | .. |
| Comb. Renewables & Waste[2] | 0.45 | 0.70 | 0.71 | 0.71 | 0.83 | .. | .. |
| Geothermal | - | 0.00 | 0.00 | 0.00 | - | .. | .. |
| Solar/Wind/Other | - | 0.06 | 0.10 | 0.11 | 0.14 | .. | .. |
| Electricity | 0.46 | 1.40 | 2.77 | 2.94 | 3.91 | .. | .. |
| Heat | - | - | 0.03 | 0.02 | 0.03 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.4* | *0.5* | *0.1* | *0.1* | *0.3* | .. | .. |
| *Oil* | *68.6* | *54.5* | *52.4* | *54.7* | *46.2* | .. | .. |
| *Gas* | *0.1* | *0.1* | *0.4* | *0.5* | *8.0* | .. | .. |
| *Comb. Renewables & Waste* | *14.9* | *14.6* | *9.3* | *8.4* | *7.7* | .. | .. |
| *Geothermal* | - | *0.1* | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | *1.2* | *1.3* | *1.2* | *1.3* | .. | .. |
| *Electricity* | *15.0* | *29.0* | *36.1* | *34.8* | *36.3* | .. | .. |
| *Heat* | - | - | *0.4* | *0.3* | *0.3* | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **3.34** | **8.90** | **12.07** | **12.57** | **16.77** | .. | .. |
| **OUTPUT (Mtoe)** | **1.27** | **2.99** | **4.64** | **4.98** | **6.72** | .. | .. |
| (TWh gross) | 14.82 | 34.78 | 53.95 | 57.91 | 78.12 | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *35.5* | *72.4* | *64.1* | *60.7* | *43.7* | .. | .. |
| *Oil* | *49.5* | *22.3* | *16.0* | *15.1* | *12.6* | .. | .. |
| *Gas* | - | *0.3* | *13.1* | *13.8* | *34.4* | .. | .. |
| *Comb. Renewables & Waste* | - | - | *0.4* | *0.4* | *0.3* | .. | .. |
| *Nuclear* | - | - | - | - | - | .. | .. |
| *Hydro* | *15.0* | *5.1* | *5.2* | *8.2* | *4.9* | .. | .. |
| *Geothermal* | - | - | - | - | *0.2* | .. | .. |
| *Solar/Wind/Other* | - | *0.0* | *1.2* | *1.8* | *4.0* | .. | .. |
| **TOTAL LOSSES** | **3.14** | **7.00** | **8.69** | **8.81** | **11.00** | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 2.07 | 5.91 | 7.41 | 7.57 | 10.00 | .. | .. |
| Other Transformation | 0.44 | -0.23 | -0.67 | -0.75 | - | .. | .. |
| Own Use and Losses[11] | 0.64 | 1.31 | 1.95 | 1.99 | 1.00 | .. | .. |
| **Statistical Differences** | **0.00** | **-0.28** | **-0.16** | **-0.51** | - | .. | .. |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 68.88 | 90.04 | 122.63 | 128.15 | 168.63 | .. | .. |
| Population (millions) | 9.08 | 10.34 | 10.95 | 10.98 | 11.00 | .. | .. |
| TPES/GDP[12] | 0.18 | 0.25 | 0.24 | 0.23 | 0.24 | .. | .. |
| Energy Production/TPES | 0.19 | 0.41 | 0.35 | 0.33 | 0.27 | .. | .. |
| Per Capita TPES[13] | 1.36 | 2.15 | 2.65 | 2.72 | 3.69 | .. | .. |
| Oil Supply/GDP[12] | 0.14 | 0.14 | 0.14 | 0.13 | 0.13 | .. | .. |
| TFC/GDP[12] | 0.13 | 0.17 | 0.17 | 0.17 | 0.18 | .. | .. |
| Per Capita TFC[13] | 1.01 | 1.50 | 1.87 | 1.97 | 2.68 | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 34.4 | 70.6 | 90.5 | 94.1 | 118.3 | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 4.5 | 10.5 | 12.2 | 12.5 | 13.8 | .. | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 4.4 | 3.0 | 2.3 | 3.0 | 4.4 | .. | .. |
| Coal | 8.7 | 8.0 | 0.9 | -0.8 | 1.0 | .. | .. |
| Oil | 3.5 | 0.7 | 2.2 | 3.8 | 3.5 | .. | .. |
| Gas | - | - | 23.9 | 12.5 | 19.5 | .. | .. |
| Comb. Renewables & Waste | - | 6.4 | 1.2 | -5.2 | 2.2 | .. | .. |
| Nuclear | - | - | - | - | - | .. | .. |
| Hydro | 8.2 | -6.2 | 3.9 | 70.1 | -3.1 | .. | .. |
| Geothermal | - | - | -8.7 | - | 95.2 | .. | .. |
| Solar/Wind/Other | - | - | 8.9 | 22.2 | 11.1 | .. | .. |
| TFC | 4.0 | 2.6 | 2.4 | 5.4 | 4.6 | .. | .. |
| Electricity Consumption | 7.0 | 3.7 | 4.2 | 4.3 | 4.8 | .. | .. |
| Energy Production | 8.3 | 8.5 | 0.9 | -3.1 | 1.7 | .. | .. |
| Net Oil Imports | 2.5 | -0.4 | 3.2 | -4.4 | 4.0 | .. | .. |
| GDP | 3.3 | 0.7 | 2.6 | 4.5 | 4.0 | .. | .. |
| Growth in the TPES/GDP Ratio | 1.1 | 2.3 | -0.3 | -1.5 | 0.4 | .. | .. |
| Growth in the TFC/GDP Ratio | 0.7 | 1.9 | -0.2 | 0.8 | 0.6 | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# HUNGARY

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

| SUPPLY | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **12.70** | **14.33** | **11.20** | **10.41** | **10.25** | **10.00** | **9.36** |
| Coal[1] | | 6.05 | 4.14 | 2.68 | 2.71 | 2.00 | 1.80 | 1.60 |
| Oil | | 2.02 | 2.27 | 1.61 | 1.61 | 1.00 | 0.80 | 0.70 |
| Gas | | 4.03 | 3.81 | 2.36 | 2.29 | 1.80 | 1.40 | 1.00 |
| Comb. Renewables & Waste[2] | | 0.59 | 0.42 | 0.80 | 0.82 | 1.50 | 2.00 | 2.00 |
| Nuclear | | - | 3.58 | 3.65 | 2.89 | 3.83 | 3.83 | 3.83 |
| Hydro | | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Geothermal | | - | 0.09 | 0.09 | 0.09 | 0.10 | 0.15 | 0.20 |
| Solar/Wind/Other[3] | | - | - | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| **TOTAL NET IMPORTS[4]** | | **8.66** | **14.17** | **14.68** | **16.35** | **16.40** | **17.94** | **19.31** |
| Coal[1] | Exports | 0.11 | - | 0.04 | 0.05 | - | - | - |
| | Imports | 1.74 | 1.63 | 0.95 | 1.05 | 0.32 | 0.32 | 0.32 |
| | Net Imports | 1.63 | 1.63 | 0.90 | 1.00 | 0.32 | 0.32 | 0.32 |
| Oil | Exports | 0.92 | 1.52 | 2.58 | 2.51 | 1.50 | 1.50 | 1.50 |
| | Imports | 7.39 | 7.96 | 7.29 | 7.32 | 7.74 | 8.14 | 8.84 |
| | Bunkers | - | - | - | - | - | - | - |
| | Net Imports | 6.48 | 6.44 | 4.71 | 4.81 | 6.24 | 6.64 | 7.34 |
| Gas | Exports | 0.01 | 0.02 | - | - | - | - | - |
| | Imports | 0.17 | 5.19 | 8.70 | 9.94 | 9.68 | 10.66 | 11.45 |
| | Net Imports | 0.15 | 5.17 | 8.70 | 9.94 | 9.68 | 10.66 | 11.45 |
| Electricity | Exports | 0.09 | 0.19 | 0.72 | 0.61 | 0.16 | 0.16 | 0.15 |
| | Imports | 0.49 | 1.14 | 1.08 | 1.21 | 0.31 | 0.47 | 0.35 |
| | Net Imports | 0.40 | 0.96 | 0.37 | 0.60 | 0.16 | 0.31 | 0.20 |
| **TOTAL STOCK CHANGES** | | **-0.02** | **0.06** | **-0.07** | **-0.42** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **21.33** | **28.55** | **25.81** | **26.34** | **26.65** | **27.94** | **28.67** |
| Coal[1] | | 7.91 | 6.12 | 3.62 | 3.75 | 2.32 | 2.12 | 1.92 |
| Oil | | 8.21 | 8.51 | 6.47 | 6.30 | 7.24 | 7.44 | 8.04 |
| Gas | | 4.17 | 8.91 | 10.81 | 11.88 | 11.48 | 12.06 | 12.45 |
| Comb. Renewables & Waste[2] | | 0.64 | 0.38 | 0.80 | 0.82 | 1.50 | 2.00 | 2.00 |
| Nuclear | | - | 3.58 | 3.65 | 2.89 | 3.83 | 3.83 | 3.83 |
| Hydro | | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Geothermal | | - | 0.09 | 0.09 | 0.09 | 0.10 | 0.15 | 0.20 |
| Solar/Wind/Other[3] | | - | - | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| Electricity Trade[5] | | 0.40 | 0.96 | 0.37 | 0.60 | 0.16 | 0.31 | 0.20 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *37.1* | *21.4* | *14.0* | *14.2* | *8.7* | *7.6* | *6.7* |
| *Oil* | | *38.5* | *29.8* | *25.0* | *23.9* | *27.2* | *26.6* | *28.0* |
| *Gas* | | *19.6* | *31.2* | *41.9* | *45.1* | *43.1* | *43.2* | *43.4* |
| *Comb. Renewables & Waste* | | *3.0* | *1.3* | *3.1* | *3.1* | *5.6* | *7.2* | *7.0* |
| *Nuclear* | | - | *12.5* | *14.1* | *11.0* | *14.4* | *13.7* | *13.4* |
| *Hydro* | | - | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* |
| *Geothermal* | | - | *0.3* | *0.3* | *0.3* | *0.4* | *0.5* | *0.7* |
| *Solar/Wind/Other* | | - | - | - | - | - | - | - |
| *Electricity Trade* | | *1.9* | *3.4* | *1.4* | *2.3* | *0.6* | *1.1* | *0.7* |

0 is negligible. - is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **17.14** | **21.02** | **18.47** | **19.00** | **19.88** | **20.22** | **20.66** |
| Coal[1] | 4.17 | 2.68 | 0.68 | 0.66 | 0.72 | 0.52 | 0.52 |
| Oil | 6.71 | 7.41 | 5.76 | 5.72 | 6.00 | 6.20 | 6.80 |
| Gas | 3.08 | 6.20 | 7.19 | 7.73 | 7.73 | 8.11 | 8.30 |
| Comb. Renewables & Waste[2] | 0.62 | 0.34 | 0.74 | 0.75 | 1.00 | 1.40 | 1.40 |
| Geothermal | - | 0.09 | 0.08 | 0.08 | 0.10 | 0.15 | 0.20 |
| Solar/Wind/Other | - | - | 0.00 | 0.00 | - | - | - |
| Electricity | 1.51 | 2.72 | 2.71 | 2.70 | 2.78 | 2.20 | 1.80 |
| Heat | 1.06 | 1.59 | 1.30 | 1.37 | 1.55 | 1.64 | 1.64 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *24.3* | *12.7* | *3.7* | *3.5* | *3.6* | *2.6* | *2.5* |
| *Oil* | *39.1* | *35.2* | *31.2* | *30.1* | *30.2* | *30.7* | *32.9* |
| *Gas* | *17.9* | *29.5* | *39.0* | *40.7* | *38.9* | *40.1* | *40.2* |
| *Comb. Renewables & Waste* | *3.6* | *1.6* | *4.0* | *3.9* | *5.0* | *6.9* | *6.8* |
| *Geothermal* | - | *0.4* | *0.4* | *0.4* | *0.5* | *0.7* | *1.0* |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *8.8* | *12.9* | *14.7* | *14.2* | *14.0* | *10.9* | *8.7* |
| *Heat* | *6.2* | *7.6* | *7.1* | *7.2* | *7.8* | *8.1* | *7.9* |
| **TOTAL INDUSTRY[6]** | **7.90** | **8.08** | **5.11** | **4.85** | **5.33** | **5.06** | **5.10** |
| Coal[1] | 1.87 | 0.80 | 0.41 | 0.38 | 0.52 | 0.32 | 0.32 |
| Oil | 2.34 | 2.11 | 1.55 | 1.42 | 1.38 | 1.27 | 1.41 |
| Gas | 2.29 | 3.76 | 1.78 | 1.69 | 2.01 | 2.11 | 2.11 |
| Comb. Renewables & Waste[2] | 0.02 | 0.00 | 0.03 | 0.05 | 0.20 | 0.20 | 0.20 |
| Geothermal | - | - | - | 0.00 | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 0.92 | 1.18 | 0.88 | 0.82 | 0.82 | 0.74 | 0.63 |
| Heat | 0.46 | 0.23 | 0.46 | 0.48 | 0.40 | 0.43 | 0.43 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *23.6* | *9.9* | *8.1* | *7.9* | *9.8* | *6.3* | *6.3* |
| *Oil* | *29.6* | *26.1* | *30.4* | *29.4* | *26.0* | *25.2* | *27.7* |
| *Gas* | *29.0* | *46.5* | *34.8* | *34.8* | *37.6* | *41.6* | *41.4* |
| *Comb. Renewables & Waste* | *0.2* | - | *0.6* | *1.1* | *3.8* | *4.0* | *3.9* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *11.7* | *14.6* | *17.3* | *17.0* | *15.4* | *14.5* | *12.4* |
| *Heat* | *5.9* | *2.8* | *8.9* | *9.9* | *7.5* | *8.4* | *8.4* |
| **TRANSPORT[7]** | **2.37** | **3.15** | **3.66** | **3.82** | **4.05** | **4.51** | **4.94** |
| **TOTAL OTHER SECTORS[8]** | **6.88** | **9.79** | **9.69** | **10.33** | **10.50** | **10.65** | **10.61** |
| Coal[1] | 1.93 | 1.88 | 0.26 | 0.27 | 0.20 | 0.20 | 0.20 |
| Oil | 2.45 | 2.25 | 0.65 | 0.57 | 0.65 | 0.49 | 0.50 |
| Gas | 0.78 | 2.44 | 5.41 | 6.04 | 5.72 | 6.01 | 6.19 |
| Comb. Renewables & Waste[2] | 0.60 | 0.34 | 0.71 | 0.69 | 0.80 | 1.20 | 1.20 |
| Geothermal | - | 0.09 | 0.08 | 0.08 | 0.10 | 0.15 | 0.20 |
| Solar/Wind/Other | - | - | 0.00 | 0.00 | - | - | - |
| Electricity | 0.52 | 1.43 | 1.74 | 1.79 | 1.88 | 1.40 | 1.11 |
| Heat | 0.60 | 1.36 | 0.85 | 0.89 | 1.15 | 1.21 | 1.21 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *28.1* | *19.2* | *2.7* | *2.6* | *1.9* | *1.9* | *1.9* |
| *Oil* | *35.7* | *22.9* | *6.7* | *5.5* | *6.2* | *4.6* | *4.7* |
| *Gas* | *11.4* | *25.0* | *55.8* | *58.5* | *54.5* | *56.4* | *58.3* |
| *Comb. Renewables & Waste* | *8.7* | *3.4* | *7.3* | *6.7* | *7.6* | *11.3* | *11.3* |
| *Geothermal* | - | *0.9* | *0.8* | *0.8* | *1.0* | *1.4* | *1.9* |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *7.5* | *14.6* | *17.9* | *17.3* | *17.9* | *13.1* | *10.5* |
| *Heat* | *8.7* | *13.9* | *8.7* | *8.6* | *11.0* | *11.4* | *11.4* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| ELECTRICITY GENERATION[9] | | | | | | | |
| **INPUT (Mtoe)** | **6.37** | **10.23** | **10.09** | **9.77** | **10.55** | **11.05** | **11.05** |
| **OUTPUT (Mtoe)** | **1.52** | **2.45** | **3.11** | **2.94** | **3.32** | **3.38** | **3.42** |
| (TWh gross) | 17.64 | 28.44 | 36.16 | 34.15 | 38.65 | 39.26 | 39.78 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *66.0* | *30.5* | *25.1* | *27.1* | *14.2* | *11.5* | *8.8* |
| *Oil* | *17.2* | *4.8* | *5.9* | *4.8* | *10.3* | *8.9* | *8.8* |
| *Gas* | *16.2* | *15.7* | *29.7* | *34.8* | *36.2* | *40.8* | *44.0* |
| *Comb. Renewables & Waste* | - | *0.1* | *0.2* | *0.6* | *1.0* | *1.2* | *1.2* |
| *Nuclear* | - | *48.3* | *38.6* | *32.3* | *37.5* | *36.9* | *36.4* |
| *Hydro* | *0.6* | *0.6* | *0.5* | *0.5* | *0.5* | *0.5* | *0.5* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | *0.0* | *0.0* | *0.2* | *0.2* | *0.3* |
| **TOTAL LOSSES** | **4.87** | **7.99** | **7.29** | **7.17** | **6.77** | **7.72** | **8.01** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 3.67 | 6.03 | 5.50 | 5.30 | 5.58 | 5.98 | 5.92 |
| Other Transformation | 0.21 | -0.05 | 0.04 | 0.08 | -0.22 | -0.42 | -0.41 |
| Own Use and Losses[11] | 0.99 | 2.02 | 1.74 | 1.78 | 1.41 | 2.16 | 2.50 |
| **Statistical Differences -** | **0.68** | **-0.45** | **0.06** | **0.18** | **-** | **-** | **-** |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 30.13 | 43.22 | 50.17 | 51.70 | 65.78 | 102.16 | 158.65 |
| Population (millions) | 10.43 | 10.37 | 10.16 | 10.13 | 10.06 | 9.86 | 9.54 |
| TPES/GDP[12] | 0.71 | 0.66 | 0.51 | 0.51 | 0.41 | 0.27 | 0.18 |
| Energy Production/TPES | 0.60 | 0.50 | 0.43 | 0.40 | 0.38 | 0.36 | 0.33 |
| Per Capita TPES[13] | 2.05 | 2.75 | 2.54 | 2.60 | 2.65 | 2.83 | 3.01 |
| Oil Supply/GDP[12] | 0.27 | 0.20 | 0.13 | 0.12 | 0.11 | 0.07 | 0.05 |
| TFC/GDP[12] | 0.57 | 0.49 | 0.37 | 0.37 | 0.30 | 0.20 | 0.13 |
| Per Capita TFC[13] | 1.64 | 2.03 | 1.82 | 1.88 | 1.98 | 2.05 | 2.17 |
| Energy-related $CO_2$ Emissions (Mt CO2)[14] | 68.5 | 70.6 | 55.7 | 57.7 | 53.3 | 54.3 | 55.9 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.2 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 4.9 | 0.1 | -0.8 | 2.0 | 0.2 | 0.5 | 0.3 |
| Coal | 1.2 | -3.0 | -4.3 | 3.5 | -6.6 | -0.9 | -1.0 |
| Oil | 5.6 | -2.6 | -2.3 | -2.5 | 2.0 | 0.3 | 0.8 |
| Gas | 10.0 | 1.7 | 1.6 | 10.0 | -0.5 | 0.5 | 0.3 |
| Comb. Renewables & Waste | -2.6 | -3.3 | 6.4 | 3.4 | 9.0 | 2.9 | - |
| Nuclear | - | - | 0.2 | -21.0 | 4.1 | - | - |
| Hydro | 6.3 | 1.3 | 1.0 | -11.8 | 0.9 | - | - |
| Geothermal | - | - | - | - | 2.2 | 4.1 | 2.9 |
| Solar/Wind/Other | - | - | - | - | 17.0 | 2.9 | 2.3 |
| TFC | 4.5 | -0.5 | -1.1 | 2.9 | 0.7 | 0.2 | 0.2 |
| Electricity Consumption | 6.0 | 2.2 | -0.0 | -0.3 | 0.4 | -2.3 | -2.0 |
| Energy Production | 2.4 | -0.2 | -2.0 | -7.0 | -0.2 | -0.2 | -0.7 |
| Net Oil Imports | 7.1 | -3.8 | -2.6 | 2.2 | 3.8 | 0.6 | 1.0 |
| GDP | 4.3 | 1.0 | 1.3 | 3.0 | 3.5 | 4.5 | 4.5 |
| Growth in the TPES/GDP Ratio | 0.6 | -0.9 | -2.1 | -1.0 | -3.2 | -3.9 | -4.1 |
| Growth in the TFC/GDP Ratio | 0.2 | -1.5 | -2.3 | -0.2 | -2.7 | -4.1 | -4.1 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# IRELAND

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **1.120** | **3.467** | **1.574** | **1.896** | **2.967** | **..** | **..** |
| Coal[1] | | 0.045 | 0.016 | - | - | - | .. | .. |
| Peat | | 1.020 | 1.411 | 0.609 | 1.092 | 0.940 | .. | .. |
| Oil | | - | - | - | - | - | .. | .. |
| Gas | | - | 1.872 | 0.677 | 0.544 | 1.549 | .. | .. |
| Comb. Renewables & Waste[2] | | - | 0.108 | 0.176 | 0.170 | 0.205 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.055 | 0.060 | 0.078 | 0.051 | 0.070 | .. | .. |
| Geothermal | | - | - | - | - | - | .. | .. |
| Solar/Wind/Other[3] | | - | - | 0.034 | 0.039 | 0.203 | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **5.901** | **7.134** | **13.634** | **13.437** | **13.795** | **..** | **..** |
| Coal[1] | Exports | 0.073 | 0.022 | 0.018 | 0.018 | 0.009 | .. | .. |
| | Imports | 0.578 | 2.066 | 1.781 | 1.682 | 0.967 | .. | .. |
| | Net Imports | 0.505 | 2.044 | 1.763 | 1.664 | 0.958 | .. | .. |
| Peat | Exports | - | - | - | - | 0.010 | .. | .. |
| | Imports | - | - | - | - | - | .. | .. |
| | Net Imports | - | - | - | - | -0.010 | .. | .. |
| Oil | Exports | 0.472 | 0.680 | 1.470 | 1.592 | 1.347 | .. | .. |
| | Imports | 5.956 | 5.788 | 10.447 | 10.305 | 9.859 | .. | .. |
| | Bunkers | 0.092 | 0.018 | 0.150 | 0.172 | 0.084 | .. | .. |
| | Net Imports | 5.392 | 5.090 | 8.827 | 8.541 | 8.428 | .. | .. |
| Gas | Exports | - | - | - | - | - | .. | .. |
| | Imports | - | - | 3.000 | 3.133 | 4.354 | .. | .. |
| | Net Imports | - | - | 3.000 | 3.133 | 4.354 | .. | .. |
| Electricity | Exports | 0.002 | - | 0.005 | 0.001 | 0.025 | .. | .. |
| | Imports | 0.006 | - | 0.049 | 0.101 | 0.090 | .. | .. |
| | Net Imports | 0.004 | - | 0.044 | 0.100 | 0.065 | .. | .. |
| **TOTAL STOCK CHANGES** | | **0.168** | **-0.176** | **0.107** | **-0.241** | **-** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **7.189** | **10.424** | **15.315** | **15.092** | **16.762** | **..** | **..** |
| Coal[1] | | 0.565 | 2.139 | 1.713 | 1.720 | 0.958 | .. | .. |
| Peat | | 1.020 | 1.374 | 0.895 | 0.870 | 0.930 | .. | .. |
| Oil | | 5.545 | 4.871 | 8.699 | 8.490 | 8.428 | .. | .. |
| Gas | | - | 1.872 | 3.678 | 3.652 | 5.903 | .. | .. |
| Comb. Renewables & Waste[2] | | - | 0.108 | 0.176 | 0.170 | 0.205 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.055 | 0.060 | 0.078 | 0.051 | 0.070 | .. | .. |
| Geothermal | | - | - | - | - | - | .. | .. |
| Solar/Wind/Other[3] | | - | - | 0.034 | 0.039 | 0.203 | .. | .. |
| Electricity Trade[5] | | 0.004 | - | 0.043 | 0.100 | 0.065 | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *7.9* | *20.5* | *11.2* | *11.4* | *5.7* | .. | .. |
| *Peat* | | *14.2* | *13.2* | *5.8* | *5.8* | *5.5* | .. | .. |
| *Oil* | | *77.1* | *46.7* | *56.8* | *56.3* | *50.3* | .. | .. |
| *Gas* | | - | *18.0* | *24.0* | *24.2* | *35.2* | .. | .. |
| *Comb. Renewables & Waste* | | - | *1.0* | *1.1* | *1.1* | *1.2* | .. | .. |
| *Nuclear* | | - | - | - | - | - | .. | .. |
| *Hydro* | | *0.8* | *0.6* | *0.5* | *0.3* | *0.4* | .. | .. |
| *Geothermal* | | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | | - | - | *0.2* | *0.3* | *1.2* | .. | .. |
| *Electricity Trade* | | *0.1* | - | *0.3* | *0.7* | *0.4* | .. | .. |

0 is negligible. - is nil, .. is not available
Please note: All forecasts are based on the 2003 submission.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **5.416** | **7.676** | **11.817** | **11.671** | **13.033** | **..** | **..** |
| Coal[1] | 0.520 | 1.053 | 0.406 | 0.397 | 0.226 | .. | .. |
| Peat | 0.408 | 0.348 | 0.106 | 0.105 | 0.135 | .. | .. |
| Oil | 3.856 | 4.149 | 7.723 | 7.799 | 8.232 | .. | .. |
| Gas | 0.103 | 0.998 | 1.548 | 1.277 | 2.009 | .. | .. |
| Comb. Renewables & Waste[2] | - | 0.108 | 0.156 | 0.152 | 0.151 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 0.529 | 1.021 | 1.877 | 1.938 | 2.280 | .. | .. |
| Heat | - | - | 0.001 | 0.003 | - | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *9.6* | *13.7* | *3.4* | *3.4* | *1.7* | .. | .. |
| *Peat* | *7.5* | *4.5* | *0.9* | *0.9* | *1.0* | .. | .. |
| *Oil* | *71.2* | *54.1* | *65.4* | *66.8* | *63.2* | .. | .. |
| *Gas* | *1.9* | *13.0* | *13.1* | *10.9* | *15.4* | .. | .. |
| *Comb. Renewables & Waste* | - | *1.4* | *1.3* | *1.3* | *1.2* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *9.8* | *13.3* | *15.9* | *16.6* | *17.5* | .. | .. |
| *Heat* | - | - | - | - | - | .. | .. |
| **TOTAL INDUSTRY[6]** | **1.920** | **2.370** | **2.835** | **2.387** | **2.407** | **..** | **..** |
| Coal[1] | 0.044 | 0.255 | 0.043 | 0.041 | 0.062 | .. | .. |
| Peat | - | - | - | - | - | .. | .. |
| Oil | 1.662 | 0.879 | 1.199 | 1.193 | 0.896 | .. | .. |
| Gas | 0.025 | 0.787 | 0.783 | 0.437 | 0.527 | .. | .. |
| Comb. Renewables & Waste[2] | - | 0.063 | 0.113 | 0.106 | 0.109 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 0.189 | 0.386 | 0.697 | 0.610 | 0.813 | .. | .. |
| Heat | - | - | - | - | - | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.3* | *10.8* | *1.5* | *1.7* | *2.6* | .. | .. |
| *Peat* | - | - | - | - | - | .. | .. |
| *Oil* | *86.6* | *37.1* | *42.3* | *50.0* | *37.2* | .. | .. |
| *Gas* | *1.3* | *33.2* | *27.6* | *18.3* | *21.9* | .. | .. |
| *Comb. Renewables & Waste* | - | *2.7* | *4.0* | *4.4* | *4.5* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *9.8* | *16.3* | *24.6* | *25.6* | *33.8* | .. | .. |
| *Heat* | - | - | - | - | - | .. | .. |
| **TRANSPORT[7]** | **1.406** | **2.031** | **4.491** | **4.532** | **5.134** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **2.090** | **3.275** | **4.491** | **4.751** | **5.492** | **..** | **..** |
| Coal[1] | 0.476 | 0.798 | 0.363 | 0.356 | 0.164 | .. | .. |
| Peat | 0.408 | 0.348 | 0.106 | 0.105 | 0.135 | .. | .. |
| Oil | 0.788 | 1.240 | 2.036 | 2.075 | 2.204 | .. | .. |
| Gas | 0.078 | 0.211 | 0.765 | 0.840 | 1.482 | .. | .. |
| Comb. Renewables & Waste[2] | - | 0.045 | 0.043 | 0.046 | 0.042 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 0.340 | 0.634 | 1.177 | 1.326 | 1.465 | .. | .. |
| Heat | - | - | 0.001 | 0.003 | - | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *22.8* | *24.4* | *8.1* | *7.5* | *3.0* | .. | .. |
| *Peat* | *19.5* | *10.6* | *2.4* | *2.2* | *2.5* | .. | .. |
| *Oil* | *37.7* | *37.9* | *45.3* | *43.7* | *40.1* | .. | .. |
| *Gas* | *3.7* | *6.4* | *17.0* | *17.7* | *27.0* | .. | .. |
| *Comb. Renewables & Waste* | - | *1.4* | *1.0* | *1.0* | *0.8* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *16.3* | *19.4* | *26.2* | *27.9* | *26.7* | .. | .. |
| *Heat* - | - | - | *0.1* | - | .. | .. | |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **1.766** | **3.167** | **5.162** | **4.882** | **5.768** | .. | .. |
| **OUTPUT (Mtoe)** | **0.632** | **1.224** | **2.136** | **2.139** | **2.583** | .. | .. |
| (TWh gross) | 7.348 | 14.229 | 24.843 | 24.877 | 30.034 | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *1.0* | *41.6* | *27.4* | *24.9* | *15.3* | .. | .. |
| *Peat* | *23.9* | *15.8* | *8.4* | *8.2* | *6.9* | .. | .. |
| *Oil* | *66.3* | *10.0* | *15.0* | *9.9* | *1.4* | .. | .. |
| *Gas* | - | *27.7* | *43.6* | *52.5* | *65.3* | .. | .. |
| *Comb. Renewables & Waste* | - | - | *0.3* | *0.3* | *0.6* | .. | .. |
| *Nuclear* | - | - | - | - | - | .. | .. |
| *Hydro* | *8.8* | *4.9* | *3.7* | *2.4* | *2.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | *1.6* | *1.8* | *7.9* | .. | .. |
| **TOTAL LOSSES** | **1.649** | **2.273** | **3.580** | **3.353** | **3.729** | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 1.134 | 1.943 | 3.026 | 2.742 | 3.185 | .. | .. |
| Other Transformation | 0.329 | 0.021 | 0.057 | 0.105 | - | .. | .. |
| Own Use and Losses[11] | 0.186 | 0.309 | 0.497 | 0.506 | 0.544 | .. | .. |
| **Statistical Differences** | **0.12** | **0.48** | **-0.08** | **0.07** | - | - | - |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 24.15 | 47.45 | 106.84 | 110.74 | 159.17 | .. | .. |
| Population (millions) | 3.07 | 3.51 | 3.93 | 3.99 | 4.17 | .. | .. |
| TPES/GDP[12] | 0.30 | 0.22 | 0.14 | 0.14 | 0.11 | .. | .. |
| Energy Production/TPES | 0.16 | 0.33 | 0.10 | 0.13 | 0.18 | .. | .. |
| Per Capita TPES[13] | 2.34 | 2.97 | 3.90 | 3.78 | 4.02 | .. | .. |
| Oil Supply/GDP[12] | 0.23 | 0.10 | 0.08 | 0.08 | 0.05 | .. | .. |
| TFC/GDP[12] | 0.22 | 0.16 | 0.11 | 0.11 | 0.08 | .. | .. |
| Per Capita TFC[13] | 1.76 | 2.19 | 3.01 | 2.92 | 3.13 | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 21.0 | 29.8 | 42.4 | 41.0 | 44.4 | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 1.1 | 1.1 | 2.8 | 2.8 | 2.5 | .. | .. |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | 3.6 | 1.5 | 3.3 | -1.5 | 1.5 | .. | .. |
| Coal | 6.9 | 8.8 | -1.8 | 0.4 | -8.0 | .. | .. |
| Peat | 2.1 | 1.6 | -3.5 | -2.8 | 1.0 | .. | .. |
| Oil | 2.3 | -2.4 | 5.0 | -2.4 | -0.1 | .. | .. |
| Gas | - | 13.6 | 5.8 | -0.7 | 7.1 | .. | .. |
| Comb. Renewables & Waste | - | - | 4.2 | -3.4 | 2.7 | .. | .. |
| Nuclear | - | - | - | - | - | .. | .. |
| Hydro | 4.3 | -1.5 | 2.2 | -34.6 | 4.6 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | 14.7 | 26.6 | .. | .. |
| TFC | 4.3 | 0.9 | 3.7 | -1.2 | 1.6 | .. | .. |
| Electricity Consumption | 5.8 | 2.9 | 5.2 | 3.2 | 2.3 | .. | .. |
| Energy Production | 4.6 | 8.1 | -6.4 | 20.5 | 6.6 | .. | .. |
| Net Oil Imports | 2.9 | -2.0 | 4.7 | -3.2 | -0.2 | .. | .. |
| GDP | 4.9 | 3.6 | 7.0 | 3.7 | 5.3 | .. | .. |
| Growth in the TPES/GDP Ratio | -1.3 | -2.0 | -3.5 | -4.9 | -3.6 | .. | .. |
| Growth in the TFC/GDP Ratio | -0.6 | -2.6 | -3.1 | -4.7 | -3.5 | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **20.5** | **25.3** | **27.5** | **27.7** | **30.6** | **35.1** | **38.9** |
| Coal[1] | | 0.3 | 0.3 | 0.1 | 0.2 | 1.0 | 1.0 | 1.0 |
| Oil | | 1.1 | 4.5 | 5.7 | 5.8 | 5.7 | 4.9 | 4.8 |
| Gas | | 12.6 | 14.0 | 12.0 | 11.4 | 8.0 | 7.0 | 7.0 |
| Comb. Renewables & Waste[2] | | 0.2 | 0.8 | 1.9 | 2.4 | 5.4 | 7.6 | 9.3 |
| Nuclear | | 0.8 | - | - | - | - | - | - |
| Hydro | | 3.2 | 2.7 | 3.4 | 2.9 | 4.0 | 4.5 | 4.6 |
| Geothermal | | 2.1 | 3.0 | 4.2 | 4.8 | 6.0 | 9.1 | 9.2 |
| Solar/Wind/Other[3] | | - | 0.0 | 0.2 | 0.2 | 0.5 | 1.0 | 3.0 |
| **TOTAL NET IMPORTS[4]** | | **109.3** | **124.5** | **149.0** | **151.1** | **164.5** | **196.3** | **215.4** |
| Coal[1] | Exports | 0.4 | 0.1 | 0.1 | 0.1 | - | - | - |
| | Imports | 8.2 | 13.9 | 13.2 | 14.6 | 13.4 | 13.3 | 13.3 |
| | Net Imports | 7.7 | 13.7 | 13.1 | 14.5 | 13.4 | 13.3 | 13.3 |
| Oil | Exports | 29.4 | 19.9 | 22.1 | 24.5 | 24.0 | 25.0 | 24.0 |
| | Imports | 136.4 | 105.0 | 107.6 | 108.4 | 103.6 | 114.0 | 120.0 |
| | Bunkers | 7.1 | 2.7 | 3.0 | 3.2 | 3.0 | 3.5 | 4.0 |
| | Net Imports | 99.9 | 82.4 | 82.5 | 80.7 | 76.6 | 85.5 | 92.0 |
| Gas | Exports | - | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| | Imports | 1.6 | 25.3 | 48.5 | 50.9 | 67.6 | 90.5 | 103.1 |
| | Net Imports | 1.6 | 25.3 | 48.5 | 50.8 | 67.5 | 90.4 | 103.0 |
| Electricity | Exports | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| | Imports | 0.3 | 3.1 | 4.4 | 4.4 | 6.5 | 6.5 | 6.5 |
| | Net Imports | 0.1 | 3.0 | 4.4 | 4.4 | 6.4 | 6.4 | 6.4 |
| **TOTAL STOCK CHANGES** | | **-0.9** | **-1.8** | **-3.0** | **2.2** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **128.9** | **148.0** | **173.6** | **181.0** | **195.2** | **231.3** | **254.3** |
| Coal[1] | | 8.1 | 14.6 | 13.7 | 14.9 | 14.4 | 14.3 | 14.3 |
| Oil | | 100.1 | 84.8 | 87.5 | 87.4 | 82.3 | 90.4 | 96.8 |
| Gas | | 14.2 | 39.0 | 57.7 | 63.3 | 75.5 | 97.4 | 110.0 |
| Comb. Renewables & Waste[2] | | 0.2 | 0.9 | 2.5 | 3.1 | 6.1 | 8.2 | 10.0 |
| Nuclear | | 0.8 | - | - | - | - | - | - |
| Hydro | | 3.2 | 2.7 | 3.4 | 2.9 | 4.0 | 4.5 | 4.6 |
| Geothermal | | 2.1 | 3.0 | 4.2 | 4.8 | 6.0 | 9.1 | 9.2 |
| Solar/Wind/Other[3] | | - | 0.0 | 0.2 | 0.2 | 0.5 | 1.0 | 3.0 |
| Electricity Trade[5] | | 0.1 | 3.0 | 4.4 | 4.4 | 6.4 | 6.4 | 6.4 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *6.3* | *9.9* | *7.9* | *8.2* | *7.4* | *6.2* | *5.6* |
| *Oil* | | *77.6* | *57.3* | *50.4* | *48.3* | *42.1* | *39.1* | *38.1* |
| *Gas* | | *11.0* | *26.3* | *33.2* | *35.0* | *38.7* | *42.1* | *43.3* |
| *Comb. Renewables & Waste* | | *0.2* | *0.6* | *1.4* | *1.7* | *3.1* | *3.5* | *3.9* |
| *Nuclear* | | *0.6* | *-* | *-* | *-* | *-* | *-* | *-* |
| *Hydro* | | *2.5* | *1.8* | *2.0* | *1.6* | *2.1* | *2.0* | *1.8* |
| *Geothermal* | | *1.7* | *2.0* | *2.4* | *2.7* | *3.1* | *3.9* | *3.6* |
| *Solar/Wind/Other* | | *-* | *-* | *0.1* | *0.1* | *0.3* | *0.4* | *1.2* |
| *Electricity Trade* | | *0.1* | *2.0* | *2.5* | *2.4* | *3.3* | *2.8* | *2.5* |

0 is negligible. - is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **98.7** | **117.6** | **133.8** | **139.2** | **154.4** | **182.2** | **202.8** |
| Coal[1] | 3.3 | 3.4 | 2.3 | 2.9 | 2.3 | 1.7 | 1.5 |
| Oil | 72.1 | 64.2 | 66.6 | 67.9 | 73.1 | 83.5 | 91.3 |
| Gas | 12.8 | 30.6 | 38.7 | 41.6 | 46.7 | 54.6 | 60.8 |
| Comb. Renewables & Waste[2] | - | 0.9 | 1.7 | 1.6 | 2.8 | 3.4 | 4.5 |
| Geothermal | - | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.6 |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.0 |
| Electricity | 10.6 | 18.5 | 24.3 | 25.1 | 29.1 | 38.3 | 43.2 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.3* | *2.9* | *1.7* | *2.0* | *1.5* | *0.9* | *0.7* |
| *Oil* | *73.0* | *54.5* | *49.7* | *48.8* | *47.3* | *45.8* | *45.0* |
| *Gas* | *12.9* | *26.0* | *29.0* | *29.9* | *30.2* | *30.0* | *30.0* |
| *Comb. Renewables & Waste* | - | *0.7* | *1.3* | *1.1* | *1.8* | *1.8* | *2.2* |
| *Geothermal* | - | *0.2* | *0.2* | *0.2* | *0.3* | *0.3* | *0.3* |
| *Solar/Wind/Other* | - | - | - | - | *0.1* | *0.1* | *0.5* |
| *Electricity* | *10.7* | *15.7* | *18.2* | *18.0* | *18.8* | *21.0* | *21.3* |
| *Heat* | - | - | - | - | - | - | - |
| **TOTAL INDUSTRY[6]** | **47.6** | **44.6** | **47.0** | **48.5** | **53.0** | **59.4** | **65.0** |
| Coal[1] | 2.6 | 3.3 | 2.3 | 2.8 | 2.3 | 1.7 | 1.5 |
| Oil | 29.7 | 16.9 | 14.6 | 15.2 | 16.4 | 17.0 | 18.3 |
| Gas | 8.7 | 14.6 | 17.5 | 17.8 | 20.5 | 23.8 | 25.2 |
| Comb. Renewables & Waste[2] | - | 0.2 | 0.3 | 0.3 | 0.5 | 0.6 | 1.0 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 6.6 | 9.5 | 12.3 | 12.4 | 13.3 | 16.3 | 19.0 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.6* | *7.3* | *4.8* | *5.8* | *4.3* | *2.9* | *2.2* |
| *Oil* | *62.3* | *37.9* | *31.1* | *31.3* | *31.0* | *28.6* | *28.2* |
| *Gas* | *18.2* | *32.9* | *37.3* | *36.7* | *38.6* | *40.1* | *38.8* |
| *Comb. Renewables & Waste* | - | *0.5* | *0.6* | *0.6* | *0.9* | *1.0* | *1.5* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *13.9* | *21.4* | *26.2* | *25.6* | *25.1* | *27.4* | *29.3* |
| *Heat* | - | - | - | - | - | - | - |
| **TRANSPORT[7]** | **20.5** | **35.3** | **43.5** | **44.1** | **49.2** | **60.3** | **68.7** |
| **TOTAL OTHER SECTORS[8]** | **30.6** | **37.8** | **43.4** | **46.6** | **52.3** | **62.5** | **69.2** |
| Coal[1] | 0.5 | 0.1 | 0.0 | 0.0 | - | - | - |
| Oil | 22.5 | 12.8 | 9.6 | 9.8 | 9.7 | 9.3 | 9.0 |
| Gas | 4.0 | 15.7 | 20.9 | 23.5 | 25.7 | 29.9 | 33.6 |
| Comb. Renewables & Waste[2] | - | 0.6 | 1.4 | 1.3 | 1.5 | 1.8 | 2.0 |
| Geothermal | - | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.6 |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.0 |
| Electricity | 3.6 | 8.3 | 11.2 | 11.8 | 14.9 | 20.8 | 23.0 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.5* | *0.3* | - | - | - | - | - |
| *Oil* | *73.5* | *33.8* | *22.2* | *21.0* | *18.6* | *14.9* | *13.0* |
| *Gas* | *13.1* | *41.6* | *48.2* | *50.4* | *49.1* | *47.9* | *48.6* |
| *Comb. Renewables & Waste* | - | *1.7* | *3.2* | *2.7* | *2.8* | *2.8* | *2.8* |
| *Geothermal* | - | *0.5* | *0.5* | *0.5* | *0.9* | *0.8* | *0.9* |
| *Solar/Wind/Other* | - | - | - | - | *0.2* | *0.3* | *1.4* |
| *Electricity* | *11.8* | *22.1* | *25.9* | *25.4* | *28.5* | *33.3* | *33.3* |
| *Heat* | - | - | - | - | - | - | - |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **28.0** | **43.1** | **53.7** | **56.7** | **56.6** | **74.8** | **83.0** |
| **OUTPUT (Mtoe)** | **12.4** | **18.3** | **23.9** | **24.4** | **26.9** | **37.1** | **42.0** |
| (TWh gross) | 143.9 | 213.1 | 277.5 | 283.4 | 313.0 | 431.0 | 488.6 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *3.6* | *16.8* | *14.6* | *15.6* | *17.9* | *14.3* | *12.9* |
| *Oil* | *62.4* | *48.2* | *31.6* | *26.8* | *6.4* | *2.9* | *2.5* |
| *Gas* | *3.1* | *18.6* | *35.8* | *41.4* | *53.4* | *61.9* | *62.6* |
| *Comb. Renewables & Waste* | *0.9* | *0.0* | *1.3* | *1.6* | *3.7* | *4.2* | *4.3* |
| *Nuclear* | *2.2* | - | - | - | - | - | - |
| *Hydro* | *26.1* | *14.8* | *14.2* | *11.9* | *15.0* | *12.2* | *11.0* |
| *Geothermal* | *1.7* | *1.5* | *1.7* | *1.9* | *2.0* | *2.3* | *2.0* |
| *Solar/Wind/Other* | - | *0.0* | *0.8* | *0.8* | *1.6* | *2.1* | *4.8* |
| **TOTAL LOSSES** | **29.9** | **30.4** | **40.0** | **41.8** | **40.8** | **49.2** | **51.5** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 15.6 | 24.8 | 29.8 | 32.3 | 29.7 | 37.7 | 41.0 |
| Other Transformation | 6.0 | -3.5 | 0.3 | -0.1 | -0.4 | -0.5 | -0.9 |
| Own Use and Losses[11] | 8.3 | 9.1 | 9.9 | 9.6 | 11.4 | 11.9 | 11.4 |
| **Statistical Differences** | **0.3** | **-0.0** | **-0.3** | **0.1** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 576.33 | 917.51 | 1097.66 | 1100.48 | 1238.31 | 1509.49 | 1932.28 |
| Population (millions) | 54.75 | 56.72 | 57.99 | 58.10 | 58.50 | 58.00 | 57.00 |
| TPES/GDP[12] | 0.22 | 0.16 | 0.16 | 0.16 | 0.16 | 0.15 | 0.13 |
| Energy Production/TPES | 0.16 | 0.17 | 0.16 | 0.15 | 0.16 | 0.15 | 0.15 |
| Per Capita TPES[13] | 2.35 | 2.61 | 2.99 | 3.12 | 3.34 | 3.99 | 4.46 |
| Oil Supply/GDP[12] | 0.17 | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 | 0.05 |
| TFC/GDP[12] | 0.17 | 0.13 | 0.12 | 0.13 | 0.12 | 0.12 | 0.10 |
| Per Capita TFC[13] | 1.80 | 2.07 | 2.31 | 2.40 | 2.64 | 3.14 | 3.56 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 334.4 | 400.1 | 434.8 | 453.4 | 463.5 | 538.0 | 587.2 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 26.3 | 15.0 | 19.2 | 21.2 | 20.5 | 22.0 | 23.6 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 0.5 | 1.0 | 1.3 | 4.3 | 1.1 | 1.7 | 1.0 |
| Coal | 4.3 | 3.1 | -0.5 | 8.3 | -0.5 | -0.1 | - |
| Oil | -1.5 | -0.7 | 0.3 | -0.1 | -0.9 | 0.9 | 0.7 |
| Gas | 8.1 | 5.1 | 3.3 | 9.8 | 2.5 | 2.6 | 1.2 |
| Comb. Renewables & Waste | 23.4 | 0.8 | 8.5 | 23.1 | 10.1 | 3.1 | 2.0 |
| Nuclear | -2.9 | - | - | - | - | - | - |
| Hydro | 3.4 | -3.3 | 1.9 | -14.5 | 4.8 | 1.1 | 0.2 |
| Geothermal | 0.1 | 3.0 | 3.0 | 13.8 | 3.1 | 4.3 | 0.1 |
| Solar/Wind/Other | - | - | 35.9 | 7.0 | 13.9 | 6.5 | 11.7 |
| TFC | 1.3 | 0.9 | 1.1 | 4.0 | 1.5 | 1.7 | 1.1 |
| Electricity Consumption | 4.0 | 3.0 | 2.3 | 3.1 | 2.2 | 2.8 | 1.2 |
| Energy Production | 0.1 | 1.9 | 0.7 | 0.5 | 1.5 | 1.4 | 1.0 |
| Net Oil Imports | -1.8 | -0.7 | 0.0 | -2.1 | -0.8 | 1.1 | 0.7 |
| GDP | 3.5 | 2.4 | 1.5 | 0.3 | 1.7 | 2.0 | 2.5 |
| Growth in the TPES/GDP Ratio | -2.9 | -1.3 | -0.2 | 4.0 | -0.6 | -0.3 | -1.5 |
| Growth in the TFC/GDP Ratio | -2.1 | -1.5 | -0.4 | 3.8 | -0.2 | -0.3 | -1.4 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

| SUPPLY | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **29.4** | **75.7** | **97.7** | **84.6** | **135.1** | **..** | **149.3** |
| Coal[1] | | 17.9 | 4.5 | - | - | - | - | - |
| Oil | | 0.7 | 0.5 | 0.6 | 0.7 | .. | .. | .. |
| Gas | | 2.3 | 1.9 | 2.4 | 2.5 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | - | 5.7 | 6.7 | 6.9 | 22.2 | .. | 25.0 |
| Nuclear | | 2.5 | 52.7 | 76.9 | 62.5 | 100.9 | .. | 112.5 |
| Hydro | | 5.7 | 7.7 | 7.1 | 8.1 | 9.1 | .. | 8.9 |
| Geothermal | | 0.2 | 1.6 | 3.1 | 3.2 | 2.9 | .. | 2.9 |
| Solar/Wind/Other[3] | | - | 1.2 | 0.8 | 0.7 | .. | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **300.7** | **371.7** | **421.6** | **431.8** | **401.4** | **..** | **434.7** |
| Coal[1] | Exports | 0.4 | 1.2 | 2.3 | 1.9 | .. | .. | .. |
| | Imports | 41.3 | 73.0 | 106.0 | 109.6 | 93.4 | .. | 98.0 |
| | Net Imports | 40.9 | 71.8 | 103.7 | 107.7 | 93.4 | .. | 98.0 |
| Oil | Exports | 2.9 | 3.6 | 3.7 | 3.8 | .. | .. | .. |
| | Imports | 276.7 | 266.3 | 262.1 | 264.5 | 231.2 | .. | 236.8 |
| | Bunkers | 16.8 | 5.4 | 5.0 | 5.0 | .. | .. | .. |
| | Net Imports | 257.0 | 257.4 | 253.4 | 255.7 | 231.2 | .. | 236.8 |
| Gas | Exports | - | - | - | - | - | - | - |
| | Imports | 2.8 | 42.4 | 64.4 | 68.4 | 76.8 | .. | 99.9 |
| | Net Imports | 2.8 | 42.4 | 64.4 | 68.4 | 76.8 | .. | 99.9 |
| Electricity | Exports | - | - | - | - | - | - | - |
| | Imports | - | - | - | - | - | - | - |
| | Net Imports | - | - | - | - | - | - | - |
| **TOTAL STOCK CHANGES** | | **-6.6** | **-2.1** | **1.4** | **0.6** | **..** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **323.5** | **445.3** | **520.7** | **517.1** | **536.5** | **..** | **583.9** |
| Coal[1] | | 57.9 | 77.9 | 104.3 | 107.7 | 93.4 | .. | 98.0 |
| Oil | | 252.1 | 254.4 | 255.4 | 257.0 | 231.2 | .. | 236.8 |
| Gas | | 5.1 | 44.3 | 66.4 | 71.0 | 76.8 | .. | 99.9 |
| Comb. Renewables & Waste[2] | | - | 5.7 | 6.7 | 6.9 | 22.2 | .. | 25.0 |
| Nuclear | | 2.5 | 52.7 | 76.9 | 62.5 | 100.9 | .. | 112.5 |
| Hydro | | 5.7 | 7.7 | 7.1 | 8.1 | 9.1 | .. | 8.9 |
| Geothermal | | 0.2 | 1.6 | 3.1 | 3.2 | 2.9 | .. | 2.9 |
| Solar/Wind/Other[3] | | - | 1.2 | 0.8 | 0.7 | .. | .. | .. |
| Electricity Trade[5] | | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *17.9* | *17.5* | *20.0* | *20.8* | *17.4* | *..* | *16.8* |
| *Oil* | | *77.9* | *57.1* | *49.0* | *49.7* | *43.1* | *..* | *40.5* |
| *Gas* | | *1.6* | *9.9* | *12.7* | *13.7* | *14.3* | *..* | *17.1* |
| *Comb. Renewables & Waste* | | *-* | *1.3* | *1.3* | *1.3* | *4.1* | *..* | *4.3* |
| *Nuclear* | | *0.8* | *11.8* | *14.8* | *12.1* | *18.8* | *..* | *19.3* |
| *Hydro* | | *1.8* | *1.7* | *1.4* | *1.6* | *1.7* | *..* | *1.5* |
| *Geothermal* | | *0.1* | *0.4* | *0.6* | *0.6* | *0.5* | *..* | *0.5* |
| *Solar/Wind/Other* | | *-* | *0.3* | *0.1* | *0.1* | *..* | *..* | *..* |
| *Electricity Trade* | | *-* | *-* | *-* | *-* | *-* | *..* | *-* |

0 is negligible. - is nil, .. is not available

Please note: Only partial information is available for 2010 and 2030. Forecast data for combustible renewable & waste include solar, wind, etc.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **234.4** | **291.8** | **356.2** | **353.5** | **349.3** | **..** | **370.6** |
| Coal[1] | 20.2 | 24.1 | 22.5 | 24.5 | 35.0 | .. | 32.4 |
| Oil | 171.5 | 183.6 | 223.6 | 219.0 | 196.6 | .. | 195.9 |
| Gas | 7.0 | 14.8 | 24.1 | 24.9 | 26.1 | .. | 34.4 |
| Comb. Renewables & Waste[2] | - | 3.3 | 3.3 | 3.4 | 4.4 | .. | 2.6 |
| Geothermal | - | 0.1 | 0.2 | 0.2 | 0.1 | .. | 0.1 |
| Solar/Wind/Other | - | 1.2 | 0.7 | 0.6 | .. | .. | .. |
| Electricity | 35.7 | 64.5 | 81.2 | 80.3 | 87.1 | .. | 105.1 |
| Heat | 0.0 | 0.2 | 0.6 | 0.5 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *8.6* | *8.2* | *6.3* | *6.9* | *10.0* | .. | *8.7* |
| *Oil* | *73.2* | *62.9* | *62.8* | *61.9* | *56.3* | .. | *52.9* |
| *Gas* | *3.0* | *5.1* | *6.8* | *7.0* | *7.5* | .. | *9.3* |
| *Comb. Renewables & Waste* | - | *1.1* | *0.9* | *1.0* | *1.3* | .. | *0.7* |
| *Geothermal* | - | - | *0.1* | *0.1* | - | .. | - |
| *Solar/Wind/Other* | - | *0.4* | *0.2* | *0.2* | .. | .. | .. |
| *Electricity* | *15.2* | *22.1* | *22.8* | *22.7* | *24.9* | .. | *28.4* |
| *Heat* | - | *0.1* | *0.2* | *0.2* | .. | .. | .. |
| **TOTAL INDUSTRY[6]** | **140.2** | **126.6** | **145.2** | **147.1** | **154.3** | **..** | **151.4** |
| Coal[1] | 18.2 | 24.0 | 22.3 | 24.3 | .. | .. | .. |
| Oil | 94.9 | 63.2 | 76.1 | 75.1 | .. | .. | .. |
| Gas | 2.1 | 4.8 | 10.3 | 11.2 | .. | .. | .. |
| Comb. Renewables & Waste[2] | - | 3.2 | 3.2 | 3.4 | .. | .. | .. |
| Geothermal | - | - | - | - | .. | .. | .. |
| Solar/Wind/Other | - | - | - | - | .. | .. | .. |
| Electricity | 25.1 | 31.5 | 33.2 | 33.1 | .. | .. | .. |
| Heat | - | - | - | - | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *13.0* | *19.0* | *15.4* | *16.5* | .. | .. | .. |
| *Oil* | *67.7* | *49.9* | *52.4* | *51.1* | .. | .. | .. |
| *Gas* | *1.5* | *3.8* | *7.1* | *7.6* | .. | .. | .. |
| *Comb. Renewables & Waste* | - | *2.5* | *2.2* | *2.3* | .. | .. | .. |
| *Geothermal* | - | - | - | - | .. | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | .. | .. | .. |
| *Electricity* | *17.9* | *24.9* | *22.9* | *22.5* | .. | .. | .. |
| *Heat* | - | - | - | - | .. | .. | .. |
| **TRANSPORT[7]** | **42.6** | **75.8** | **94.3** | **93.2** | **89.5** | **..** | **93.4** |
| **TOTAL OTHER SECTORS[8]** | **51.6** | **89.3** | **116.7** | **113.2** | **105.5** | **..** | **125.8** |
| Coal[1] | 1.8 | 0.1 | 0.2 | 0.2 | .. | .. | .. |
| Oil | 35.3 | 46.1 | 54.8 | 52.2 | .. | .. | .. |
| Gas | 5.0 | 10.1 | 13.7 | 13.6 | .. | .. | .. |
| Comb. Renewables & Waste[2] | - | 0.1 | 0.0 | 0.1 | .. | .. | .. |
| Geothermal | - | 0.1 | 0.2 | 0.2 | .. | .. | .. |
| Solar/Wind/Other | - | 1.2 | 0.7 | 0.6 | .. | .. | .. |
| Electricity | 9.5 | 31.5 | 46.4 | 45.7 | .. | .. | .. |
| Heat | 0.0 | 0.2 | 0.6 | 0.5 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.4* | *0.1* | *0.2* | *0.2* | .. | .. | .. |
| *Oil* | *68.5* | *51.6* | *47.0* | *46.1* | .. | .. | .. |
| *Gas* | *9.6* | *11.3* | *11.8* | *12.0* | .. | .. | .. |
| *Comb. Renewables & Waste* | - | *0.1* | - | - | .. | .. | .. |
| *Geothermal* | - | *0.1* | *0.2* | *0.2* | .. | .. | .. |
| *Solar/Wind/Other* | - | *1.3* | *0.6* | *0.6* | .. | .. | .. |
| *Electricity* | *18.4* | *35.3* | *39.8* | *40.3* | .. | .. | .. |
| *Heat* | *0.1* | *0.2* | *0.5* | *0.5* | .. | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **90.6** | **172.1** | **217.7** | **210.7** | **231.6** | .. | **266.5** |
| **OUTPUT (Mtoe)** | **40.0** | **71.8** | **90.2** | **89.2** | **81.3** | .. | **97.1** |
| (TWh gross) | 465.4 | 834.5 | 1048.9 | 1037.7 | 945.4 | .. | 1128.7 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *8.0* | *14.4* | *26.2* | *28.2* | *16.6* | .. | *16.5* |
| *Oil* | *73.2* | *29.6* | *12.5* | *13.2* | *5.5* | .. | *4.9* |
| *Gas* | *2.3* | *19.5* | *23.2* | *24.3* | *24.1* | .. | *30.1* |
| *Comb. Renewables & Waste* | - | *1.4* | *1.7* | *1.7* | *1.2* | .. | *0.9* |
| *Nuclear* | *2.1* | *24.2* | *28.1* | *23.1* | *41.0* | .. | *38.2* |
| *Hydro* | *14.3* | *10.7* | *7.9* | *9.1* | *11.2* | .. | *9.2* |
| *Geothermal* | *0.1* | *0.2* | *0.3* | *0.3* | *0.3* | .. | *0.3* |
| *Solar/Wind/Other* | - | *0.0* | *0.0* | *0.1* | .. | .. | .. |
| **TOTAL LOSSES** | **94.4** | **148.5** | **169.7** | **165.8** | **187.2** | .. | **213.4** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 50.5 | 100.2 | 127.1 | 121.0 | 150.7 | .. | 169.4 |
| Other Transformation | 24.9 | 28.5 | 22.6 | 24.8 | 36.5 | .. | 44.0 |
| Own Use and Losses[11] | 19.0 | 19.7 | 20.1 | 20.0 | .. | .. | .. |
| **Statistical Differences** | **-5.3** | **5.1** | **-5.3** | **-2.2** | **-** | **-** | **-** |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 2211.55 | 4107.83 | 4749.83 | 4876.13 | 5601.14 | .. | 7469.71 |
| Population (millions) | 108.66 | 123.54 | 127.44 | 127.62 | 127.47 | .. | 117.58 |
| TPES/GDP[12] | 0.15 | 0.11 | 0.11 | 0.11 | 0.10 | .. | 0.08 |
| Energy Production/TPES | 0.09 | 0.17 | 0.19 | 0.16 | 0.25 | .. | 0.26 |
| Per Capita TPES[13] | 2.98 | 3.60 | 4.09 | 4.05 | 4.21 | .. | 4.97 |
| Oil Supply/GDP[12] | 0.11 | 0.06 | 0.05 | 0.05 | 0.04 | .. | 0.03 |
| TFC/GDP[12] | 0.11 | 0.07 | 0.08 | 0.07 | 0.06 | .. | 0.05 |
| Per Capita TFC[13] | 2.16 | 2.36 | 2.80 | 2.77 | 2.74 | .. | 3.15 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 891.2 | 1012.8 | 1185.5 | 1201.4 | 1095.8 | .. | 1180.6 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 58.6 | 30.4 | 37.2 | 36.5 | .. | .. | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-30** |
|---|---|---|---|---|---|---|
| TPES | 1.5 | 2.1 | 1.3 | -0.7 | 0.5 | 0.4 |
| Coal | -2.0 | 3.9 | 2.5 | 3.3 | -2.0 | 0.2 |
| Oil | 0.4 | -0.2 | 0.0 | 0.6 | -1.5 | 0.1 |
| Gas | 24.2 | 8.2 | 3.4 | 6.9 | 1.1 | 1.3 |
| Comb. Renewables & Waste | - | - | 1.4 | 1.9 | 18.2 | 0.6 |
| Nuclear | 39.1 | 10.1 | 3.2 | -18.7 | 7.1 | 0.5 |
| Hydro | 3.2 | 0.9 | -0.7 | 14.8 | 1.7 | -0.1 |
| Geothermal | 22.3 | 6.7 | 5.9 | 3.1 | -1.7 | 0.0 |
| Solar/Wind/Other | - | 51.6 | -3.4 | -8.9 | - | - |
| TFC | 1.0 | 1.5 | 1.7 | -0.8 | -0.2 | 0.3 |
| Electricity Consumption | 3.9 | 3.3 | 1.9 | -1.1 | 1.2 | 0.9 |
| Energy Production | 4.9 | 6.1 | 2.1 | -13.3 | 6.9 | 0.5 |
| Net Oil Imports | 0.5 | -0.2 | -0.1 | 0.9 | -1.4 | 0.1 |
| GDP | 3.5 | 3.8 | 1.2 | 2.7 | 2.0 | 1.4 |
| Growth in the TPES/GDP Ratio | -1.9 | -1.7 | 0.1 | -3.3 | -1.4 | -1.0 |
| Growth in the TFC/GDP Ratio | -2.4 | -2.3 | 0.5 | -3.3 | -2.1 | -1.1 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **6.76** | **21.91** | **34.12** | **36.92** | **..** | **..** | **..** |
| Coal[1] | | 6.65 | 7.58 | 1.42 | 1.41 | .. | .. | .. |
| Oil | | - | - | 0.53 | 0.50 | .. | .. | .. |
| Gas | | - | - | - | - | - | - | .. |
| Comb. Renewables & Waste[2] | | - | - | 0.82 | 0.73 | 5.60 | 8.55 | .. |
| Nuclear | | - | 13.78 | 31.04 | 33.79 | 41.22 | 54.21 | .. |
| Hydro | | 0.11 | 0.55 | 0.28 | 0.42 | 0.40 | 0.40 | .. |
| Geothermal | | - | - | - | 0.00 | - | - | .. |
| Solar/Wind/Other[3] | | - | 0.00 | 0.04 | 0.07 | .. | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **13.03** | **68.51** | **165.61** | **170.52** | **..** | **..** | **..** |
| Coal[1] | Exports | 0.12 | - | - | - | - | - | .. |
| | Imports | 0.45 | 15.73 | 43.95 | 45.42 | .. | .. | .. |
| | Net Imports | 0.34 | 15.73 | 43.95 | 45.42 | .. | .. | .. |
| Oil | Exports | 1.04 | 3.73 | 32.17 | 28.57 | .. | .. | .. |
| | Imports | 14.28 | 55.41 | 138.64 | 137.26 | .. | .. | .. |
| | Bunkers | 0.56 | 1.58 | 5.66 | 6.32 | .. | .. | .. |
| | Net Imports | 12.69 | 50.10 | 100.81 | 102.37 | .. | .. | .. |
| Gas | Exports | - | - | - | - | - | - | .. |
| | Imports | - | 2.68 | 20.85 | 22.73 | 30.96 | 46.43 | .. |
| | Net Imports | - | 2.68 | 20.85 | 22.73 | 30.96 | 46.43 | .. |
| Electricity | Exports | - | - | - | - | - | - | .. |
| | Imports | - | - | - | - | - | - | .. |
| | Net Imports | - | - | - | - | - | - | .. |
| **TOTAL STOCK CHANGES** | | **1.86** | **2.24** | **1.31** | **-2.14** | **..** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **21.64** | **92.65** | **201.04** | **205.30** | **263.35** | **311.76** | **..** |
| Coal[1] | | 8.13 | 25.56 | 45.67 | 47.09 | 61.50 | 62.58 | .. |
| Oil | | 13.40 | 50.04 | 102.00 | 101.20 | 123.68 | 139.59 | .. |
| Gas | | - | 2.72 | 21.20 | 22.00 | 30.96 | 46.43 | .. |
| Comb. Renewables & Waste[2] | | - | - | 0.82 | 0.73 | 5.60 | 8.55 | .. |
| Nuclear | | - | 13.78 | 31.04 | 33.79 | 41.22 | 54.21 | .. |
| Hydro | | 0.11 | 0.55 | 0.28 | 0.42 | 0.40 | 0.40 | .. |
| Geothermal | | - | - | - | 0.00 | - | - | .. |
| Solar/Wind/Other[3] | | - | 0.00 | 0.04 | 0.07 | .. | .. | .. |
| Electricity Trade[5] | | - | - | - | - | - | - | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *37.6* | *27.6* | *22.7* | *22.9* | *23.4* | *20.1* | .. |
| *Oil* | | *61.9* | *54.0* | *50.7* | *49.3* | *47.0* | *44.8* | .. |
| *Gas* | | - | *2.9* | *10.5* | *10.7* | *11.8* | *14.9* | .. |
| *Comb. Renewables & Waste* | | - | - | *0.4* | *0.4* | *2.1* | *2.7* | .. |
| *Nuclear* | | - | *14.9* | *15.4* | *16.5* | *15.7* | *17.4* | .. |
| *Hydro* | | *0.5* | *0.6* | *0.1* | *0.2* | *0.2* | *0.1* | .. |
| *Geothermal* | | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | | - | - | - | - | .. | .. | .. |
| *Electricity Trade* | | - | - | - | - | - | - | .. |

0 is negligible. - is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **17.40** | **63.99** | **138.03** | **140.57** | **196.80** | **230.78** | **..** |
| Coal[1] | 6.49 | 11.37 | 8.88 | 8.16 | 20.70 | 20.98 | .. |
| Oil | 9.81 | 43.82 | 86.80 | 87.62 | 117.43 | 134.19 | .. |
| Gas | - | 0.67 | 13.09 | 14.01 | 23.89 | 34.02 | .. |
| Comb. Renewables & Waste[2] | - | - | 0.02 | 0.03 | 0.40 | 0.49 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | 0.00 | 0.04 | 0.03 | .. | .. | .. |
| Electricity | 1.10 | 8.12 | 25.87 | 27.35 | 30.56 | 36.71 | .. |
| Heat | - | - | 3.34 | 3.37 | 3.82 | 4.39 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *37.3* | *17.8* | *6.4* | *5.8* | *10.5* | *9.1* | .. |
| *Oil* | *56.4* | *68.5* | *62.9* | *62.3* | *59.7* | *58.1* | .. |
| *Gas* | - | *1.1* | *9.5* | *10.0* | *12.1* | *14.7* | .. |
| *Comb. Renewables & Waste* | - | - | - | - | *0.2* | *0.2* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | .. | .. | .. |
| *Electricity* | *6.3* | *12.7* | *18.7* | *19.5* | *15.5* | *15.9* | .. |
| *Heat* | - | - | *2.4* | *2.4* | *1.9* | *1.9* | .. |
| **TOTAL INDUSTRY[6]** | **7.37** | **25.17** | **65.49** | **66.65** | **97.19** | **108.04** | **..** |
| Coal[1] | 0.39 | 2.71 | 8.33 | 7.60 | 20.54 | 20.96 | .. |
| Oil | 6.22 | 17.42 | 37.84 | 38.84 | 53.49 | 58.68 | .. |
| Gas | - | 0.07 | 3.45 | 3.74 | 7.23 | 10.92 | .. |
| Comb. Renewables & Waste[2] | - | - | 0.02 | 0.02 | - | - | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 0.76 | 4.97 | 13.80 | 14.49 | 13.93 | 15.48 | .. |
| Heat | - | - | 2.06 | 1.96 | 2.00 | 2.00 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.3* | *10.8* | *12.7* | *11.4* | *21.1* | *19.4* | .. |
| *Oil* | *84.4* | *69.2* | *57.8* | *58.3* | *55.0* | *54.3* | .. |
| *Gas* | - | *0.3* | *5.3* | *5.6* | *7.4* | *10.1* | .. |
| *Comb. Renewables & Waste* | - | - | - | - | - | - | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *10.3* | *19.7* | *21.1* | *21.7* | *14.3* | *14.3* | .. |
| *Heat* | - | - | *3.1* | *2.9* | *2.1* | *1.9* | .. |
| **TRANSPORT[7]** | **2.60** | **14.93** | **33.18** | **34.13** | **46.01** | **58.31** | **..** |
| **TOTAL OTHER SECTORS[8]** | **7.43** | **23.89** | **39.37** | **39.79** | **53.61** | **64.44** | **..** |
| Coal[1] | 6.08 | 8.67 | 0.56 | 0.56 | 0.15 | 0.02 | .. |
| Oil | 1.02 | 11.56 | 16.05 | 14.99 | 18.82 | 18.43 | .. |
| Gas | - | 0.60 | 9.57 | 10.14 | 16.18 | 22.35 | .. |
| Comb. Renewables & Waste[2] | - | - | - | 0.01 | 0.40 | 0.49 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | 0.00 | 0.04 | 0.03 | .. | .. | .. |
| Electricity | 0.33 | 3.06 | 11.88 | 12.66 | 16.23 | 20.76 | .. |
| Heat | - | - | 1.28 | 1.40 | 1.82 | 2.39 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *81.9* | *36.3* | *1.4* | *1.4* | *0.3* | - | .. |
| *Oil* | *13.7* | *48.4* | *40.8* | *37.7* | *35.1* | *28.6* | .. |
| *Gas* | - | *2.5* | *24.3* | *25.5* | *30.2* | *34.7* | .. |
| *Comb. Renewables & Waste* | - | - | - | - | *0.7* | *0.8* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | .. | .. | .. |
| *Electricity* | *4.5* | *12.8* | *30.2* | *31.8* | *30.3* | *32.2* | .. |
| *Heat* | - | - | *3.2* | *3.5* | *3.4* | *3.7* | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **3.30** | **26.60** | **73.24** | **79.34** | **100.76** | **121.91** | .. |
| **OUTPUT (Mtoe)** | **1.27** | **9.06** | **28.41** | **29.66** | **33.72** | **40.59** | .. |
| (TWh gross) | 14.83 | 105.37 | 330.36 | 344.85 | 392.09 | 471.99 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *9.0* | *16.8* | *40.5* | *38.9* | *43.3* | *36.8* | .. |
| *Oil* | *82.3* | *17.9* | *9.6* | *9.2* | *5.2* | *3.2* | .. |
| *Gas* | - | *9.1* | *12.6* | *12.3* | *9.7* | *14.7* | .. |
| *Comb. Renewables & Waste* | - | - | *0.2* | *0.6* | *0.3* | *0.4* | .. |
| *Nuclear* | - | *50.2* | *36.1* | *37.6* | *40.3* | *44.1* | .. |
| *Hydro* | *8.7* | *6.0* | *1.0* | *1.4* | *1.2* | *1.0* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.0* | *0.0* | .. | .. | .. |
| **TOTAL LOSSES** | **4.13** | **28.58** | **59.81** | **63.48** | **63.13** | **76.82** | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 2.03 | 17.53 | 41.21 | 46.20 | 63.13 | 76.82 | .. |
| Other Transformation | 1.09 | 6.64 | 9.42 | 8.53 | .. | .. | .. |
| Own Use and Losses[11] | 1.01 | 4.41 | 9.18 | 8.76 | .. | .. | .. |
| **Statistical Differences** | **0.11** | **0.09** | **3.20** | **1.25** | - | - | .. |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 78.69 | 288.33 | 568.32 | 585.76 | 829.74 | 1240.08 | .. |
| Population (millions) | 34.10 | 42.87 | 47.64 | 47.93 | 49.59 | 50.65 | .. |
| TPES/GDP[12] | 0.28 | 0.32 | 0.35 | 0.35 | 0.32 | 0.25 | .. |
| Energy Production/TPES | 0.31 | 0.24 | 0.17 | 0.18 | .. | .. | .. |
| Per Capita TPES[13] | 0.63 | 2.16 | 4.22 | 4.28 | 5.31 | 6.16 | .. |
| Oil Supply/GDP[12] | 0.17 | 0.17 | 0.18 | 0.17 | 0.15 | 0.11 | .. |
| TFC/GDP[12] | 0.22 | 0.22 | 0.24 | 0.24 | 0.24 | 0.19 | .. |
| Per Capita TFC[13] | 0.51 | 1.49 | 2.90 | 2.93 | 3.97 | 4.56 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 65.8 | 226.2 | 439.1 | 448.4 | 573.6 | 648.4 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 2.1 | 5.9 | 20.8 | 23.8 | 23.8 | 23.8 | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 10.8 | 7.9 | 6.7 | 2.1 | 3.6 | 1.7 | .. |
| Coal | 6.9 | 7.0 | 5.0 | 3.1 | 3.9 | 0.2 | .. |
| Oil | 12.3 | 5.8 | 6.1 | -0.8 | 2.9 | 1.2 | .. |
| Gas | - | - | 18.6 | 3.8 | 5.0 | 4.1 | .. |
| Comb. Renewables & Waste | - | - | - | -11.4 | 33.9 | 4.3 | .. |
| Nuclear | - | 29.2 | 7.0 | 8.9 | 2.9 | 2.8 | .. |
| Hydro | 10.5 | 9.6 | -5.5 | 51.8 | -0.8 | -0.1 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | 23.3 | 83.8 | .. | .. | .. |
| TFC | 9.8 | 7.0 | 6.6 | 1.8 | 4.9 | 1.6 | .. |
| Electricity Consumption | 15.9 | 10.6 | 10.1 | 5.7 | 1.6 | 1.9 | .. |
| Energy Production | 4.9 | 8.4 | 3.8 | 8.2 | .. | .. | .. |
| Net Oil Imports | 13.3 | 5.8 | 6.0 | 1.6 | .. | .. | .. |
| GDP | 8.5 | 7.6 | 5.8 | 3.1 | 5.1 | 4.1 | .. |
| Growth in the TPES/GDP Ratio | 2.1 | 0.3 | 0.8 | -0.9 | -1.4 | -2.3 | .. |
| Growth in the TFC/GDP Ratio | 1.2 | -0.6 | 0.8 | -1.2 | -0.2 | -2.4 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

| SUPPLY | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **0.00** | **0.03** | **0.06** | **0.06** | **..** | **..** | **..** |
| Coal[1] | | – | – | – | – | .. | .. | .. |
| Oil | | – | – | – | – | .. | .. | .. |
| Gas | | – | – | – | – | .. | .. | .. |
| Comb. Renewables & Waste[2] | | – | 0.03 | 0.04 | 0.05 | .. | .. | .. |
| Nuclear | | – | – | – | – | .. | .. | .. |
| Hydro | | 0.00 | 0.01 | 0.01 | 0.01 | .. | .. | .. |
| Geothermal | | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other[3] | | – | – | 0.00 | 0.00 | .. | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **4.51** | **3.55** | **4.00** | **4.21** | **..** | **..** | **..** |
| Coal[1] | Exports | – | – | – | – | .. | .. | .. |
| | Imports | 2.44 | 1.13 | 0.09 | 0.08 | .. | .. | .. |
| | Net Imports | 2.44 | 1.13 | 0.09 | 0.08 | .. | .. | .. |
| Oil | Exports | 0.01 | 0.01 | 0.02 | 0.01 | .. | .. | .. |
| | Imports | 1.69 | 1.67 | 2.58 | 2.76 | .. | .. | .. |
| | Bunkers | – | – | – | – | .. | .. | .. |
| | Net Imports | 1.67 | 1.65 | 2.56 | 2.75 | .. | .. | .. |
| Gas | Exports | – | – | – | – | .. | .. | .. |
| | Imports | 0.22 | 0.43 | 1.05 | 1.06 | .. | .. | .. |
| | Net Imports | 0.22 | 0.43 | 1.05 | 1.06 | .. | .. | .. |
| Electricity | Exports | 0.07 | 0.06 | 0.25 | 0.24 | .. | .. | .. |
| | Imports | 0.24 | 0.40 | 0.55 | 0.56 | .. | .. | .. |
| | Net Imports | 0.18 | 0.34 | 0.30 | 0.32 | .. | .. | .. |
| **TOTAL STOCK CHANGES** | | **-0.01** | **-0.01** | **-0.02** | **-0.01** | **..** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **4.51** | **3.57** | **4.04** | **4.26** | **..** | **..** | **..** |
| Coal1 | | 2.44 | 1.13 | 0.09 | 0.08 | .. | .. | .. |
| Oil | | 1.67 | 1.64 | 2.54 | 2.74 | .. | .. | .. |
| Gas | | 0.22 | 0.43 | 1.05 | 1.06 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | – | 0.03 | 0.04 | 0.05 | .. | .. | .. |
| Nuclear | | – | – | – | – | .. | .. | .. |
| Hydro | | 0.00 | 0.01 | 0.01 | 0.01 | .. | .. | .. |
| Geothermal | | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other[3] | | – | – | 0.00 | 0.00 | .. | .. | .. |
| Electricity Trade[5] | | 0.18 | 0.34 | 0.30 | 0.32 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *54.1* | *31.7* | *2.3* | *1.8* | .. | .. | .. |
| *Oil* | | *37.1* | *46.0* | *62.9* | *64.3* | .. | .. | .. |
| *Gas* | | *4.9* | *12.0* | *26.1* | *25.0* | .. | .. | .. |
| *Comb. Renewables & Waste* | | – | *0.7* | *1.1* | *1.2* | .. | .. | .. |
| *Nuclear* | | – | – | – | – | .. | .. | .. |
| *Hydro* | | *0.1* | *0.2* | *0.2* | *0.2* | .. | .. | .. |
| *Geothermal* | | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | | – | – | – | – | .. | .. | .. |
| *Electricity Trade* | | *3.9* | *9.5* | *7.3* | *7.5* | .. | .. | .. |

0 is negligible, – is nil,.. is not available

Please note: Forecasts are not available.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **2.94** | **2.96** | **3.81** | **4.04** | **..** | **..** | **..** |
| Blast Furnace Gas | 0.74 | 0.20 | – | – | – | – | – |
| Other Coal[1] | 0.24 | 0.35 | 0.09 | 0.08 | .. | .. | .. |
| Oil | 1.54 | 1.64 | 2.54 | 2.74 | .. | .. | .. |
| Gas | 0.18 | 0.42 | 0.63 | 0.63 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | – | 0.02 | 0.02 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 0.26 | 0.36 | 0.49 | 0.52 | .. | .. | .. |
| Heat | – | – | 0.04 | 0.05 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Blast Furnace Gas* | *25.1* | *6.8* | – | – | .. | .. | .. |
| *Other Coal* | *8.1* | *11.7* | *2.4* | *1.9* | .. | .. | .. |
| *Oil* | *52.1* | *55.3* | *66.8* | *68.0* | .. | .. | .. |
| *Gas* | *6.0* | *14.2* | *16.6* | *15.7* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | – | *0.4* | *0.4* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *8.7* | *12.0* | *12.8* | *12.8* | .. | .. | .. |
| *Heat* | – | – | *0.9* | *1.2* | .. | .. | .. |
| **TOTAL INDUSTRY[6]** | **2.09** | **1.34** | **0.90** | **0.90** | **..** | **..** | **..** |
| Blast Furnace Gas | 0.74 | 0.20 | – | – | – | – | – |
| Other Coal1 | 0.20 | 0.34 | 0.09 | 0.08 | .. | .. | .. |
| Oil | 0.81 | 0.30 | 0.06 | 0.06 | .. | .. | .. |
| Gas | 0.14 | 0.28 | 0.41 | 0.40 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | – | – | – | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 0.20 | 0.23 | 0.32 | 0.34 | .. | .. | .. |
| Heat – | – | 0.02 | 0.02 | .. | .. | .. | |
| ***Shares (%)*** | | | | | | | |
| *Blast Furnace Gas* | *35.4* | *15.1* | – | – | .. | .. | .. |
| *Other Coal* | *9.7* | *25.3* | *10.3* | *8.6* | .. | .. | .. |
| *Oil* | *38.6* | *22.0* | *6.8* | *7.0* | .. | .. | .. |
| *Gas* | *6.6* | *20.8* | *45.2* | *43.9* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | – | – | – | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *9.7* | *16.8* | *35.5* | *37.8* | .. | .. | .. |
| *Heat* | – | – | *2.2* | *2.5* | .. | .. | .. |
| **TRANSPORT[7]** | **0.29** | **1.03** | **2.18** | **2.39** | **..** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **0.56** | **0.59** | **0.73** | **0.74** | **..** | **..** | **..** |
| Coal[1] | 0.03 | 0.01 | 0.00 | – | .. | .. | .. |
| Oil | 0.44 | 0.31 | 0.31 | 0.30 | .. | .. | .. |
| Gas | 0.04 | 0.14 | 0.23 | 0.24 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | – | 0.02 | 0.02 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 0.05 | 0.13 | 0.16 | 0.17 | .. | .. | .. |
| Heat | – | – | 0.02 | 0.02 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *6.1* | *1.0* | *0.1* | – | .. | .. | .. |
| *Oil* | *78.4* | *53.6* | *42.3* | *40.6* | .. | .. | .. |
| *Gas* | *6.8* | *24.1* | *31.1* | *31.8* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | – | *2.0* | *2.0* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *8.8* | *21.3* | *22.0* | *22.4* | .. | .. | .. |
| *Heat* | – | – | *2.2* | *3.1* | .. | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| ELECTRICITY GENERATION[9] | | | | | | | |
| **INPUT (Mtoe)** | **0.44** | **0.20** | **0.46** | **0.48** | .. | .. | .. |
| **OUTPUT (Mtoe)** | **0.12** | **0.05** | **0.24** | **0.24** | .. | .. | .. |
| (TWh gross) | 1.39 | 0.62 | 2.79 | 2.78 | .. | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Blast Furnace Gas* | *58.8* | *76.4* | – | – | .. | .. | .. |
| *Other Coal* | – | – | – | – | .. | .. | .. |
| *Oil* | *27.6* | *1.4* | – | – | .. | .. | .. |
| *Gas* | *10.2* | *5.4* | *92.8* | *93.9* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | *5.4* | *2.2* | *2.3* | .. | .. | .. |
| *Nuclear* | – | – | – | – | .. | .. | .. |
| *Hydro* | *3.4* | *11.2* | *4.0* | *2.8* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | *0.9* | *1.0* | .. | .. | .. |
| **TOTAL LOSSES** | **1.54** | **0.61** | **0.23** | **0.23** | .. | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 0.32 | 0.14 | 0.18 | 0.19 | .. | .. | .. |
| Other Transformation | 1.08 | 0.41 | – | – | .. | .. | .. |
| Own Use and Losses[11] | 0.14 | 0.06 | 0.05 | 0.04 | .. | .. | .. |
| **Statistical Differences** | **0.02** | **0.00** | **0.00** | **-0.00** | .. | .. | .. |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GGDP (billion 2000 USD) | 6.50 | 11.49 | 20.40 | 20.99 | .. | .. | .. |
| Population (millions) | 0.35 | 0.38 | 0.45 | 0.45 | .. | .. | .. |
| TPES/GDP[12] | 0.69 | 0.31 | 0.20 | 0.20 | .. | .. | .. |
| Energy Production/TPES | 0.00 | 0.01 | 0.01 | 0.01 | .. | .. | .. |
| Per Capita TPES[13] | 12.83 | 9.35 | 9.06 | 9.47 | .. | .. | .. |
| Oil Supply/GDP[12] | 0.26 | 0.14 | 0.12 | 0.13 | .. | .. | .. |
| TFC/GDP[12] | 0.45 | 0.26 | 0.19 | 0.19 | .. | .. | .. |
| Per Capita TFC[13] | 8.39 | 7.74 | 8.53 | 8.97 | .. | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 16.5 | 10.5 | 9.3 | 9.9 | .. | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.2 | 0.4 | 1.2 | 1.2 | .. | .. | .. |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | -2.5 | -0.8 | 1.0 | 5.5 | .. | .. | .. |
| Coal | -4.6 | -4.3 | -18.8 | -16.1 | .. | .. | .. |
| Oil | -4.0 | 2.1 | 3.7 | 7.8 | .. | .. | .. |
| Gas | 13.6 | -0.8 | 7.8 | 1.0 | .. | .. | .. |
| Comb. Renewables & Waste | – | 3.0 | 4.8 | 15.9 | .. | .. | .. |
| Nuclear | – | – | – | – | .. | .. | .. |
| Hydro | 12.2 | -2.6 | 4.3 | -30.0 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| TFC | -0.1 | 0.1 | 2.1 | 6.0 | .. | .. | .. |
| Electricity Consumption | 2.7 | 1.6 | 2.7 | 5.9 | .. | .. | .. |
| Energy Production | 36.6 | 1.6 | 5.1 | 7.1 | .. | .. | .. |
| Net Oil Imports | -3.5 | 1.8 | 3.7 | 7.3 | .. | .. | .. |
| GDP | 1.3 | 4.6 | 4.9 | 2.9 | .. | .. | .. |
| Growth in the TPES/GDP Ratio | -3.7 | -5.1 | -3.7 | 2.5 | .. | .. | .. |
| Growth in the TFC/GDP Ratio | -1.3 | -4.3 | -2.6 | 3.0 | .. | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **56.8** | **60.4** | **60.5** | **58.5** | **57.3** | **48.4** | **36.2** |
| Coal[1] | | 1.1 | - | - | - | - | - | - |
| Oil | | 1.6 | 4.1 | 3.2 | 3.2 | 1.7 | 1.3 | 0.3 |
| Gas | | 53.7 | 54.6 | 54.3 | 52.2 | 51.4 | 40.1 | 32.5 |
| Comb. Renewables & Waste[2] | | - | 0.9 | 1.9 | 1.9 | 2.7 | 3.8 | 1.9 |
| Nuclear | | 0.3 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 |
| Hydro | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Geothermal | | - | - | - | - | - | - | - |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.2 | 0.6 | 2.2 | 1.1 |
| **TOTAL NET IMPORTS[4]** | | **6.0** | **6.4** | **17.1** | **22.1** | **24.4** | **43.5** | **68.8** |
| Coal[1] | Exports | 1.4 | 2.2 | 5.7 | 4.9 | 5.9 | 4.9 | 7.4 |
| | Imports | 2.9 | 11.6 | 13.8 | 14.0 | 15.1 | 16.3 | 26.4 |
| | Net Imports | 1.5 | 9.4 | 8.1 | 9.1 | 9.3 | 11.4 | 19.0 |
| Oil | Exports | 42.4 | 60.2 | 68.5 | 69.2 | 117.5 | 123.0 | 83.0 |
| | Imports | 83.8 | 91.1 | 109.0 | 110.5 | 162.2 | 176.7 | 144.7 |
| | Bunkers | 11.6 | 10.9 | 14.5 | 13.5 | 16.2 | 18.6 | 21.4 |
| | Net Imports | 29.8 | 19.9 | 26.0 | 27.7 | 28.6 | 35.1 | 40.3 |
| Gas | Exports | 25.3 | 25.8 | 37.6 | 34.5 | 45.2 | 43.7 | 37.7 |
| | Imports | - | 2.0 | 19.2 | 18.3 | 30.4 | 40.5 | 47.3 |
| | Net Imports | -25.3 | -23.8 | -18.4 | -16.2 | -14.8 | -3.2 | 9.6 |
| Electricity | Exports | 0.1 | 0.0 | 0.4 | 0.3 | 0.7 | 1.2 | 0.8 |
| | Imports | 0.0 | 0.8 | 1.8 | 1.8 | 2.0 | 1.5 | 0.8 |
| | Net Imports | -0.1 | 0.8 | 1.4 | 1.5 | 1.3 | 0.3 | -0.1 |
| **TOTAL STOCK CHANGES** | | **-0.3** | **-0.2** | **0.9** | **0.2** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **62.4** | **66.6** | **78.6** | **80.8** | **81.7** | **91.9** | **105.0** |
| Coal[1] | | 2.9 | 8.9 | 8.4 | 8.7 | 9.3 | 11.4 | 19.0 |
| Oil | | 30.9 | 24.3 | 29.8 | 31.5 | 30.3 | 36.4 | 40.6 |
| Gas | | 28.5 | 30.8 | 35.8 | 36.0 | 36.6 | 36.8 | 42.1 |
| Comb. Renewables & Waste[2] | | - | 0.9 | 1.9 | 1.9 | 2.7 | 3.8 | 1.9 |
| Nuclear | | 0.3 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 |
| Hydro | | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Geothermal | | - | - | - | - | - | - | - |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.2 | 0.6 | 2.2 | 1.1 |
| Electricity Trade[5] | | -0.1 | 0.8 | 1.4 | 1.5 | 1.3 | 0.3 | -0.1 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *4.6* | *13.4* | *10.7* | *10.8* | *11.4* | *12.4* | *18.1* |
| *Oil* | | *49.5* | *36.5* | *38.0* | *39.0* | *37.1* | *39.6* | *38.6* |
| *Gas* | | *45.6* | *46.2* | *45.6* | *44.5* | *44.8* | *40.1* | *40.1* |
| *Comb. Renewables & Waste* | | - | *1.3* | *2.5* | *2.4* | *3.3* | *4.1* | *1.8* |
| *Nuclear* | | *0.5* | *1.4* | *1.3* | *1.3* | *1.2* | *1.1* | *0.4* |
| *Hydro* | | - | - | - | - | - | - | - |
| *Geothermal* | | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | | - | - | *0.1* | *0.2* | *0.7* | *2.4* | *1.0* |
| *Electricity Trade* | | *-0.2* | *1.2* | *1.8* | *1.8* | *1.6* | *0.3* | *-0.1* |

0 is negligible. - is nil, .. is not available

Please note: 2030 data have no official status.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **48.8** | **51.0** | **60.0** | **62.1** | **62.8** | **70.2** | **79.4** |
| Coal[1] | 1.1 | 1.2 | 0.7 | 0.7 | 1.0 | 1.2 | 1.4 |
| Oil | 24.7 | 19.9 | 25.2 | 26.8 | 25.8 | 31.0 | 33.2 |
| Gas | 19.3 | 23.0 | 22.8 | 23.3 | 21.9 | 21.7 | 27.3 |
| Comb. Renewables & Waste[2] | - | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Electricity | 3.8 | 6.3 | 8.6 | 8.6 | 10.0 | 12.0 | 13.5 |
| Heat | - | 0.3 | 2.3 | 2.3 | 3.8 | 4.0 | 3.6 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.2* | *2.4* | *1.1* | *1.1* | *1.6* | *1.6* | *1.8* |
| *Oil* | *50.5* | *39.0* | *42.1* | *43.1* | *41.1* | *44.2* | *41.8* |
| *Gas* | *39.5* | *45.1* | *38.1* | *37.6* | *34.8* | *30.9* | *34.4* |
| *Comb. Renewables & Waste* | - | *0.6* | *0.6* | *0.5* | *0.4* | *0.4* | *0.3* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | *0.1* | *0.1* |
| *Electricity* | *7.8* | *12.4* | *14.3* | *13.9* | *15.9* | *17.1* | *17.0* |
| *Heat* | - | *0.6* | *3.9* | *3.8* | *6.1* | *5.8* | *4.6* |
| **TOTAL INDUSTRY[6]** | **21.2** | **21.1** | **22.6** | **24.5** | **27.8** | **31.5** | **36.0** |
| Coal[1] | 0.8 | 1.2 | 0.6 | 0.6 | 1.0 | 1.2 | 1.4 |
| Oil | 10.4 | 8.2 | 9.6 | 11.0 | 12.9 | 15.4 | 17.8 |
| Gas | 8.1 | 8.8 | 7.7 | 8.0 | 7.1 | 7.4 | 9.4 |
| Comb. Renewables & Waste[2] | - | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 2.0 | 2.9 | 3.5 | 3.5 | 3.6 | 4.1 | 4.7 |
| Heat | - | - | 1.2 | 1.2 | 3.2 | 3.4 | 2.6 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.6* | *5.6* | *2.8* | *2.6* | *3.7* | *3.7* | *3.9* |
| *Oil* | *48.8* | *39.0* | *42.2* | *44.9* | *46.4* | *49.0* | *49.5* |
| *Gas* | *38.4* | *41.6* | *33.8* | *32.8* | *25.6* | *23.6* | *26.2* |
| *Comb. Renewables & Waste* | - | *0.3* | *0.5* | *0.4* | *0.1* | *0.1* | *0.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *9.2* | *13.5* | *15.6* | *14.3* | *12.7* | *12.9* | *13.0* |
| *Heat* | - | - | *5.1* | *5.0* | *11.5* | *10.8* | *7.3* |
| **TRANSPORT[7]** | **7.5** | **10.6** | **14.9** | **15.0** | **12.0** | **14.6** | **14.3** |
| **TOTAL OTHER SECTORS[8]** | **20.2** | **19.4** | **22.4** | **22.6** | **22.9** | **24.1** | **29.1** |
| Coal[1] | 0.3 | 0.1 | 0.0 | 0.0 | - | - | - |
| Oil | 6.9 | 1.2 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 |
| Gas | 11.1 | 14.2 | 15.2 | 15.3 | 14.7 | 14.2 | 17.9 |
| Comb. Renewables & Waste[2] | - | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Electricity | 1.8 | 3.4 | 4.9 | 5.0 | 6.3 | 7.8 | 8.7 |
| Heat | - | 0.3 | 1.2 | 1.1 | 0.6 | 0.6 | 1.0 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.6* | *0.3* | *0.1* | *0.1* | - | - | - |
| *Oil* | *34.2* | *6.2* | *3.8* | *3.9* | *4.3* | *4.6* | *4.2* |
| *Gas* | *55.3* | *73.4* | *67.8* | *67.8* | *64.3* | *59.2* | *61.6* |
| *Comb. Renewables & Waste* | - | *1.2* | *1.1* | *1.0* | *1.0* | *0.9* | *0.8* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.1* | *0.3* | *0.1* |
| *Electricity* | *8.8* | *17.3* | *21.9* | *22.2* | *27.5* | *32.4* | *29.8* |
| *Heat* | - | *1.6* | *5.2* | *4.9* | *2.8* | *2.6* | *3.5* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **12.0** | **15.4** | **20.9** | **21.2** | **25.1** | **30.6** | **34.2** |
| **OUTPUT (Mtoe)** | **4.5** | **6.2** | **8.3** | **8.3** | **9.8** | **13.2** | **15.2** |
| (TWh gross) | 52.6 | 71.9 | 96.0 | 96.8 | 114.1 | 153.7 | 177.3 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *6.0* | *38.2* | *28.0* | *28.4* | *25.2* | *24.9* | *43.9* |
| *Oil* | *12.3* | *4.3* | *2.9* | *3.0* | *3.2* | *1.8* | *4.0* |
| *Gas* | *79.5* | *50.9* | *59.4* | *58.8* | *56.2* | *45.9* | *42.2* |
| *Comb. Renewables & Waste* | - | *1.4* | *4.3* | *4.0* | *6.6* | *8.5* | *2.2* |
| *Nuclear* | *2.1* | *4.9* | *4.1* | *4.2* | *3.3* | *2.4* | *1.0* |
| *Hydro* | - | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* | *0.1* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | *0.1* | *1.2* | *1.6* | *5.4* | *16.5* | *6.6* |
| **TOTAL LOSSES** | **14.3** | **15.8** | **18.6** | **18.7** | **18.9** | **21.7** | **25.6** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 7.5 | 8.8 | 9.9 | 10.1 | 10.9 | 12.5 | 14.5 |
| Other Transformation | 1.6 | 0.9 | 1.8 | 1.8 | 2.1 | 2.3 | 2.6 |
| Own Use and Losses[11] | 5.2 | 6.0 | 6.9 | 6.8 | 5.8 | 6.9 | 8.5 |
| **Statistical Differences** | **-0.7** | **-0.2** | **-0.0** | - | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 188.17 | 278.28 | 378.06 | 374.74 | 458.38 | 603.16 | 750.03 |
| Population (millions) | 13.44 | 14.95 | 16.15 | 16.22 | 16.83 | 17.88 | 18.89 |
| TPES/GDP[12] | 0.33 | 0.24 | 0.21 | 0.22 | 0.18 | 0.15 | 0.14 |
| Energy Production/TPES | 0.91 | 0.91 | 0.77 | 0.72 | 0.70 | 0.53 | 0.34 |
| Per Capita TPES[13] | 4.65 | 4.46 | 4.87 | 4.98 | 4.86 | 5.14 | 5.56 |
| Oil Supply/GDP[12] | 0.16 | 0.09 | 0.08 | 0.08 | 0.07 | 0.06 | 0.05 |
| TFC/GDP[12] | 0.26 | 0.18 | 0.16 | 0.17 | 0.14 | 0.12 | 0.11 |
| Per Capita TFC[13] | 3.64 | 3.41 | 3.71 | 3.83 | 3.73 | 3.93 | 4.20 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 153.8 | 157.8 | 179.4 | 184.7 | 177.9 | 200.3 | 251.6 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 39.3 | 39.0 | 56.1 | 53.1 | 61.4 | 69.0 | 78.0 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.7 | -0.3 | 1.4 | 2.9 | 0.2 | 1.2 | 1.3 |
| Coal | 2.4 | 9.4 | -0.5 | 4.4 | 0.9 | 2.0 | 5.3 |
| Oil | 0.4 | -2.4 | 1.7 | 5.6 | -0.6 | 1.8 | 1.1 |
| Gas | 2.4 | -0.6 | 1.3 | 0.4 | 0.2 | 0.1 | 1.4 |
| Comb. Renewables & Waste | - | 12.0 | 7.1 | -2.4 | 5.0 | 3.6 | -6.8 |
| Nuclear | 21.0 | 0.0 | 0.9 | 2.6 | -1.1 | - | -7.2 |
| Hydro | - | - | 2.7 | -45.5 | 11.7 | - | - |
| Geothermal | - | - | - | - | - | - | - |
| Solar/Wind/Other | - | - | 26.2 | 33.3 | 20.2 | 15.1 | -7.3 |
| TFC | 2.0 | -0.7 | 1.4 | 3.6 | 0.2 | 1.1 | 1.2 |
| Electricity Consumption | 4.4 | 2.3 | 2.6 | 0.8 | 2.1 | 1.8 | 1.2 |
| Energy Production | 4.4 | -1.8 | 0.0 | -3.4 | -0.3 | -1.7 | -2.9 |
| Net Oil Imports | 1.0 | -4.1 | 2.2 | 6.6 | 0.4 | 2.1 | 1.4 |
| GDP | 2.6 | 2.2 | 2.6 | -0.9 | 2.9 | 2.8 | 2.2 |
| Growth in the TPES/GDP Ratio | -0.9 | -2.4 | -1.2 | 3.8 | -2.7 | -1.6 | -0.8 |
| Growth in the TFC/GDP Ratio | -0.6 | -2.8 | -1.2 | 4.5 | -2.7 | -1.6 | -0.9 |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **4.05** | **12.02** | **14.54** | **13.17** | **15.46** | **17.90** | **22.03** |
| Coal[1] | | 1.29 | 1.39 | 2.73 | 3.11 | 3.18 | 3.35 | 4.57 |
| Oil | | 0.18 | 1.96 | 1.67 | 1.30 | 1.23 | 1.43 | 1.12 |
| Gas | | 0.28 | 3.90 | 5.06 | 3.86 | 3.41 | 3.97 | 3.10 |
| Comb. Renewables & Waste[2] | | - | 0.55 | 0.81 | 0.83 | 1.15 | 1.31 | 1.41 |
| Nuclear | | - | - | - | - | - | - | - |
| Hydro | | 1.23 | 2.01 | 2.17 | 2.03 | 2.13 | 2.23 | 2.23 |
| Geothermal | | 1.07 | 2.21 | 2.03 | 1.97 | 4.22 | 5.42 | 8.96 |
| Solar/Wind/Other[3] | | - | 0.01 | 0.07 | 0.07 | 0.14 | 0.20 | 0.64 |
| **TOTAL NET IMPORTS**[4] | | **4.27** | **1.79** | **3.30** | **3.88** | **4.54** | **4.93** | **6.32** |
| Coal[1] | Exports | 0.02 | 0.23 | 1.42 | 1.62 | 1.80 | 2.00 | 2.00 |
| | Imports | - | 0.01 | - | - | - | - | - |
| | Net Imports | -0.02 | -0.22 | -1.42 | -1.62 | -1.80 | -2.00 | -2.00 |
| Oil | Exports | - | 1.47 | 1.34 | 1.02 | 0.95 | 1.11 | 0.87 |
| | Imports | 4.60 | 3.80 | 6.38 | 6.75 | 7.69 | 8.47 | 9.75 |
| | Bunkers | 0.31 | 0.32 | 0.32 | 0.23 | 0.39 | 0.43 | 0.56 |
| | Net Imports | 4.29 | 2.01 | 4.72 | 5.50 | 6.34 | 6.93 | 8.32 |
| Gas | Exports | - | - | - | - | - | - | - |
| | Imports | - | - | - | - | - | - | - |
| | Net Imports | - | - | - | - | - | - | - |
| Electricity | Exports | - | - | - | - | - | - | - |
| | Imports | - | - | - | - | - | - | - |
| | Net Imports | - | - | - | - | - | - | - |
| **TOTAL STOCK CHANGES** | | **-0.05** | **-0.04** | **0.03** | **0.33** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **8.27** | **13.77** | **17.87** | **17.37** | **20.00** | **22.84** | **28.35** |
| Coal[1] | | 1.26 | 1.13 | 1.24 | 1.81 | 1.38 | 1.35 | 2.57 |
| Oil | | 4.42 | 3.96 | 6.49 | 6.80 | 7.57 | 8.37 | 9.44 |
| Gas | | 0.28 | 3.90 | 5.06 | 3.86 | 3.41 | 3.97 | 3.10 |
| Comb. Renewables & Waste[2] | | - | 0.55 | 0.81 | 0.83 | 1.15 | 1.31 | 1.41 |
| Nuclear | | - | - | - | - | - | - | - |
| Hydro | | 1.23 | 2.01 | 2.17 | 2.03 | 2.13 | 2.23 | 2.23 |
| Geothermal | | 1.07 | 2.21 | 2.03 | 1.97 | 4.22 | 5.42 | 8.96 |
| Solar/Wind/Other[3] | | - | 0.01 | 0.07 | 0.07 | 0.14 | 0.20 | 0.64 |
| Electricity Trade[5] | | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *15.3* | *8.2* | *7.0* | *10.4* | *6.9* | *5.9* | *9.1* |
| *Oil* | | *53.5* | *28.8* | *36.3* | *39.1* | *37.9* | *36.6* | *33.3* |
| *Gas* | | *3.4* | *28.3* | *28.3* | *22.2* | *17.0* | *17.4* | *10.9* |
| *Comb. Renewables & Waste* | | - | *4.0* | *4.5* | *4.8* | *5.7* | *5.7* | *5.0* |
| *Nuclear* | | - | - | - | - | - | - | - |
| *Hydro* | | *14.9* | *14.6* | *12.1* | *11.7* | *10.7* | *9.7* | *7.9* |
| *Geothermal* | | *12.9* | *16.1* | *11.4* | *11.4* | *21.1* | *23.7* | *31.6* |
| *Solar/Wind/Other* | | - | *0.1* | *0.4* | *0.4* | *0.7* | *0.9* | *2.3* |
| *Electricity Trade* | | - | - | - | - | - | - | - |

0 is negligible. - is nil, .. is not available

Please note: Forecast data, except GDP and population, refer to the fiscal year.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **6.05** | **9.84** | **13.91** | **13.29** | **13.93** | **15.59** | **17.70** |
| Coal[1] | 0.87 | 1.00 | 0.88 | 1.05 | 0.91 | 0.97 | 1.09 |
| Oil | 3.67 | 4.43 | 6.16 | 6.45 | 7.01 | 7.80 | 8.88 |
| Gas | 0.14 | 1.30 | 2.95 | 1.86 | 1.81 | 2.08 | 2.35 |
| Comb. Renewables & Waste[2] | - | 0.45 | 0.64 | 0.67 | 0.64 | 0.74 | 0.79 |
| Geothermal | - | 0.27 | 0.32 | 0.32 | 0.31 | 0.31 | 0.31 |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 1.37 | 2.39 | 2.96 | 2.95 | 3.25 | 3.69 | 4.28 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *14.4* | *10.1* | *6.3* | *7.9* | *6.5* | *6.2* | *6.2* |
| *Oil* | *60.6* | *45.1* | *44.3* | *48.5* | *50.3* | *50.1* | *50.2* |
| *Gas* | *2.4* | *13.2* | *21.2* | *14.0* | *13.0* | *13.3* | *13.3* |
| *Comb. Renewables & Waste* | - | *4.6* | *4.6* | *5.1* | *4.6* | *4.7* | *4.5* |
| *Geothermal* | - | *2.8* | *2.3* | *2.4* | *2.2* | *2.0* | *1.8* |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *22.6* | *24.3* | *21.3* | *22.2* | *23.3* | *23.6* | *24.2* |
| *Heat* | - | - | - | - | - | - | - |
| **TOTAL INDUSTRY[6]** | **2.18** | **4.08** | **5.83** | **4.94** | **4.90** | **5.45** | **6.11** |
| Coal[1] | 0.69 | 0.87 | 0.74 | 0.93 | 0.91 | 0.97 | 1.09 |
| Oil | 0.96 | 0.59 | 0.56 | 0.55 | 0.44 | 0.46 | 0.50 |
| Gas | 0.05 | 1.06 | 2.52 | 1.42 | 1.38 | 1.59 | 1.79 |
| Comb. Renewables & Waste[2] | - | 0.39 | 0.57 | 0.61 | 0.57 | 0.65 | 0.70 |
| Geothermal | - | 0.22 | 0.26 | 0.27 | 0.25 | 0.25 | 0.25 |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 0.48 | 0.96 | 1.18 | 1.17 | 1.35 | 1.54 | 1.79 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *31.5* | *21.3* | *12.8* | *18.7* | *18.5* | *17.8* | *17.8* |
| *Oil* | *43.9* | *14.4* | *9.5* | *11.2* | *9.1* | *8.3* | *8.1* |
| *Gas* | *2.4* | *25.9* | *43.3* | *28.8* | *28.2* | *29.1* | *29.3* |
| *Comb. Renewables & Waste* | - | *9.5* | *9.8* | *12.3* | *11.6* | *11.9* | *11.4* |
| *Geothermal* | - | *5.4* | *4.4* | *5.4* | *5.1* | *4.6* | *4.1* |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *22.2* | *23.6* | *20.2* | *23.6* | *27.6* | *28.2* | *29.2* |
| *Heat* | - | - | - | - | - | - | - |
| **TRANSPORT[7]** | **2.15** | **3.54** | **5.31** | **5.54** | **6.27** | **7.06** | **8.11** |
| **TOTAL OTHER SECTORS[8]** | **1.72** | **2.22** | **2.77** | **2.81** | **2.75** | **3.08** | **3.48** |
| Coal[1] | 0.19 | 0.13 | 0.14 | 0.12 | 0.00 | - | - |
| Oil | 0.57 | 0.37 | 0.33 | 0.40 | 0.35 | 0.35 | 0.35 |
| Gas | 0.09 | 0.18 | 0.43 | 0.44 | 0.42 | 0.49 | 0.55 |
| Comb. Renewables & Waste[2] | - | 0.06 | 0.06 | 0.06 | 0.08 | 0.09 | 0.10 |
| Geothermal | - | 0.05 | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 0.88 | 1.42 | 1.75 | 1.75 | 1.84 | 2.09 | 2.42 |
| Heat | - | - | - | - | - | - | - |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *10.7* | *5.7* | *5.0* | *4.4* | *0.1* | - | - |
| *Oil* | *32.8* | *16.6* | *12.0* | *14.0* | *12.7* | *11.4* | *10.1* |
| *Gas* | *5.3* | *8.1* | *15.4* | *15.5* | *15.4* | *15.9* | *15.9* |
| *Comb. Renewables & Waste* | - | *2.9* | *2.3* | *2.3* | *2.8* | *2.9* | *2.7* |
| *Geothermal* | - | *2.4* | *2.2* | *1.9* | *2.2* | *2.0* | *1.7* |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *51.2* | *64.3* | *63.2* | *62.0* | *66.8* | *67.9* | *69.6* |
| *Heat* | - | - | - | - | - | - | - |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| ELECTRICITY GENERATION[9] | | | | | | | |
| **INPUT (Mtoe)** | **3.16** | **5.28** | **6.23** | **6.38** | **8.29** | **9.79** | **13.49** |
| **OUTPUT (Mtoe)** | **1.59** | **2.78** | **3.53** | **3.54** | **3.62** | **4.12** | **4.77** |
| (TWh gross) | 18.53 | 32.27 | 41.10 | 41.11 | 42.15 | 47.86 | 55.52 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *8.5* | *1.5* | *3.5* | *8.1* | *4.6* | *3.2* | *10.7* |
| *Oil* | *6.1* | *0.0* | - | *0.0* | *0.0* | *0.0* | *0.0* |
| *Gas* | *1.4* | *17.6* | *24.8* | *24.4* | *19.2* | *22.8* | *8.6* |
| *Comb. Renewables & Waste* | - | *1.3* | *1.4* | *1.3* | *2.7* | *2.7* | *2.5* |
| *Nuclear* | - | - | - | - | - | - | - |
| *Hydro* | *77.3* | *72.3* | *61.4* | *57.5* | *58.9* | *54.1* | *46.6* |
| *Geothermal* | *6.7* | *6.9* | *7.0* | *6.7* | *10.8* | *12.4* | *18.1* |
| *Solar/Wind/Other* | - | *0.4* | *2.0* | *1.9* | *3.9* | *4.8* | *13.4* |
| **TOTAL LOSSES** | **2.35** | **4.01** | **3.73** | **4.00** | **6.08** | **7.25** | **10.65** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 1.57 | 2.51 | 2.69 | 2.85 | 4.67 | 5.67 | 8.71 |
| Other Transformation | 0.36 | 0.60 | -0.16 | -0.04 | 0.36 | 0.36 | 0.36 |
| Own Use and Losses[11] | 0.43 | 0.90 | 1.19 | 1.19 | 1.05 | 1.22 | 1.58 |
| **Statistical Differences** | **-0.13** | **-0.08** | **0.23** | **0.08** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 32.37 | 39.46 | 56.41 | 58.46 | 71.46 | 91.48 | 117.10 |
| Population (millions) | 2.97 | 3.41 | 3.98 | 4.04 | 4.50 | 5.00 | 5.50 |
| TPES/GDP[12] | 0.26 | 0.35 | 0.32 | 0.30 | 0.28 | 0.25 | 0.24 |
| Energy Production/TPES | 0.49 | 0.87 | 0.81 | 0.76 | 0.77 | 0.78 | 0.78 |
| Per Capita TPES[13] | 2.78 | 4.04 | 4.49 | 4.30 | 4.44 | 4.57 | 5.15 |
| Oil Supply/GDP[12] | 0.14 | 0.10 | 0.12 | 0.12 | 0.11 | 0.09 | 0.08 |
| TFC/GDP[12] | 0.19 | 0.25 | 0.25 | 0.23 | 0.19 | 0.17 | 0.15 |
| Per Capita TFC[13] | 2.04 | 2.88 | 3.50 | 3.29 | 3.09 | 3.12 | 3.22 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 17.0 | 22.0 | 31.6 | 32.7 | 32.2 | 35.7 | 41.6 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 1.6 | 2.4 | 2.9 | 2.7 | 3.2 | 3.4 | 3.8 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.5 | 3.9 | 2.2 | -2.8 | 2.0 | 1.3 | 2.2 |
| Coal | -4.5 | 1.5 | 0.8 | 45.5 | -3.8 | -0.2 | 6.6 |
| Oil | -0.9 | -0.5 | 4.2 | 4.8 | 1.5 | 1.0 | 1.2 |
| Gas | 20.3 | 14.7 | 2.2 | -23.7 | -1.8 | 1.5 | -2.4 |
| Comb. Renewables & Waste | - | 1.1 | 3.3 | 3.0 | 4.7 | 1.4 | 0.7 |
| Nuclear | - | - | - | - | - | - | - |
| Hydro | 4.6 | 2.0 | 0.6 | -6.2 | 0.7 | 0.4 | - |
| Geothermal | -2.2 | 8.1 | -0.7 | -2.9 | 11.5 | 2.5 | 5.2 |
| Solar/Wind/Other | - | 12.5 | 16.7 | -5.7 | 11.6 | 3.4 | 12.5 |
| TFC | 2.1 | 3.3 | 2.9 | -4.4 | 0.7 | 1.1 | 1.3 |
| Electricity Consumption | 3.0 | 3.5 | 1.8 | -0.6 | 1.4 | 1.3 | 1.5 |
| Energy Production | 4.6 | 7.7 | 1.6 | -9.4 | 2.3 | 1.5 | 2.1 |
| Net Oil Imports | -2.5 | -5.4 | 7.4 | 16.5 | 2.1 | 0.9 | 1.8 |
| GDP | 0.0 | 1.8 | 3.0 | 3.6 | 2.9 | 2.5 | 2.5 |
| Growth in the TPES/GDP Ratio | 1.5 | 2.1 | -0.8 | -6.2 | -0.9 | -1.1 | -0.3 |
| Growth in the TFC/GDP Ratio | 2.0 | 1.5 | -0.1 | -7.8 | -2.2 | -1.3 | -1.2 |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **8.08** | **120.30** | **234.18** | **233.21** | .. | .. | .. |
| Coal[1] | | 0.29 | 0.20 | 1.43 | 1.98 | .. | .. | .. |
| Oil | | 1.52 | 84.51 | 161.05 | 154.40 | .. | .. | .. |
| Gas | | – | 24.14 | 59.15 | 66.25 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | – | 1.03 | 1.40 | 1.48 | .. | .. | .. |
| Nuclear | | – | – | – | – | .. | .. | .. |
| Hydro | | 6.27 | 10.42 | 11.13 | 9.07 | .. | .. | .. |
| Geothermal | | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other[3] | | – | 0.00 | 0.02 | 0.03 | .. | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **6.15** | **-96.94** | **-205.40** | **-208.77** | .. | .. | .. |
| Coal1 | Exports | 0.09 | 0.17 | 1.38 | 1.81 | .. | .. | .. |
| | Imports | 0.67 | 0.84 | 0.69 | 0.71 | .. | .. | .. |
| | Net Imports | 0.58 | 0.67 | -0.69 | -1.10 | .. | .. | .. |
| Oil | Exports | 3.58 | 78.10 | 154.57 | 152.36 | .. | .. | .. |
| | Imports | 10.23 | 4.47 | 4.34 | 4.41 | .. | .. | .. |
| | Bunkers | 0.64 | 0.45 | 0.67 | 0.57 | .. | .. | .. |
| | Net Imports | 6.01 | -74.08 | -150.90 | -148.52 | .. | .. | .. |
| Gas | Exports | – | 22.17 | 53.01 | 59.88 | .. | .. | .. |
| | Imports | – | – | – | – | .. | .. | .. |
| | Net Imports | – | -22.17 | -53.01 | -59.88 | .. | .. | .. |
| Electricity | Exports | 0.45 | 1.40 | 1.29 | 0.48 | .. | .. | .. |
| | Imports | 0.01 | 0.03 | 0.46 | 1.15 | .. | .. | .. |
| | Net Imports | -0.45 | -1.37 | -0.84 | 0.68 | .. | .. | .. |
| **TOTAL STOCK CHANGES** | | **0.41** | **-1.87** | **0.03** | **-1.09** | .. | .. | .. |
| **TOTAL SUPPLY (TPES)** | | **14.63** | **21.49** | **28.81** | **23.35** | .. | .. | .. |
| Coal[1] | | 0.91 | 0.86 | 0.81 | 0.79 | .. | .. | .. |
| Oil | | 7.90 | 8.57 | 10.11 | 4.88 | .. | .. | .. |
| Gas | | – | 1.98 | 6.14 | 6.37 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | – | 1.03 | 1.43 | 1.53 | .. | .. | .. |
| Nuclear | | – | – | – | – | .. | .. | .. |
| Hydro | | 6.27 | 10.42 | 11.13 | 9.07 | .. | .. | .. |
| Geothermal | | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other[3] | | – | 0.00 | 0.02 | 0.03 | .. | .. | .. |
| Electricity Trade[5] | | -0.45 | -1.37 | -0.84 | 0.68 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *6.2* | *4.0* | *2.8* | *3.4* | .. | .. | .. |
| *Oil* | | *54.0* | *39.9* | *35.1* | *20.9* | .. | .. | .. |
| *Gas* | | – | *9.2* | *21.3* | *27.3* | .. | .. | .. |
| *Comb. Renewables & Waste* | | – | *4.8* | *5.0* | *6.5* | .. | .. | .. |
| *Nuclear* | | – | – | – | – | .. | .. | .. |
| *Hydro* | | *42.8* | *48.5* | *38.6* | *38.9* | .. | .. | .. |
| *Geothermal* | | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | | – | – | *0.1* | *0.1* | .. | .. | .. |
| *Electricity Trade* | | *-3.1* | *-6.4* | *-2.9* | *2.9* | .. | .. | .. |

0 is negligible, – is nil, .. is not available

Please note: Oil production and export data reported to the IEA for 2002 and 2003 are under investigation by Statistics Norway.
As a consequence, revisions to these data should be included in next year's edition of the publication. Forecasts are not available.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **13.73** | **18.03** | **20.64** | **20.93** | .. | .. | .. |
| Coal[1] | 0.81 | 0.78 | 0.71 | 0.70 | .. | .. | .. |
| Oil | 7.68 | 7.96 | 8.64 | 9.20 | .. | .. | .. |
| Gas | 0.01 | – | 0.51 | 0.70 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | 0.90 | 1.22 | 1.28 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 5.23 | 8.33 | 9.38 | 8.86 | .. | .. | .. |
| Heat | – | 0.07 | 0.17 | 0.19 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.9* | *4.3* | *3.5* | *3.3* | .. | .. | .. |
| *Oil* | *55.9* | *44.1* | *41.9* | *44.0* | .. | .. | .. |
| *Gas* | *0.1* | – | *2.4* | *3.4* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | *5.0* | *5.9* | *6.1* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *38.1* | *46.2* | *45.5* | *42.3* | .. | .. | .. |
| *Heat* | – | *0.4* | *0.8* | *0.9* | .. | .. | .. |
| **TOTAL INDUSTRY[6]** | **6.96** | **7.89** | **8.55** | **9.25** | .. | .. | .. |
| Coal[1] | 0.76 | 0.77 | 0.71 | 0.70 | .. | .. | .. |
| Oil | 3.01 | 2.79 | 2.73 | 3.10 | .. | .. | .. |
| Gas | 0.00 | – | 0.50 | 0.69 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | 0.38 | 0.52 | 0.57 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 3.20 | 3.94 | 4.08 | 4.17 | .. | .. | .. |
| Heat | – | 0.02 | 0.02 | 0.03 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *10.9* | *9.7* | *8.3* | *7.5* | .. | .. | .. |
| *Oil* | *43.2* | *35.4* | *31.9* | *33.5* | .. | .. | .. |
| *Gas* | – | – | *5.8* | *7.4* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | *4.8* | *6.0* | *6.1* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *45.9* | *49.9* | *47.7* | *45.1* | .. | .. | .. |
| *Heat* | – | *0.2* | *0.3* | *0.3* | .. | .. | .. |
| **TRANSPORT[7]** | **2.62** | **4.22** | **4.71** | **4.78** | .. | .. | .. |
| **TOTAL OTHER SECTORS[8]** | **4.15** | **5.92** | **7.37** | **6.90** | .. | .. | .. |
| Coal[1] | 0.06 | 0.01 | 0.00 | 0.00 | .. | .. | .. |
| Oil | 2.10 | 1.02 | 1.36 | 1.47 | .. | .. | .. |
| Gas | 0.01 | – | 0.01 | 0.01 | .. | .. | .. |
| Comb. Renewables & Waste[2] | – | 0.52 | 0.71 | 0.72 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | – | .. | .. | .. |
| Electricity | 1.98 | 4.31 | 5.15 | 4.54 | .. | .. | .. |
| Heat | – | 0.06 | 0.15 | 0.16 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.3* | *0.2* | – | – | .. | .. | .. |
| *Oil* | *50.6* | *17.2* | *18.4* | *21.3* | .. | .. | .. |
| *Gas* | *0.2* | – | *0.1* | *0.1* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | *8.7* | *9.6* | *10.4* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | .. | .. | .. |
| *Electricity* | *47.8* | *72.9* | *69.9* | *65.8* | .. | .. | .. |
| *Heat* | – | *1.0* | *2.0* | *2.3* | .. | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **6.31** | **10.58** | **11.43** | **9.49** | .. | .. | .. |
| **OUTPUT (Mtoe)** | **6.28** | **10.46** | **11.20** | **9.17** | .. | .. | .. |
| (TWh gross) | 73.03 | 121.61 | 130.28 | 106.67 | .. | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *0.0* | *0.2* | *0.1* | *0.1* | .. | .. | .. |
| *Oil* | *0.2* | *0.0* | *0.0* | *0.0* | .. | .. | .. |
| *Gas* | – | – | *0.2* | *0.3* | .. | .. | .. |
| *Comb. Renewables & Waste* | – | *0.2* | *0.2* | *0.4* | .. | .. | .. |
| *Nuclear* | – | – | – | – | .. | .. | .. |
| *Hydro* | *99.8* | *99.6* | *99.3* | *98.9* | .. | .. | .. |
| *Geothermal* | – | – | – | – | .. | .. | .. |
| *Solar/Wind/Other* | – | – | *0.2* | *0.3* | .. | .. | .. |
| **TOTAL LOSSES** | **0.86** | **3.67** | **4.27** | **4.45** | .. | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 0.03 | 0.03 | 0.05 | 0.08 | .. | .. | .. |
| Other Transformation | 0.09 | -0.03 | -0.42 | -0.51 | .. | .. | .. |
| Own Use and Losses[11] | 0.73 | 3.66 | 4.64 | 4.88 | .. | .. | .. |
| **Statistical Differences** | **0.05** | **-0.20** | **3.90** | **-2.03** | .. | .. | .. |

## INDICATORS

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GGDP (billion 2000 USD) | 63.75 | 115.80 | 173.82 | 174.54 | .. | .. | .. |
| Population (millions) | 3.96 | 4.24 | 4.54 | 4.57 | .. | .. | .. |
| TPES/GDP[12] | 0.23 | 0.19 | 0.17 | 0.13 | .. | .. | .. |
| Energy Production/TPES | 0.55 | 5.60 | 8.13 | 9.99 | .. | .. | .. |
| Per Capita TPES[13] | 3.70 | 5.07 | 6.35 | 5.11 | .. | .. | .. |
| Oil Supply/GDP[12] | 0.12 | 0.07 | 0.06 | 0.03 | .. | .. | .. |
| TFC/GDP[12] | 0.22 | 0.16 | 0.12 | 0.12 | .. | .. | .. |
| Per Capita TFC[13] | 3.47 | 4.25 | 4.55 | 4.58 | .. | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 24.2 | 28.7 | 33.1 | 35.8 | .. | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 2.8 | 2.7 | 3.3 | 2.4 | .. | .. | .. |

## GROWTH RATES (% per year)

| | 73–79 | 79–90 | 90–02 | 02–03 | 03–10 | 10–20 | 20–30 |
|---|---|---|---|---|---|---|---|
| TPES | 4.0 | 1.4 | 2.5 | -19.0 | .. | .. | .. |
| Coal | 1.4 | -1.3 | -0.5 | -3.0 | .. | .. | .. |
| Oil | 2.2 | -0.4 | 1.4 | -51.8 | .. | .. | .. |
| Gas | – | 9.8 | 9.9 | 3.7 | .. | .. | .. |
| Comb. Renewables & Waste | – | 5.6 | 2.8 | 6.9 | .. | .. | .. |
| Nuclear | – | – | – | – | .. | .. | .. |
| Hydro | 3.3 | 2.9 | 0.6 | -18.5 | .. | .. | .. |
| Geothermal | – | – | – | – | .. | .. | .. |
| Solar/Wind/Other | – | – | – | 52.9 | .. | .. | .. |
| TFC | 3.5 | 0.6 | 1.1 | 1.4 | .. | .. | .. |
| Electricity Consumption | 3.6 | 2.3 | 1.0 | -5.6 | .. | .. | .. |
| Energy Production | 33.7 | 9.1 | 5.7 | -0.4 | .. | .. | .. |
| Net Oil Imports | – | 20.4 | 6.1 | -1.6 | .. | .. | .. |
| GDP | 4.9 | 2.8 | 3.4 | 0.4 | .. | .. | .. |
| Growth in the TPES/GDP Ratio | -0.9 | -1.4 | -0.9 | -19.3 | .. | .. | .. |
| Growth in the TFC/GDP Ratio | -1.4 | -2.2 | -2.2 | 1.0 | .. | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **1.40** | **3.39** | **3.64** | **4.34** | **5.64** | **..** | **..** |
| Coal[1] | | 0.13 | 0.12 | - | - | - | .. | .. |
| Oil | | - | - | - | - | - | .. | .. |
| Gas | | - | - | - | - | - | .. | .. |
| Comb. Renewables & Waste[2] | | 0.64 | 2.48 | 2.84 | 2.85 | 3.79 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.63 | 0.79 | 0.67 | 1.35 | 1.11 | .. | .. |
| Geothermal | | - | 0.00 | 0.08 | 0.08 | 0.07 | .. | .. |
| Solar/Wind/Other[3] | | - | 0.01 | 0.05 | 0.06 | 0.67 | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **5.69** | **14.82** | **22.17** | **21.94** | **24.34** | **..** | **..** |
| Coal[1] | Exports | 0.01 | 0.01 | - | - | - | .. | .. |
| | Imports | 0.28 | 3.00 | 3.47 | 3.27 | 3.07 | .. | .. |
| | Net Imports | 0.27 | 2.99 | 3.47 | 3.27 | 3.07 | .. | .. |
| Oil | Exports | 0.23 | 2.50 | 1.40 | 1.72 | .. | .. | .. |
| | Imports | 6.44 | 14.93 | 17.69 | 18.08 | 17.51 | .. | .. |
| | Bunkers | 0.80 | 0.61 | 0.48 | 0.58 | 1.36 | .. | .. |
| | Net Imports | 5.42 | 11.82 | 15.81 | 15.79 | 16.15 | .. | .. |
| Gas | Exports | - | - | - | - | - | .. | .. |
| | Imports | - | - | 2.73 | 2.64 | 5.12 | .. | .. |
| | Net Imports | - | - | 2.73 | 2.64 | 5.12 | .. | .. |
| Electricity | Exports | 0.01 | 0.15 | 0.30 | 0.27 | - | .. | .. |
| | Imports | 0.01 | 0.15 | 0.46 | 0.51 | - | .. | .. |
| | Net Imports | -0.00 | 0.00 | 0.16 | 0.24 | - | .. | .. |
| **TOTAL STOCK CHANGES** | | **0.14** | **-0.47** | **0.64** | **-0.50** | **-** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **7.23** | **17.75** | **26.46** | **25.78** | **29.98** | **..** | **..** |
| Coal[1] | | 0.51 | 2.76 | 3.48 | 3.28 | 3.07 | .. | .. |
| Oil | | 5.45 | 11.71 | 16.45 | 15.28 | 16.15 | .. | .. |
| Gas | | - | - | 2.73 | 2.64 | 5.12 | .. | .. |
| Comb. Renewables & Waste[2] | | 0.64 | 2.48 | 2.84 | 2.85 | 3.79 | .. | .. |
| Nuclear | | - | - | - | - | - | .. | .. |
| Hydro | | 0.63 | 0.79 | 0.67 | 1.35 | 1.11 | .. | .. |
| Geothermal | | - | 0.00 | 0.08 | 0.08 | 0.07 | .. | .. |
| Solar/Wind/Other[3] | | - | 0.01 | 0.05 | 0.06 | 0.67 | .. | .. |
| Electricity Trade[5] | | -0.00 | 0.00 | 0.16 | 0.24 | - | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *7.0* | *15.5* | *13.1* | *12.7* | *10.2* | .. | .. |
| *Oil* | | *75.4* | *66.0* | *62.2* | *59.3* | *53.9* | .. | .. |
| *Gas* | | - | - | *10.3* | *10.2* | *17.1* | .. | .. |
| *Comb. Renewables & Waste* | | *8.8* | *14.0* | *10.7* | *11.0* | *12.6* | .. | .. |
| *Nuclear* | | - | - | - | - | - | .. | .. |
| *Hydro* | | *8.7* | *4.4* | *2.5* | *5.2* | *3.7* | .. | .. |
| *Geothermal* | | - | - | *0.3* | *0.3* | *0.2* | .. | .. |
| *Solar/Wind/Other* | | - | *0.1* | *0.2* | *0.2* | *2.2* | .. | .. |
| *Electricity Trade* | | - | - | *0.6* | *0.9* | - | .. | .. |

0 is negligible. - is nil, .. is not available
Please note: All forecasts are based on the 2003 submission.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **6.11** | **14.00** | **20.78** | **20.86** | **23.81** | **..** | **..** |
| Coal[1] | 0.19 | 0.59 | 0.18 | 0.14 | 0.17 | .. | .. |
| Oil | 4.59 | 8.97 | 13.17 | 13.09 | 14.33 | .. | .. |
| Gas | 0.05 | 0.05 | 1.18 | 1.21 | 1.72 | .. | .. |
| Comb. Renewables & Waste[2] | 0.58 | 2.33 | 2.46 | 2.47 | 2.55 | .. | .. |
| Geothermal | - | - | 0.00 | 0.00 | - | .. | .. |
| Solar/Wind/Other | - | 0.01 | 0.02 | 0.02 | 0.06 | .. | .. |
| Electricity | 0.70 | 2.03 | 3.57 | 3.71 | 4.54 | .. | .. |
| Heat | - | 0.03 | 0.20 | 0.23 | 0.44 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.1* | *4.2* | *0.9* | *0.7* | *0.7* | .. | .. |
| *Oil* | *75.1* | *64.0* | *63.4* | *62.7* | *60.2* | .. | .. |
| *Gas* | *0.8* | *0.4* | *5.7* | *5.8* | *7.2* | .. | .. |
| *Comb. Renewables & Waste* | *9.5* | *16.6* | *11.9* | *11.8* | *10.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | *0.1* | *0.1* | *0.1* | *0.3* | .. | .. |
| *Electricity* | *11.5* | *14.5* | *17.2* | *17.8* | *19.1* | .. | .. |
| *Heat* | - | *0.2* | *1.0* | *1.1* | *1.9* | .. | .. |
| **TOTAL INDUSTRY[6]** | **2.71** | **6.81** | **8.46** | **8.16** | **9.39** | **..** | **..** |
| Coal[1] | 0.14 | 0.59 | 0.18 | 0.14 | 0.17 | .. | .. |
| Oil | 1.81 | 3.96 | 4.45 | 4.12 | 4.26 | .. | .. |
| Gas | 0.00 | - | 0.92 | 0.92 | 1.20 | .. | .. |
| Comb. Renewables & Waste[2] | 0.32 | 1.18 | 1.31 | 1.32 | 1.40 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 0.44 | 1.05 | 1.42 | 1.45 | 1.93 | .. | .. |
| Heat | - | 0.03 | 0.19 | 0.21 | 0.42 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.1* | *8.7* | *2.1* | *1.7* | *1.8* | .. | .. |
| *Oil* | *66.9* | *58.2* | *52.6* | *50.6* | *45.4* | .. | .. |
| *Gas* | *0.1* | - | *10.8* | *11.3* | *12.8* | .. | .. |
| *Comb. Renewables & Waste* | *11.8* | *17.3* | *15.5* | *16.2* | *14.9* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *16.2* | *15.4* | *16.7* | *17.7* | *20.6* | .. | .. |
| *Heat* | - | *0.4* | *2.2* | *2.6* | *4.5* | .. | .. |
| **TRANSPORT[7]** | **1.95** | **3.82** | **6.90** | **7.26** | **8.27** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **1.46** | **3.37** | **5.42** | **5.45** | **6.16** | **..** | **..** |
| Coal[1] | 0.04 | 0.00 | - | - | - | .. | .. |
| Oil | 0.87 | 1.21 | 1.86 | 1.76 | 1.85 | .. | .. |
| Gas | 0.05 | 0.05 | 0.26 | 0.28 | 0.52 | .. | .. |
| Comb. Renewables & Waste[2] | 0.26 | 1.15 | 1.15 | 1.15 | 1.15 | .. | .. |
| Geothermal | - | - | 0.00 | 0.00 | - | .. | .. |
| Solar/Wind/Other | - | 0.01 | 0.02 | 0.02 | 0.06 | .. | .. |
| Electricity | 0.25 | 0.95 | 2.12 | 2.23 | 2.56 | .. | .. |
| Heat | - | - | 0.01 | 0.01 | 0.02 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.4* | - | - | - | - | .. | .. |
| *Oil* | *59.7* | *35.9* | *34.4* | *32.2* | *30.1* | .. | .. |
| *Gas* | *3.2* | *1.5* | *4.8* | *5.1* | *8.4* | .. | .. |
| *Comb. Renewables & Waste* | *17.9* | *34.1* | *21.2* | *21.1* | *18.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | *0.3* | *0.4* | *0.4* | *1.0* | .. | .. |
| *Electricity* | *16.8* | *28.1* | *39.0* | *40.9* | *41.6* | .. | .. |
| *Heat* | - | - | *0.2* | *0.2* | *0.3* | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **1.33** | **5.10** | **8.42** | **7.78** | **10.49** | .. | .. |
| **OUTPUT (Mtoe)** | **0.84** | **2.44** | **3.93** | **4.00** | **5.18** | .. | .. |
| (TWh gross) | 9.79 | 28.36 | 45.65 | 46.52 | 60.20 | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *3.9* | *32.1* | *33.3* | *31.2* | *21.8* | .. | .. |
| *Oil* | *19.2* | *33.1* | *25.0* | *13.2* | *7.9* | .. | .. |
| *Gas* | - | - | *19.8* | *16.6* | *33.8* | .. | .. |
| *Comb. Renewables & Waste* | *2.0* | *2.4* | *3.8* | *3.8* | *3.0* | .. | .. |
| *Nuclear* | - | - | - | - | - | .. | .. |
| *Hydro* | *74.8* | *32.3* | *17.1* | *33.8* | *21.5* | .. | .. |
| *Geothermal* | - | *0.0* | *0.2* | *0.2* | *0.1* | .. | .. |
| *Solar/Wind/Other* | - | *0.0* | *0.8* | *1.1* | *11.8* | .. | .. |
| **TOTAL LOSSES** | **1.26** | **3.21** | **5.50** | **4.87** | **6.17** | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 0.49 | 2.63 | 4.29 | 3.55 | 4.69 | .. | .. |
| Other Transformation | 0.27 | -0.38 | -0.08 | -0.08 | - | .. | .. |
| Own Use and Losses[11] | 0.51 | 0.96 | 1.28 | 1.40 | 1.48 | .. | .. |
| **Statistical Differences** | **-0.15** | **0.53** | **0.18** | **0.04** | - | .. | .. |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 47.40 | 80.99 | 108.61 | 107.30 | 132.87 | .. | .. |
| Population (millions) | 8.64 | 9.90 | 10.37 | 10.44 | 10.50 | .. | .. |
| TPES/GDP[12] | 0.15 | 0.22 | 0.24 | 0.24 | 0.23 | .. | .. |
| Energy Production/TPES | 0.19 | 0.19 | 0.14 | 0.17 | 0.19 | .. | .. |
| Per Capita TPES[13] | 0.84 | 1.79 | 2.55 | 2.47 | 2.85 | .. | .. |
| Oil Supply/GDP[12] | 0.12 | 0.14 | 0.15 | 0.14 | 0.12 | .. | .. |
| TFC/GDP[12] | 0.13 | 0.17 | 0.19 | 0.19 | 0.18 | .. | .. |
| Per Capita TFC[13] | 0.71 | 1.41 | 2.00 | 2.00 | 2.27 | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 16.4 | 39.6 | 63.4 | 58.9 | 66.3 | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 3.5 | 3.5 | 3.4 | 3.8 | 6.3 | .. | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 5.5 | 5.4 | 3.4 | -2.6 | 2.2 | .. | .. |
| Coal | -2.4 | 18.2 | 1.9 | -5.6 | -0.9 | .. | .. |
| Oil | 6.1 | 3.8 | 2.9 | -7.1 | 0.8 | .. | .. |
| Gas | - | - | - | -3.4 | 9.9 | .. | .. |
| Comb. Renewables & Waste | 3.2 | 11.2 | 1.1 | 0.3 | 4.2 | .. | .. |
| Nuclear | - | - | - | - | - | .. | .. |
| Hydro | 7.3 | -1.8 | -1.3 | 101.5 | -2.8 | .. | .. |
| Geothermal | - | - | 32.0 | -7.1 | -1.7 | .. | .. |
| Solar/Wind/Other | - | - | 13.6 | 23.5 | 40.2 | .. | .. |
| TFC | 4.7 | 5.2 | 3.3 | 0.4 | 1.9 | .. | .. |
| Electricity Consumption | 8.5 | 5.3 | 4.8 | 4.1 | 2.9 | .. | .. |
| Energy Production | 4.4 | 5.9 | 0.6 | 19.1 | 3.8 | .. | .. |
| Net Oil Imports | 8.1 | 2.9 | 2.4 | -0.1 | 0.3 | .. | .. |
| GDP | 2.9 | 3.4 | 2.5 | -1.2 | 3.1 | .. | .. |
| Growth in the TPES/GDP Ratio | 2.5 | 2.0 | 0.9 | -1.4 | -0.9 | .. | .. |
| Growth in the TFC/GDP Ratio | 1.8 | 1.7 | 0.8 | 1.6 | -1.2 | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **11.3** | **34.6** | **31.8** | **33.0** | **..** | **..** | **..** |
| Coal[1] | | 6.5 | 11.7 | 7.5 | 7.0 | .. | .. | .. |
| Oil | | 0.7 | 1.2 | 0.3 | 0.3 | .. | .. | .. |
| Gas | | 0.0 | 1.3 | 0.5 | 0.2 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | 0.0 | 4.1 | 4.3 | 4.7 | .. | .. | .. |
| Nuclear | | 1.7 | 14.1 | 16.4 | 16.1 | .. | .. | .. |
| Hydro | | 2.5 | 2.2 | 2.0 | 3.5 | .. | .. | .. |
| Geothermal | | – | – | 0.0 | 0.0 | .. | .. | .. |
| Solar/Wind/Other[3] | | – | 0.0 | 0.8 | 1.1 | .. | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **42.5** | **56.6** | **101.9** | **102.7** | **..** | **..** | **..** |
| Coal1 | Exports | 0.0 | 0.0 | 0.5 | 0.5 | .. | .. | .. |
| | Imports | 2.2 | 7.1 | 14.8 | 13.3 | .. | .. | .. |
| | Net Imports | 2.2 | 7.1 | 14.4 | 12.7 | .. | .. | .. |
| Oil | Exports | 4.3 | 12.3 | 6.2 | 7.0 | .. | .. | .. |
| | Imports | 45.3 | 61.8 | 81.2 | 82.7 | .. | .. | .. |
| | Bunkers | 1.4 | 3.7 | 6.8 | 7.0 | .. | .. | .. |
| | Net Imports | 39.6 | 45.9 | 68.1 | 68.7 | .. | .. | .. |
| Gas | Exports | – | – | – | – | – | .. | .. |
| | Imports | 0.9 | 3.7 | 18.9 | 21.2 | .. | .. | .. |
| | Net Imports | 0.9 | 3.7 | 18.9 | 21.2 | .. | .. | .. |
| Electricity | Exports | 0.2 | 0.3 | 0.6 | 0.7 | .. | .. | .. |
| | Imports | 0.0 | 0.3 | 1.1 | 0.8 | .. | .. | .. |
| | Net Imports | -0.2 | -0.0 | 0.5 | 0.1 | .. | .. | .. |
| **TOTAL STOCK CHANGES** | | **-1.5** | **-0.1** | **-2.1** | **0.4** | **..** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **52.4** | **91.1** | **131.6** | **136.1** | **170.2** | **..** | **..** |
| Coal[1] | | 9.0 | 19.3 | 21.6 | 20.1 | 15.1 | .. | .. |
| Oil | | 38.4 | 46.5 | 67.3 | 69.0 | 81.6 | .. | .. |
| Gas | | 0.9 | 5.0 | 18.7 | 21.3 | 37.0 | .. | .. |
| Comb. Renewables & Waste[2] | | 0.0 | 4.1 | 4.3 | 4.7 | 13.4 | .. | .. |
| Nuclear | | 1.7 | 14.1 | 16.4 | 16.1 | 16.5 | .. | .. |
| Hydro | | 2.5 | 2.2 | 2.0 | 3.5 | 3.3 | .. | .. |
| Geothermal | | – | – | 0.0 | 0.0 | 0.0 | .. | .. |
| Solar/Wind/Other[3] | | – | 0.0 | 0.8 | 1.1 | 2.8 | .. | .. |
| Electricity Trade[5] | | -0.2 | -0.0 | 0.5 | 0.1 | 0.4 | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *17.2* | *21.2* | *16.4* | *14.8* | *8.9* | .. | .. |
| *Oil* | | *73.3* | *51.0* | *51.1* | *50.7* | *48.0* | .. | .. |
| *Gas* | | *1.8* | *5.5* | *14.2* | *15.7* | *21.8* | .. | .. |
| *Comb. Renewables & Waste* | | – | *4.5* | *3.3* | *3.5* | *7.8* | .. | .. |
| *Nuclear* | | *3.3* | *15.5* | *12.5* | *11.8* | *9.7* | .. | .. |
| *Hydro* | | *4.7* | *2.4* | *1.5* | *2.6* | *2.0* | .. | .. |
| *Geothermal* | | – | – | – | – | – | .. | .. |
| *Solar/Wind/Other* | | – | – | *0.6* | *0.8* | *1.6* | .. | .. |
| *Electricity Trade* | | *-0.3* | – | *0.3* | *0.1* | *0.2* | .. | .. |

0 is negligible, – is nil, .. is not available

Please note: The forecast data for 2010 have been estimated by the IEA Secretariat based on the official 2011 Spanish forecasts., assuming a linear growth between 2003 and 2011.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **39.9** | **62.5** | **94.6** | **100.2** | **127.7** | **..** | **..** |
| Coal[1] | 4.0 | 3.2 | 1.5 | 1.6 | 2.2 | .. | .. |
| Oil | 30.1 | 39.9 | 57.7 | 60.2 | 73.8 | .. | .. |
| Gas | 0.7 | 4.6 | 14.2 | 15.8 | 22.9 | .. | .. |
| Comb. Renewables & Waste[2] | – | 3.9 | 3.5 | 3.8 | 4.9 | .. | .. |
| Geothermal | – | – | 0.0 | 0.0 | 0.0 | .. | .. |
| Solar/Wind/Other | – | – | 0.0 | 0.0 | 0.3 | .. | .. |
| Electricity | 5.1 | 10.8 | 17.7 | 18.7 | 23.6 | .. | .. |
| Heat | – | 0.0 | – | – | – | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *9.9* | *5.2* | *1.6* | *1.6* | *1.8* | .. | .. |
| *Oil* | *75.6* | *63.9* | *61.0* | *60.1* | *57.8* | .. | .. |
| *Gas* | *1.8* | *7.4* | *15.0* | *15.8* | *17.9* | .. | .. |
| *Comb. Renewables & Waste* | – | *6.3* | *3.7* | *3.8* | *3.8* | .. | .. |
| *Geothermal* | – | – | – | – | – | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | *0.3* | .. | .. |
| *Electricity* | *12.7* | *17.3* | *18.7* | *18.7* | *18.5* | .. | .. |
| *Heat* | – | – | – | – | – | .. | .. |
| **TOTAL INDUSTRY[6]** | **20.7** | **25.3** | **36.4** | **38.4** | **46.6** | **..** | **..** |
| Coal[1] | 3.6 | 2.9 | 1.4 | 1.5 | 2.1 | .. | .. |
| Oil | 13.4 | 11.3 | 14.9 | 15.0 | 16.0 | .. | .. |
| Gas | 0.4 | 3.8 | 10.8 | 12.1 | 17.2 | .. | .. |
| Comb. Renewables & Waste[2] | – | 1.8 | 1.3 | 1.5 | 2.3 | .. | .. |
| Geothermal | – | – | – | – | – | .. | .. |
| Solar/Wind/Other | – | – | – | 0.0 | – | .. | .. |
| Electricity | 3.3 | 5.4 | 7.9 | 8.3 | 8.9 | .. | .. |
| Heat | – | – | – | – | – | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *17.5* | *11.6* | *3.9* | *3.9* | *4.6* | .. | .. |
| *Oil* | *64.7* | *44.6* | *41.0* | *39.1* | *34.4* | .. | .. |
| *Gas* | *2.0* | *14.9* | *29.7* | *31.5* | *36.9* | .. | .. |
| *Comb. Renewables & Waste* | – | *7.3* | *3.7* | *4.0* | *4.9* | .. | .. |
| *Geothermal* | – | – | – | – | – | .. | .. |
| *Solar/Wind/Other* | – | – | – | – | – | .. | .. |
| *Electricity* | *15.8* | *21.5* | *21.7* | *21.6* | *19.2* | .. | .. |
| *Heat* | – | – | – | – | – | .. | .. |
| **TRANSPORT[7]** | **11.9** | **22.8** | **35.7** | **37.6** | **48.8** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **7.2** | **14.4** | **22.6** | **24.2** | **32.3** | **..** | **..** |
| Coal[1] | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | .. | .. |
| Oil | 4.9 | 6.1 | 7.7 | 8.2 | 10.7 | .. | .. |
| Gas | 0.3 | 0.8 | 3.4 | 3.7 | 5.7 | .. | .. |
| Comb. Renewables & Waste[2] | – | 2.1 | 2.1 | 2.1 | 2.1 | .. | .. |
| Geothermal | – | – | 0.0 | 0.0 | 0.0 | .. | .. |
| Solar/Wind/Other | – | – | 0.0 | 0.0 | 0.3 | .. | .. |
| Electricity | 1.7 | 5.1 | 9.4 | 10.0 | 13.4 | .. | .. |
| Heat | – | 0.0 | – | – | – | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *4.3* | *2.1* | *0.3* | *0.3* | *0.3* | .. | .. |
| *Oil* | *68.2* | *42.4* | *33.9* | *34.0* | *33.2* | .. | .. |
| *Gas* | *4.1* | *5.8* | *15.0* | *15.4* | *17.5* | .. | .. |
| *Comb. Renewables & Waste* | – | *14.4* | *9.1* | *8.7* | *6.4* | .. | .. |
| *Geothermal* | – | – | – | – | – | .. | .. |
| *Solar/Wind/Other* | – | – | *0.2* | *0.2* | *1.0* | .. | .. |
| *Electricity* | *23.4* | *35.2* | *41.5* | *41.3* | *41.5* | .. | .. |
| *Heat* | – | – | – | – | – | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **12.6** | **33.0** | **48.9** | **49.4** | **61.1** | .. | .. |
| **OUTPUT (Mtoe)** | **6.5** | **13.0** | **20.8** | **22.2** | **27.4** | .. | .. |
| (TWh gross) | 75.7 | 151.2 | 241.6 | 257.9 | 319.1 | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *18.9* | *40.1* | *34.1* | *29.5* | *16.4* | .. | .. |
| *Oil* | *33.2* | *5.7* | *11.8* | *9.3* | *4.6* | .. | .. |
| *Gas* | *1.0* | *1.0* | *13.4* | *15.3* | *31.3* | .. | .. |
| *Comb. Renewables & Waste* | *0.1* | *0.4* | *1.2* | *1.4* | *7.1* | .. | .. |
| *Nuclear* | *8.7* | *35.9* | *26.1* | *24.0* | *19.9* | .. | .. |
| *Hydro* | *38.2* | *16.8* | *9.5* | *15.9* | *12.2* | .. | .. |
| *Geothermal* | – | – | – | – | – | .. | .. |
| *Solar/Wind/Other* | – | *0.0* | *3.9* | *4.7* | *8.5* | .. | .. |
| **TOTAL LOSSES** | **13.4** | **28.4** | **37.0** | **36.7** | **42.4** | .. | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 6.1 | 20.0 | 28.1 | 27.2 | 33.7 | .. | .. |
| Other Transformation | 3.6 | 2.3 | 1.2 | 1.3 | .. | .. | .. |
| Own Use and Losses[11] | 3.7 | 6.1 | 7.7 | 8.2 | 8.7 | .. | .. |
| **Statistical Differences** | **-0.9** | **0.2** | **-0.0** | **-0.8** | **–** | .. | .. |

## INDICATORS

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 276.03 | 431.41 | 591.13 | 605.90 | 736.06 | .. | .. |
| Population (millions) | 34.81 | 38.85 | 40.55 | 40.81 | 42.44 | .. | .. |
| TPES/GDP[12] | 0.19 | 0.21 | 0.22 | 0.22 | 0.23 | .. | .. |
| Energy Production/TPES | 0.22 | 0.38 | 0.24 | 0.24 | .. | .. | .. |
| Per Capita TPES[13] | 1.50 | 2.34 | 3.25 | 3.34 | 4.01 | .. | .. |
| Oil Supply/GDP[12] | 0.14 | 0.11 | 0.11 | 0.11 | 0.11 | .. | .. |
| TFC/GDP[12] | 0.14 | 0.14 | 0.16 | 0.17 | 0.17 | .. | .. |
| Per Capita TFC[13] | 1.15 | 1.61 | 2.33 | 2.46 | 3.01 | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 141.6 | 206.7 | 302.8 | 313.2 | 365.3 | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 7.0 | 15.0 | 30.0 | 30.8 | 30.8 | .. | .. |

## GROWTH RATES (% per year)

| | 73–79 | 79–90 | 90–02 | 02–03 | 03–10 | 10–20 | 20–30 |
|---|---|---|---|---|---|---|---|
| TPES | 4.1 | 2.9 | 3.1 | 3.4 | 3.2 | .. | .. |
| Coal | 3.0 | 5.4 | 0.9 | -6.8 | -4.0 | .. | .. |
| Oil | 4.1 | -0.5 | 3.1 | 2.6 | 2.4 | .. | .. |
| Gas | 6.7 | 12.3 | 11.7 | 13.9 | 8.2 | .. | .. |
| Comb. Renewables & Waste | 24.8 | 49.4 | 0.5 | 10.4 | 15.9 | .. | .. |
| Nuclear | 0.4 | 20.9 | 1.3 | -1.8 | 0.4 | .. | .. |
| Hydro | 8.2 | -5.3 | -0.9 | 79.1 | -0.8 | .. | .. |
| Geothermal | – | – | – | – | -9.4 | .. | .. |
| Solar/Wind/Other | – | – | 65.5 | 28.5 | 14.4 | .. | .. |
| TFC | 4.1 | 1.9 | 3.5 | 5.9 | 3.5 | .. | .. |
| Electricity Consumption | 6.4 | 3.6 | 4.2 | 6.0 | 3.4 | .. | .. |
| Energy Production | 5.5 | 7.5 | -0.7 | 3.8 | .. | .. | .. |
| Net Oil Imports | 3.2 | -0.4 | 3.3 | 0.9 | .. | .. | .. |
| GDP | 2.3 | 2.9 | 2.7 | 2.5 | 2.8 | .. | .. |
| Growth in the TPES/GDP Ratio | 1.8 | -0.0 | 0.4 | 0.9 | 0.4 | .. | .. |
| Growth in the TFC/GDP Ratio | 1.8 | -0.9 | 0.8 | 3.3 | 0.7 | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# SWEDEN

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **9.3** | **29.8** | **32.5** | **31.7** | **33.7** | **..** | **..** |
| Coal[1] | | 0.0 | 0.0 | - | - | - | .. | .. |
| Peat | | - | 0.2 | 0.3 | 0.4 | 0.3 | .. | .. |
| Oil | | - | 0.0 | - | - | - | .. | .. |
| Gas | | - | - | - | - | - | .. | .. |
| Comb. Renewables & Waste[2] | | 3.5 | 5.5 | 8.2 | 8.8 | 9.5 | .. | .. |
| Nuclear | | 0.6 | 17.8 | 17.8 | 17.6 | 17.2 | .. | .. |
| Hydro | | 5.1 | 6.2 | 5.7 | 4.6 | 6.0 | .. | .. |
| Geothermal | | - | - | - | - | - | .. | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.4 | 0.4 | 0.8 | .. | .. |
| **TOTAL NET IMPORTS[4]** | | **29.6** | **17.6** | **18.6** | **21.1** | **19.9** | **..** | **..** |
| Coal[1] | Exports | 0.0 | 0.0 | 0.0 | 0.0 | - | .. | .. |
| | Imports | 1.7 | 2.6 | 2.3 | 2.5 | 2.4 | .. | .. |
| | Net Imports | 1.7 | 2.6 | 2.3 | 2.5 | 2.4 | .. | .. |
| Peat | Exports | - | - | - | - | - | .. | .. |
| | Imports | - | - | - | - | - | .. | .. |
| | Net Imports | - | - | - | - | - | .. | .. |
| Oil | Exports | 1.4 | 8.7 | 9.5 | 10.2 | - | .. | .. |
| | Imports | 30.4 | 24.0 | 25.7 | 28.5 | 18.3 | .. | .. |
| | Bunkers | 1.1 | 0.7 | 1.2 | 1.6 | 1.9 | .. | .. |
| | Net Imports | 27.8 | 14.6 | 15.0 | 16.6 | 16.4 | .. | .. |
| Gas | Exports | - | - | - | - | - | .. | .. |
| | Imports | - | 0.6 | 0.9 | 0.9 | 0.8 | .. | .. |
| | Net Imports | - | 0.6 | 0.9 | 0.9 | 0.8 | .. | .. |
| Electricity | Exports | 0.4 | 1.3 | 1.3 | 1.0 | - | .. | .. |
| | Imports | 0.5 | 1.1 | 1.7 | 2.1 | 0.4 | .. | .. |
| | Net Imports | 0.1 | -0.2 | 0.5 | 1.1 | 0.4 | .. | .. |
| **TOTAL STOCK CHANGES** | | **0.5** | **0.2** | **1.7** | **-1.2** | **-** | **..** | **..** |
| **TOTAL SUPPLY (TPES)** | | **39.3** | **47.6** | **52.8** | **51.5** | **53.7** | **..** | **..** |
| Coal[1] | | 1.6 | 2.7 | 2.5 | 2.3 | 2.4 | .. | .. |
| Peat | | - | 0.2 | 0.3 | 0.4 | 0.3 | .. | .. |
| Oil | | 28.4 | 14.7 | 16.5 | 15.5 | 16.4 | .. | .. |
| Gas | | - | 0.6 | 0.9 | 0.9 | 0.8 | .. | .. |
| Comb. Renewables & Waste[2] | | 3.5 | 5.5 | 8.2 | 8.8 | 9.5 | .. | .. |
| Nuclear | | 0.6 | 17.8 | 17.8 | 17.6 | 17.2 | .. | .. |
| Hydro | | 5.1 | 6.2 | 5.7 | 4.6 | 6.0 | .. | .. |
| Geothermal | | - | - | - | - | - | .. | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.4 | 0.4 | 0.8 | .. | .. |
| Electricity Trade[5] | | 0.1 | -0.2 | 0.5 | 1.1 | 0.4 | .. | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *4.1* | *5.7* | *4.7* | *4.5* | *4.4* | .. | .. |
| *Peat* | | - | *0.5* | *0.6* | *0.7* | *0.5* | .. | .. |
| *Oil* | | *72.2* | *30.8* | *31.3* | *30.2* | *30.6* | .. | .. |
| *Gas* | | - | *1.2* | *1.7* | *1.7* | *1.4* | .. | .. |
| *Comb. Renewables & Waste* | | *9.0* | *11.6* | *15.6* | *17.1* | *17.8* | .. | .. |
| *Nuclear* | | *1.4* | *37.4* | *33.6* | *34.1* | *32.1* | .. | .. |
| *Hydro* | | *13.1* | *13.1* | *10.8* | *8.9* | *11.1* | .. | .. |
| *Geothermal* | | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | | - | - | *0.8* | *0.7* | *1.4* | .. | .. |
| *Electricity Trade* | | *0.2* | *-0.3* | *0.9* | *2.1* | *0.7* | .. | .. |

0 is negligible. - is nil, .. is not available
Please note: All forecast data are based on the 2003 submission.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **35.3** | **32.1** | **35.9** | **35.8** | **37.3** | **..** | **..** |
| Coal[1] | 0.9 | 1.0 | 0.9 | 0.8 | 0.7 | .. | .. |
| Peat | - | 0.0 | 0.0 | 0.0 | - | .. | .. |
| Oil | 24.8 | 14.0 | 14.2 | 14.1 | 14.5 | .. | .. |
| Gas | 0.1 | 0.4 | 0.5 | 0.5 | 0.5 | .. | .. |
| Comb. Renewables & Waste[2] | 3.5 | 4.6 | 5.0 | 5.1 | 6.2 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | .. | .. |
| Electricity | 6.0 | 10.4 | 11.3 | 11.2 | 11.7 | .. | .. |
| Heat | - | 1.7 | 4.0 | 4.1 | 3.8 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.6* | *3.3* | *2.6* | *2.2* | *1.9* | .. | .. |
| *Peat* | - | - | - | - | - | .. | .. |
| *Oil* | *70.4* | *43.7* | *39.5* | *39.4* | *38.8* | .. | .. |
| *Gas* | *0.3* | *1.1* | *1.4* | *1.5* | *1.3* | .. | .. |
| *Comb. Renewables & Waste* | *9.8* | *14.4* | *13.9* | *14.4* | *16.5* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *16.9* | *32.2* | *31.4* | *31.2* | *31.3* | .. | .. |
| *Heat* | - | *5.3* | *11.2* | *11.3* | *10.1* | .. | .. |
| **TOTAL INDUSTRY[6]** | **15.5** | **13.3** | **14.7** | **14.3** | **15.9** | **..** | **..** |
| Coal[1] | 0.9 | 1.0 | 0.9 | 0.8 | 0.7 | .. | .. |
| Peat | - | 0.0 | 0.0 | 0.0 | - | .. | .. |
| Oil | 8.3 | 3.5 | 4.1 | 3.9 | 4.1 | .. | .. |
| Gas | 0.0 | 0.3 | 0.3 | 0.3 | 0.3 | .. | .. |
| Comb. Renewables & Waste[2] | 2.9 | 3.7 | 4.0 | 4.2 | 5.2 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | - | - | - | .. | .. |
| Electricity | 3.4 | 4.6 | 4.9 | 4.8 | 5.1 | .. | .. |
| Heat | - | 0.2 | 0.4 | 0.4 | 0.4 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.7* | *7.6* | *6.4* | *5.5* | *4.5* | .. | .. |
| *Peat* | - | - | - | *0.1* | - | .. | .. |
| *Oil* | *53.4* | *26.5* | *27.7* | *27.0* | *26.0* | .. | .. |
| *Gas* | *0.1* | *1.9* | *2.2* | *2.3* | *2.0* | .. | .. |
| *Comb. Renewables & Waste* | *18.9* | *27.7* | *27.4* | *29.1* | *32.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *21.9* | *35.0* | *33.6* | *33.4* | *32.1* | .. | .. |
| *Heat* | - | *1.3* | *2.7* | *2.7* | *2.7* | .. | .. |
| **TRANSPORT[7]** | **5.5** | **7.4** | **8.1** | **8.3** | **8.3** | **..** | **..** |
| **TOTAL OTHER SECTORS[8]** | **14.3** | **11.5** | **13.1** | **13.2** | **13.1** | **..** | **..** |
| Coal[1] | 0.0 | 0.0 | - | - | - | .. | .. |
| Peat | - | - | - | - | - | .. | .. |
| Oil | 11.2 | 3.3 | 2.2 | 2.2 | 2.3 | .. | .. |
| Gas | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | .. | .. |
| Comb. Renewables & Waste[2] | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | .. | .. |
| Electricity | 2.4 | 5.5 | 6.1 | 6.1 | 6.3 | .. | .. |
| Heat | - | 1.5 | 3.6 | 3.7 | 3.3 | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *0.3* | *0.4* | - | - | - | .. | .. |
| *Peat* | - | - | - | - | - | .. | .. |
| *Oil* | *78.7* | *28.9* | *17.1* | *16.9* | *17.6* | .. | .. |
| *Gas* | *0.7* | *0.9* | *1.2* | *1.4* | *1.4* | .. | .. |
| *Comb. Renewables & Waste* | *3.6* | *8.4* | *7.4* | *7.4* | *7.4* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | - | - | - | - | .. | .. |
| *Electricity* | *16.6* | *47.9* | *46.7* | *46.4* | *48.2* | .. | .. |
| *Heat* | - | *13.4* | *27.6* | *27.9* | *25.5* | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **8.2** | **26.7** | **28.8** | **28.1** | **28.6** | **..** | **..** |
| **OUTPUT (Mtoe)** | **6.7** | **12.6** | **12.6** | **11.7** | **13.0** | **..** | **..** |
| (TWh gross) | 78.1 | 146.0 | 146.7 | 135.6 | 151.3 | .. | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *0.6* | *1.2* | *2.4* | *3.0* | *1.8* | .. | .. |
| *Peat* | - | *0.0* | *0.1* | *0.1* | *0.1* | .. | .. |
| *Oil* | *19.4* | *0.8* | *2.1* | *2.9* | *2.1* | .. | .. |
| *Gas* | - | *0.3* | *0.3* | *0.4* | *0.4* | .. | .. |
| *Comb. Renewables & Waste* | *0.5* | *1.3* | *3.0* | *4.2* | *3.7* | .. | .. |
| *Nuclear* | *2.7* | *46.7* | *46.4* | *49.7* | *43.7* | .. | .. |
| *Hydro* | *76.7* | *49.7* | *45.2* | *39.3* | *45.7* | .. | .. |
| *Geothermal* | - | - | - | - | - | .. | .. |
| *Solar/Wind/Other* | - | *0.0* | *0.4* | *0.5* | *2.6* | .. | .. |
| **TOTAL LOSSES** | **3.4** | **16.1** | **17.1** | **16.9** | **16.3** | **..** | **..** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 1.5 | 12.2 | 12.7 | 12.8 | 12.0 | .. | .. |
| Other Transformation | 1.0 | 1.1 | 2.2 | 1.9 | 2.1 | .. | .. |
| Own Use and Losses[11] | 1.0 | 2.8 | 2.2 | 2.2 | 2.2 | .. | .. |
| **Statistical Differences** | **0.60** | **-0.68** | **-0.14** | **-1.12** | **-** | **..** | **..** |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 139.98 | 196.64 | 246.86 | 250.48 | 288.37 | .. | .. |
| Population (millions) | 8.14 | 8.56 | 8.93 | 8.96 | 9.18 | .. | .. |
| TPES/GDP[12] | 0.28 | 0.24 | 0.21 | 0.21 | 0.19 | .. | .. |
| Energy Production/TPES | 0.24 | 0.63 | 0.61 | 0.61 | 0.63 | .. | .. |
| Per Capita TPES[13] | 4.83 | 5.56 | 5.92 | 5.75 | 5.84 | .. | .. |
| Oil Supply/GDP[12] | 0.20 | 0.07 | 0.07 | 0.06 | 0.06 | .. | .. |
| TFC/GDP[12] | 0.25 | 0.16 | 0.15 | 0.14 | 0.13 | .. | .. |
| Per Capita TFC[13] | 4.34 | 3.76 | 4.02 | 4.00 | 4.07 | .. | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 84.9 | 51.7 | 52.1 | 53.6 | 49.1 | .. | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 3.9 | 3.2 | 5.4 | 6.7 | 7.6 | .. | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.8 | 0.8 | 0.9 | -2.5 | 0.6 | .. | .. |
| Coal | 1.6 | 3.9 | -0.7 | -6.7 | 0.2 | .. | .. |
| Peat | - | - | 3.3 | 3.8 | -4.5 | .. | .. |
| Oil | -0.8 | -5.4 | 1.0 | -5.9 | 0.8 | .. | .. |
| Gas | - | - | 3.7 | -0.3 | -1.9 | .. | .. |
| Comb. Renewables & Waste | 1.8 | 3.1 | 3.4 | 6.9 | 1.2 | .. | .. |
| Nuclear | 46.7 | 11.3 | -0.0 | -1.0 | -0.3 | .. | .. |
| Hydro | 0.3 | 1.6 | -0.7 | -19.8 | 3.8 | .. | .. |
| Geothermal | - | - | - | - | - | .. | .. |
| Solar/Wind/Other | - | - | 24.8 | 3.5 | 28.2 | .. | .. |
| TFC | 0.4 | -1.1 | 0.9 | -0.3 | 0.6 | .. | .. |
| Electricity Consumption | 3.5 | 3.2 | 0.7 | -1.2 | 0.7 | .. | .. |
| Energy Production | 8.0 | 6.6 | 0.7 | -2.4 | 0.9 | .. | .. |
| Net Oil Imports | 0.3 | -5.8 | 0.2 | 10.8 | -0.2 | .. | .. |
| GDP | 1.8 | 2.1 | 1.9 | 1.5 | 2.0 | .. | .. |
| Growth in the TPES/GDP Ratio | -0.0 | -1.3 | -1.0 | -3.9 | -1.4 | .. | .. |
| Growth in the TFC/GDP Ratio | -1.3 | -3.2 | -1.0 | -1.7 | -1.4 | .. | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

## SUPPLY

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **4.28** | **9.83** | **11.94** | **12.00** | **11.21** | **10.50** | **9.01** |
| Coal[1] | | - | - | - | - | - | - | - |
| Oil | | - | - | - | - | - | - | - |
| Gas | | - | 0.00 | - | - | - | - | - |
| Comb. Renewables & Waste[2] | | 0.24 | 1.02 | 1.66 | 1.68 | 2.03 | 2.10 | 2.03 |
| Nuclear | | 1.64 | 6.18 | 7.12 | 7.19 | 6.29 | 5.52 | 4.10 |
| Hydro | | 2.40 | 2.56 | 3.03 | 2.99 | 2.88 | 2.88 | 2.88 |
| Geothermal | | - | 0.06 | 0.11 | 0.12 | - | - | - |
| Solar/Wind/Other[3] | | - | 0.01 | 0.02 | 0.02 | 0.00 | 0.01 | 0.01 |
| **TOTAL NET IMPORTS[4]** | | **15.23** | **15.16** | **15.24** | **14.93** | **15.87** | **16.20** | **16.47** |
| Coal[1] | Exports | 0.02 | 0.01 | - | - | - | - | - |
| | Imports | 0.24 | 0.35 | 0.11 | 0.08 | 0.10 | 0.10 | 0.10 |
| | Net Imports | 0.22 | 0.34 | 0.11 | 0.08 | 0.10 | 0.10 | 0.10 |
| Oil | Exports | 0.23 | 0.16 | 0.62 | 0.65 | - | - | - |
| | Imports | 15.38 | 13.54 | 13.65 | 13.15 | 13.04 | 12.94 | 12.63 |
| | Bunkers | - | 0.02 | 0.01 | 0.01 | - | - | - |
| | Net Imports | 15.16 | 13.36 | 13.03 | 12.49 | 13.04 | 12.94 | 12.63 |
| Gas | Exports | - | - | - | - | - | - | - |
| | Imports | 0.15 | 1.63 | 2.49 | 2.63 | 2.85 | 2.99 | 3.13 |
| | Net Imports | 0.15 | 1.63 | 2.49 | 2.63 | 2.85 | 2.99 | 3.13 |
| Electricity | Exports | 0.90 | 1.97 | 2.78 | 2.86 | 0.12 | .. | .. |
| | Imports | 0.60 | 1.79 | 2.39 | 2.59 | .. | 0.17 | 0.61 |
| | Net Imports | -0.30 | -0.18 | -0.39 | -0.27 | -0.12 | 0.17 | 0.61 |
| **TOTAL STOCK CHANGES** | | **0.22** | **0.12** | **-0.04** | **0.15** | **-** | **-** | **-** |
| **TOTAL SUPPLY (TPES)** | | **19.72** | **25.11** | **27.14** | **27.08** | **27.08** | **26.70** | **25.48** |
| Coal[1] | | 0.33 | 0.36 | 0.14 | 0.14 | 0.10 | 0.10 | 0.10 |
| Oil | | 15.26 | 13.46 | 12.96 | 12.58 | 13.04 | 12.94 | 12.63 |
| Gas | | 0.15 | 1.63 | 2.49 | 2.63 | 2.85 | 2.99 | 3.13 |
| Comb. Renewables & Waste[2] | | 0.24 | 1.03 | 1.66 | 1.68 | 2.03 | 2.10 | 2.03 |
| Nuclear | | 1.64 | 6.18 | 7.12 | 7.19 | 6.29 | 5.52 | 4.10 |
| Hydro | | 2.40 | 2.56 | 3.03 | 2.99 | 2.88 | 2.88 | 2.88 |
| Geothermal | | - | 0.06 | 0.11 | 0.12 | - | - | - |
| Solar/Wind/Other[3] | | - | 0.01 | 0.02 | 0.02 | 0.00 | 0.01 | 0.01 |
| Electricity Trade[5] | | -0.30 | -0.18 | -0.39 | -0.27 | -0.12 | 0.17 | 0.61 |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *1.7* | *1.4* | *0.5* | *0.5* | *0.4* | *0.4* | *0.4* |
| *Oil* | | *77.4* | *53.6* | *47.8* | *46.5* | *48.2* | *48.5* | *49.6* |
| *Gas* | | *0.8* | *6.5* | *9.2* | *9.7* | *10.5* | *11.2* | *12.3* |
| *Comb. Renewables & Waste* | | *1.2* | *4.1* | *6.1* | *6.2* | *7.5* | *7.9* | *8.0* |
| *Nuclear* | | *8.3* | *24.6* | *26.2* | *26.5* | *23.2* | *20.7* | *16.1* |
| *Hydro* | | *12.2* | *10.2* | *11.2* | *11.1* | *10.6* | *10.8* | *11.3* |
| *Geothermal* | | - | *0.2* | *0.4* | *0.4* | - | - | - |
| *Solar/Wind/Other* | | - | - | *0.1* | *0.1* | - | - | - |
| *Electricity Trade* | | *-1.5* | *-0.7* | *-1.4* | *-1.0* | *-0.5* | *0.6* | *2.4* |

0 is negligible. - is nil, .. is not available

Please note: All forecast data are based on the 2002 submission.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **17.57** | **19.65** | **21.05** | **21.57** | **21.76** | **21.89** | **21.69** |
| Coal[1] | 0.29 | 0.35 | 0.14 | 0.14 | 0.10 | 0.10 | 0.10 |
| Oil | 14.30 | 12.85 | 12.75 | 12.90 | 12.65 | 12.56 | 12.26 |
| Gas | 0.24 | 1.52 | 2.28 | 2.40 | 2.68 | 2.77 | 2.85 |
| Comb. Renewables & Waste[2] | 0.24 | 0.59 | 0.81 | 0.95 | 1.31 | 1.38 | 1.39 |
| Geothermal | - | 0.06 | 0.11 | 0.12 | - | - | - |
| Solar/Wind/Other | - | 0.01 | 0.02 | 0.02 | - | - | - |
| Electricity | 2.50 | 4.04 | 4.63 | 4.74 | 4.76 | 4.83 | 4.83 |
| Heat | - | 0.25 | 0.33 | 0.30 | 0.27 | 0.26 | 0.26 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.6* | *1.8* | *0.6* | *0.6* | *0.5* | *0.4* | *0.5* |
| *Oil* | *81.4* | *65.4* | *60.6* | *59.8* | *58.1* | *57.4* | *56.5* |
| *Gas* | *1.3* | *7.7* | *10.8* | *11.1* | *12.3* | *12.6* | *13.1* |
| *Comb. Renewables & Waste* | *1.4* | *3.0* | *3.8* | *4.4* | *6.0* | *6.3* | *6.4* |
| *Geothermal* | - | *0.3* | *0.5* | *0.6* | - | - | - |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | - | - | - |
| *Electricity* | *14.2* | *20.6* | *22.0* | *22.0* | *21.9* | *22.1* | *22.3* |
| *Heat* | - | *1.3* | *1.5* | *1.4* | *1.2* | *1.2* | *1.2* |
| **TOTAL INDUSTRY[6]** | **4.78** | **3.93** | **4.55** | **4.59** | **4.85** | **4.89** | **5.03** |
| Coal[1] | 0.08 | 0.33 | 0.13 | 0.13 | 0.10 | 0.10 | 0.10 |
| Oil | 3.70 | 1.31 | 1.51 | 1.51 | 1.42 | 1.38 | 1.39 |
| Gas | 0.05 | 0.59 | 0.75 | 0.79 | 1.14 | 1.14 | 1.19 |
| Comb. Renewables & Waste[2] | - | 0.16 | 0.44 | 0.44 | 0.49 | 0.51 | 0.50 |
| Geothermal | - | - | 0.01 | 0.01 | - | - | - |
| Solar/Wind/Other | - | - | - | - | - | - | - |
| Electricity | 0.95 | 1.48 | 1.56 | 1.57 | 1.63 | 1.69 | 1.77 |
| Heat | - | 0.05 | 0.15 | 0.14 | 0.08 | 0.07 | 0.07 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *1.6* | *8.4* | *2.8* | *2.9* | *2.0* | *2.0* | *2.0* |
| *Oil* | *77.4* | *33.4* | *33.2* | *32.9* | *29.3* | *28.3* | *27.7* |
| *Gas* | *1.1* | *15.1* | *16.6* | *17.2* | *23.4* | *23.3* | *23.7* |
| *Comb. Renewables & Waste* | - | *4.1* | *9.7* | *9.5* | *10.2* | *10.5* | *9.9* |
| *Geothermal* | - | - | *0.2* | *0.2* | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - |
| *Electricity* | *19.9* | *37.7* | *34.2* | *34.2* | *33.5* | *34.5* | *35.3* |
| *Heat* | - | *1.2* | *3.4* | *3.1* | *1.6* | *1.4* | *1.4* |
| **TRANSPORT[7]** | **4.29** | **6.29** | **7.07** | **7.00** | **7.10** | **7.43** | **7.47** |
| **TOTAL OTHER SECTORS[8]** | **8.49** | **9.43** | **9.43** | **9.98** | **9.81** | **9.58** | **9.20** |
| Coal[1] | 0.21 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| Oil | 6.48 | 5.47 | 4.41 | 4.64 | 4.43 | 4.06 | 3.72 |
| Gas | 0.19 | 0.92 | 1.53 | 1.62 | 1.54 | 1.63 | 1.66 |
| Comb. Renewables & Waste[2] | 0.24 | 0.43 | 0.36 | 0.51 | 0.82 | 0.87 | 0.89 |
| Geothermal | - | 0.06 | 0.10 | 0.11 | - | - | - |
| Solar/Wind/Other | - | 0.01 | 0.02 | 0.02 | - | - | - |
| Electricity | 1.37 | 2.34 | 2.83 | 2.91 | 2.83 | 2.83 | 2.74 |
| Heat | - | 0.20 | 0.17 | 0.16 | 0.19 | 0.19 | 0.19 |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *2.5* | *0.2* | *0.1* | *0.1* | - | - | - |
| *Oil* | *76.3* | *57.9* | *46.8* | *46.5* | *45.2* | *42.4* | *40.4* |
| *Gas* | *2.2* | *9.8* | *16.2* | *16.2* | *15.7* | *17.0* | *18.0* |
| *Comb. Renewables & Waste* | *2.8* | *4.5* | *3.9* | *5.1* | *8.4* | *9.1* | *9.7* |
| *Geothermal* | - | *0.6* | *1.1* | *1.1* | - | - | - |
| *Solar/Wind/Other* | - | *0.1* | *0.2* | *0.2* | - | - | - |
| *Electricity* | *16.1* | *24.8* | *30.0* | *29.2* | *28.8* | *29.5* | *29.8* |
| *Heat* | - | *2.1* | *1.8* | *1.6* | *1.9* | *2.0* | *2.1* |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **4.48** | **9.40** | **11.20** | **11.13** | **10.07** | **9.35** | **7.91** |
| **OUTPUT (Mtoe)** | **3.17** | **4.70** | **5.59** | **5.59** | **5.22** | **5.00** | **4.56** |
| (TWh gross) | 36.82 | 54.70 | 64.94 | 64.94 | 60.73 | 58.18 | 53.03 |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | - | *0.1* | - | - | - | - | - |
| *Oil* | *7.1* | *0.5* | *0.1* | *0.1* | *0.1* | *0.1* | *0.2* |
| *Gas* | - | *0.6* | *1.4* | *1.4* | *1.7* | *2.2* | *2.7* |
| *Comb. Renewables & Waste* | - | *1.2* | *2.3* | *2.5* | *3.2* | *3.6* | *4.2* |
| *Nuclear* | *17.1* | *43.2* | *41.9* | *42.3* | *39.8* | *36.4* | *29.6* |
| *Hydro* | *75.8* | *54.5* | *54.2* | *53.6* | *55.2* | *57.6* | *63.2* |
| *Geothermal* | - | - | - | - | - | - | - |
| *Solar/Wind/Other* | - | *0.0* | *0.0* | *0.0* | *0.1* | *0.1* | *0.1* |
| **TOTAL LOSSES** | **2.17** | **5.10** | **6.12** | **6.07** | **5.31** | **4.81** | **3.80** |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 1.32 | 4.42 | 5.26 | 5.22 | 4.55 | 4.06 | 3.05 |
| Other Transformation | 0.14 | 0.01 | -0.03 | -0.02 | 0.00 | - | - |
| Own Use and Losses[11] | 0.72 | 0.67 | 0.89 | 0.87 | 0.76 | 0.75 | 0.74 |
| **Statistical Differences** | **-0.02** | **0.36** | **-0.04** | **-0.57** | - | - | - |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 174.28 | 221.69 | 249.42 | 248.54 | 289.43 | 329.34 | 374.74 |
| Population (millions) | 6.44 | 6.80 | 7.34 | 7.41 | 7.50 | 7.40 | 7.40 |
| TPES/GDP[12] | 0.11 | 0.11 | 0.11 | 0.11 | 0.09 | 0.08 | 0.07 |
| Energy Production/TPES | 0.22 | 0.39 | 0.44 | 0.44 | 0.41 | 0.39 | 0.35 |
| Per Capita TPES[13] | 3.06 | 3.69 | 3.70 | 3.66 | 3.61 | 3.61 | 3.44 |
| Oil Supply/GDP[12] | 0.09 | 0.06 | 0.05 | 0.05 | 0.05 | 0.04 | 0.03 |
| TFC/GDP[12] | 0.10 | 0.09 | 0.08 | 0.09 | 0.08 | 0.07 | 0.06 |
| Per Capita TFC[13] | 2.73 | 2.89 | 2.87 | 2.91 | 2.90 | 2.96 | 2.93 |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 43.6 | 41.5 | 42.8 | 44.2 | 44.2 | 44.2 | 43.7 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 2.1 | 3.2 | 4.1 | 3.7 | 3.7 | 3.7 | 3.7 |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 0.2 | 2.1 | 0.7 | -0.2 | - | -0.1 | -0.5 |
| Coal | -6.3 | 4.5 | -7.8 | 2.9 | -5.0 | - | 0.3 |
| Oil | -2.2 | 0.1 | -0.3 | -3.0 | 0.5 | -0.1 | -0.2 |
| Gas | 31.0 | 7.2 | 3.6 | 5.7 | 1.2 | 0.5 | 0.5 |
| Comb. Renewables & Waste | 11.2 | 7.7 | 4.1 | 0.8 | 2.8 | 0.3 | -0.3 |
| Nuclear | 11.0 | 6.5 | 1.2 | 0.9 | -1.9 | -1.3 | -2.9 |
| Hydro | 2.1 | -0.5 | 1.4 | -1.1 | -0.6 | - | - |
| Geothermal | - | - | 5.0 | 9.2 | - | - | - |
| Solar/Wind/Other | - | - | 9.2 | 4.3 | -25.7 | 5.2 | 1.8 |
| TFC | -0.6 | 1.4 | 0.6 | 2.5 | 0.1 | 0.1 | -0.1 |
| Electricity Consumption | 2.6 | 3.0 | 1.1 | 2.4 | 0.0 | 0.2 | 0.0 |
| Energy Production | 6.5 | 4.2 | 1.6 | 0.5 | -1.0 | -0.6 | -1.5 |
| Net Oil Imports | -1.6 | -0.3 | -0.2 | -4.1 | 0.6 | -0.1 | -0.2 |
| GDP | -0.4 | 2.4 | 1.0 | -0.4 | 2.2 | 1.3 | 1.3 |
| Growth in the TPES/GDP Ratio | 0.6 | -0.3 | -0.3 | 0.1 | -2.2 | -1.4 | -1.7 |
| Growth in the TFC/GDP Ratio | -0.3 | -1.0 | -0.4 | 2.8 | -2.0 | -1.2 | -1.4 |

Please note: Rounding may cause totals to differ from the sum of the elements.

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **15.52** | **25.86** | **24.56** | **23.64** | **36.69** | **65.65** | **..** |
| Coal[1] | | 5.21 | 12.41 | 11.77 | 10.81 | 22.67 | 36.76 | .. |
| Oil | | 3.59 | 3.61 | 2.39 | 2.32 | 1.57 | 0.69 | .. |
| Gas | | – | 0.18 | 0.31 | 0.46 | 0.24 | 0.23 | .. |
| Comb. Renewables & Waste[2] | | 6.45 | 7.21 | 6.05 | 5.79 | 4.42 | 3.93 | .. |
| Nuclear | | – | – | – | – | – | 8.23 | .. |
| Hydro | | 0.22 | 1.99 | 2.90 | 3.04 | 4.90 | 9.42 | .. |
| Geothermal | | 0.05 | 0.43 | 0.82 | 0.86 | 1.98 | 4.81 | .. |
| Solar/Wind/Other[3] | | – | 0.03 | 0.32 | 0.36 | 0.92 | 1.58 | .. |
| **TOTAL NET IMPORTS[4]** | | **8.74** | **27.98** | **50.77** | **55.95** | **88.89** | **156.63** | **..** |
| Coal1 | Exports | – | – | – | 0.00 | – | – | .. |
| | Imports | 0.01 | 4.21 | 8.31 | 10.93 | 12.33 | 43.54 | .. |
| | Net Imports | 0.01 | 4.21 | 8.31 | 10.92 | 12.33 | 43.54 | .. |
| Oil | Exports | 0.86 | 1.90 | 3.13 | 4.39 | – | – | .. |
| | Imports | 9.68 | 23.18 | 31.52 | 32.71 | 39.61 | 60.22 | .. |
| | Bunkers | 0.09 | 0.12 | 0.53 | 0.63 | – | – | .. |
| | Net Imports | 8.73 | 21.16 | 27.86 | 27.70 | 39.61 | 60.22 | .. |
| Gas | Exports | – | – | – | – | 0.67 | 0.67 | .. |
| | Imports | – | 2.68 | 14.34 | 17.28 | 37.63 | 51.98 | .. |
| | Net Imports | – | 2.68 | 14.34 | 17.28 | 36.96 | 51.31 | .. |
| Electricity | Exports | – | 0.08 | 0.04 | 0.05 | – | – | .. |
| | Imports | – | 0.02 | 0.31 | 0.10 | – | 1.56 | .. |
| | Net Imports | – | -0.06 | 0.27 | 0.05 | – | 1.56 | .. |
| **TOTAL STOCK CHANGES** | | **0.11** | **-0.83** | **0.25** | **-0.63** | **–** | **–** | **..** |
| **TOTAL SUPPLY (TPES)** | | **24.37** | **53.01** | **75.58** | **78.95** | **125.59** | **222.27** | **..** |
| Coal[1] | | 5.15 | 16.94 | 19.96 | 21.37 | 35.00 | 80.29 | .. |
| Oil | | 12.50 | 23.61 | 30.53 | 29.77 | 41.18 | 60.92 | .. |
| Gas | | – | 2.86 | 14.73 | 17.72 | 37.19 | 51.54 | .. |
| Comb. Renewables & Waste[2] | | 6.45 | 7.21 | 6.05 | 5.79 | 4.42 | 3.93 | .. |
| Nuclear | | – | – | – | – | – | 8.23 | .. |
| Hydro | | 0.22 | 1.99 | 2.90 | 3.04 | 4.90 | 9.42 | .. |
| Geothermal | | 0.05 | 0.43 | 0.82 | 0.86 | 1.98 | 4.81 | .. |
| Solar/Wind/Other[3] | | – | 0.03 | 0.32 | 0.36 | 0.92 | 1.58 | .. |
| Electricity Trade[5] | | – | -0.06 | 0.27 | 0.05 | – | 1.56 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *21.1* | *32.0* | *26.4* | *27.1* | *27.9* | *36.1* | .. |
| *Oil* | | *51.3* | *44.5* | *40.4* | *37.7* | *32.8* | *27.4* | .. |
| *Gas* | | – | *5.4* | *19.5* | *22.4* | *29.6* | *23.2* | .. |
| *Comb. Renewables & Waste* | | *26.5* | *13.6* | *8.0* | *7.3* | *3.5* | *1.8* | .. |
| *Nuclear* | | – | – | – | – | – | *3.7* | .. |
| *Hydro* | | *0.9* | *3.8* | *3.8* | *3.8* | *3.9* | *4.2* | .. |
| *Geothermal* | | *0.2* | *0.8* | *1.1* | *1.1* | *1.6* | *2.2* | .. |
| *Solar/Wind/Other* | | – | *0.1* | *0.4* | *0.4* | *0.7* | *0.7* | .. |
| *Electricity Trade* | | – | *-0.1* | *0.4* | *0.1* | – | *0.7* | .. |

0 is negligible, – is nil, .. is not available

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **20.03** | **40.55** | **56.67** | **60.01** | **97.31** | **167.78** | **..** |
| Coal[1] | 2.93 | 7.57 | 8.76 | 10.40 | 17.85 | 41.69 | .. |
| Oil | 9.70 | 20.80 | 26.94 | 26.59 | 36.08 | 54.81 | .. |
| Gas | 0.04 | 0.72 | 5.22 | 6.65 | 19.62 | 24.79 | .. |
| Comb. Renewables & Waste[2] | 6.45 | 7.21 | 5.97 | 5.75 | 4.42 | 3.93 | .. |
| Geothermal | 0.05 | 0.36 | 0.73 | 0.78 | 1.65 | 4.48 | .. |
| Solar/Wind/Other | – | 0.03 | 0.32 | 0.35 | 0.50 | 0.86 | .. |
| Electricity | 0.85 | 3.87 | 8.73 | 9.49 | 17.20 | 37.22 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *14.6* | *18.7* | *15.5* | *17.3* | *18.3* | *24.8* | .. |
| *Oil* | *48.5* | *51.3* | *47.5* | *44.3* | *37.1* | *32.7* | .. |
| *Gas* | *0.2* | *1.8* | *9.2* | *11.1* | *20.2* | *14.8* | .. |
| *Comb. Renewables & Waste* | *32.2* | *17.8* | *10.5* | *9.6* | *4.5* | *2.3* | .. |
| *Geothermal* | *0.2* | *0.9* | *1.3* | *1.3* | *1.7* | *2.7* | .. |
| *Solar/Wind/Other* | – | *0.1* | *0.6* | *0.6* | *0.5* | *0.5* | .. |
| *Electricity* | *4.3* | *9.5* | *15.4* | *15.8* | *17.7* | *22.2* | .. |
| *Heat* | – | – | – | – | – | – | .. |
| **TOTAL INDUSTRY[6]** | **4.30** | **13.71** | **21.97** | **23.84** | **44.01** | **79.44** | **..** |
| Coal[1] | 1.14 | 4.52 | 7.39 | 8.61 | 13.94 | 33.88 | .. |
| Oil | 2.60 | 6.16 | 8.25 | 8.26 | 9.59 | 12.21 | .. |
| Gas | 0.00 | 0.67 | 2.01 | 2.24 | 11.79 | 13.65 | .. |
| Comb. Renewables & Waste[2] | – | – | – | – | – | – | .. |
| Geothermal | – | – | – | – | – | – | .. |
| Solar/Wind/Other | – | 0.01 | 0.12 | 0.12 | 0.17 | 0.26 | .. |
| Electricity | 0.55 | 2.35 | 4.20 | 4.62 | 8.53 | 19.44 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *26.5* | *33.0* | *33.6* | *36.1* | *31.7* | *42.7* | .. |
| *Oil* | *60.5* | *44.9* | *37.5* | *34.7* | *21.8* | *15.4* | .. |
| *Gas* | *0.1* | *4.9* | *9.1* | *9.4* | *26.8* | *17.2* | .. |
| *Comb. Renewables & Waste* | – | – | – | – | – | – | .. |
| *Geothermal* | – | – | – | – | – | – | .. |
| *Solar/Wind/Other* | – | *0.1* | *0.5* | *0.5* | *0.4* | *0.3* | .. |
| *Electricity* | *12.9* | *17.2* | *19.1* | *19.4* | *19.4* | *24.5* | .. |
| *Heat* | – | – | – | – | – | – | .. |
| **TRANSPORT[7]** | **4.49** | **9.58** | **12.93** | **12.95** | **19.92** | **34.04** | **..** |
| **TOTAL OTHER SECTORS[8]** | **11.25** | **17.26** | **21.78** | **23.22** | **33.39** | **54.30** | **..** |
| Coal[1] | 1.27 | 3.03 | 1.37 | 1.79 | 3.91 | 7.81 | .. |
| Oil | 3.15 | 5.11 | 5.89 | 5.49 | 6.73 | 8.92 | .. |
| Gas | 0.04 | 0.05 | 3.16 | 4.36 | 7.82 | 11.12 | .. |
| Comb. Renewables & Waste[2] | 6.45 | 7.21 | 5.97 | 5.75 | 4.42 | 3.93 | .. |
| Geothermal | 0.05 | 0.36 | 0.73 | 0.78 | 1.65 | 4.48 | .. |
| Solar/Wind/Other | – | 0.02 | 0.20 | 0.23 | 0.33 | 0.61 | .. |
| Electricity | 0.29 | 1.49 | 4.46 | 4.81 | 8.52 | 17.44 | .. |
| Heat | – | – | – | – | – | – | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *11.2* | *17.6* | *6.3* | *7.7* | *11.7* | *14.4* | .. |
| *Oil* | *28.0* | *29.6* | *27.0* | *23.7* | *20.2* | *16.4* | .. |
| *Gas* | *0.3* | *0.3* | *14.5* | *18.8* | *23.4* | *20.5* | .. |
| *Comb. Renewables & Waste* | *57.4* | *41.7* | *27.4* | *24.8* | *13.2* | *7.2* | .. |
| *Geothermal* | *0.4* | *2.1* | *3.4* | *3.4* | *4.9* | *8.3* | .. |
| *Solar/Wind/Other* | – | *0.1* | *0.9* | *1.0* | *1.0* | *1.1* | .. |
| *Electricity* | *2.6* | *8.6* | *20.5* | *20.7* | *25.5* | *32.1* | .. |
| *Heat* | – | – | – | – | – | – | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION**[9] | | | | | | | |
| **INPUT (Mtoe)** | **2.77** | **11.08** | **24.08** | **24.90** | **41.21** | **84.49** | **..** |
| **OUTPUT (Mtoe)** | **1.07** | **4.95** | **11.13** | **12.09** | **20.81** | **41.40** | **..** |
| (TWh gross) | 12.43 | 57.54 | 129.40 | 140.58 | 242.02 | 481.38 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *26.1* | *35.1* | *24.8* | *22.9* | *27.3* | *33.3* | .. |
| *Oil* | *51.4* | *6.9* | *8.3* | *6.5* | *2.9* | *1.3* | .. |
| *Gas* | – | *17.7* | *40.6* | *45.2* | *44.1* | *34.3* | .. |
| *Comb. Renewables & Waste* | *1.6* | – | *0.1* | *0.1* | – | – | .. |
| *Nuclear* | – | – | – | – | – | *6.6* | .. |
| *Hydro* | *20.9* | *40.2* | *26.0* | *25.1* | *23.6* | *22.8* | .. |
| *Geothermal* | – | *0.1* | *0.1* | *0.1* | *0.2* | *0.1* | .. |
| *Solar/Wind/Other* | – | – | *0.0* | *0.0* | *2.0* | *1.7* | .. |
| **TOTAL LOSSES** | **4.04** | **11.58** | **18.73** | **18.80** | **28.28** | **54.49** | **..** |
| *of which:* | | | | | | | |
| Electricity and Heat Generation[10] | 1.70 | 6.13 | 12.95 | 12.81 | 20.40 | 43.09 | .. |
| Other Transformation | 1.34 | 2.89 | 1.00 | 1.21 | 2.25 | 2.83 | .. |
| Own Use and Losses[11] | 0.99 | 2.56 | 4.78 | 4.77 | 5.63 | 8.58 | .. |
| **Statistical Differences** | **0.30** | **0.88** | **0.18** | **0.15** | **–** | **–** | **..** |

## INDICATORS

| | 1973 | 1990 | 2002 | 2003P | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 66.33 | 140.20 | 198.97 | 210.50 | 304.18 | 565.65 | .. |
| Population (millions) | 38.45 | 56.20 | 69.67 | 70.80 | 78.46 | 87.76 | .. |
| TPES/GDP[12] | 0.37 | 0.38 | 0.38 | 0.38 | 0.41 | 0.39 | .. |
| Energy Production/TPES | 0.64 | 0.49 | 0.32 | 0.30 | 0.29 | 0.30 | .. |
| Per Capita TPES[13] | 0.63 | 0.94 | 1.08 | 1.12 | 1.60 | 2.53 | .. |
| Oil Supply/GDP[12] | 0.19 | 0.17 | 0.15 | 0.14 | 0.14 | 0.11 | .. |
| TFC/GDP[12] | 0.30 | 0.29 | 0.28 | 0.29 | 0.32 | 0.30 | .. |
| Per Capita TFC[13] | 0.52 | 0.72 | 0.81 | 0.85 | 1.24 | 1.91 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 52.7 | 128.8 | 193.6 | 202.9 | 329.9 | 595.4 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 0.4 | 0.9 | 4.3 | 4.7 | 2.8 | 2.8 | .. |

## GROWTH RATES (% per year)

| | 73–79 | 79–90 | 90–02 | 02–03 | 03–10 | 10–20 | 20–30 |
|---|---|---|---|---|---|---|---|
| TPES | 3.7 | 5.2 | 3.0 | 4.5 | 6.9 | 5.9 | .. |
| Coal | 4.1 | 9.0 | 1.4 | 7.1 | 7.3 | 8.7 | .. |
| Oil | 3.1 | 4.2 | 2.2 | -2.5 | 4.7 | 4.0 | .. |
| Gas | – | – | 14.7 | 20.3 | 11.2 | 3.3 | .. |
| Comb. Renewables & Waste | 3.1 | -0.7 | -1.4 | -4.3 | -3.8 | -1.2 | .. |
| Nuclear | – | – | – | – | – | – | .. |
| Hydro | 25.7 | 7.6 | 3.2 | 4.9 | 7.1 | 6.7 | .. |
| Geothermal | 3.8 | 19.7 | 5.5 | 4.9 | 12.7 | 9.3 | .. |
| Solar/Wind/Other | – | – | 22.6 | 10.2 | 14.5 | 5.6 | .. |
| TFC | 4.1 | 4.3 | 2.8 | 5.9 | 7.2 | 5.6 | .. |
| Electricity Consumption | 11.3 | 8.2 | 7.0 | 8.7 | 8.9 | 8.0 | .. |
| Energy Production | 1.9 | 3.7 | -0.4 | -3.8 | 6.5 | 6.0 | .. |
| Net Oil Imports | 5.1 | 5.5 | 2.3 | -0.6 | 5.2 | 4.3 | .. |
| GDP | 4.5 | 4.5 | 3.0 | 5.8 | 5.4 | 6.4 | .. |
| Growth in the TPES/GDP Ratio | -0.8 | 0.7 | 0.0 | -1.3 | 1.4 | -0.5 | .. |
| Growth in the TFC/GDP Ratio | -0.4 | -0.2 | -0.1 | 0.1 | 1.7 | -0.8 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# UNITED KINGDOM

## ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

**SUPPLY**

| | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **108.5** | **208.0** | **257.9** | **246.4** | .. | .. | .. |
| Coal[1] | | 75.9 | 53.6 | 17.8 | 16.8 | .. | .. | .. |
| Oil | | 0.5 | 95.2 | 121.0 | 110.7 | .. | .. | .. |
| Gas | | 24.4 | 40.9 | 93.4 | 92.6 | .. | .. | .. |
| Comb. Renewables & Waste[2] | | - | 0.6 | 2.3 | 2.7 | 8.9 | 12.9 | .. |
| Nuclear | | 7.3 | 17.1 | 22.9 | 23.1 | 18.2 | 7.7 | .. |
| Hydro | | 0.3 | 0.4 | 0.4 | 0.3 | 0.5 | 0.7 | .. |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.1 | 1.0 | 1.5 | .. |
| **TOTAL NET IMPORTS**[4] | | **110.4** | **2.1** | **-30.6** | **-16.4** | .. | .. | .. |
| Coal[1] | Exports | 2.0 | 1.8 | 0.6 | 0.5 | .. | .. | .. |
| | Imports | 1.1 | 10.3 | 18.1 | 20.5 | .. | .. | .. |
| | Net Imports | -0.9 | 8.5 | 17.4 | 20.0 | .. | .. | .. |
| Oil | Exports | 20.9 | 76.5 | 114.6 | 101.7 | .. | .. | .. |
| | Imports | 136.9 | 65.4 | 74.7 | 73.9 | .. | .. | .. |
| | Bunkers | 5.4 | 2.5 | 1.9 | 1.8 | .. | .. | .. |
| | Net Imports | 110.6 | -13.6 | -41.8 | -29.5 | .. | .. | .. |
| Gas | Exports | - | - | 11.7 | 13.7 | .. | .. | .. |
| | Imports | 0.7 | 6.2 | 4.7 | 6.7 | .. | .. | .. |
| | Net Imports | 0.7 | 6.2 | -7.0 | -7.0 | .. | .. | .. |
| Electricity | Exports | 0.0 | 0.0 | 0.1 | 0.3 | - | - | .. |
| | Imports | 0.0 | 1.0 | 0.8 | 0.4 | 0.7 | 0.7 | .. |
| | Net Imports | 0.0 | 1.0 | 0.7 | 0.2 | 0.7 | 0.7 | .. |
| **TOTAL STOCK CHANGES** | | **1.8** | **2.1** | **1.1** | **1.9** | .. | .. | .. |
| **TOTAL SUPPLY (TPES)** | | **220.7** | **212.2** | **228.5** | **232.0** | **238.6** | **246.4** | .. |
| Coal[1] | | 76.4 | 63.1 | 35.7 | 38.2 | 37.6 | 29.9 | .. |
| Oil | | 111.6 | 82.6 | 80.5 | 81.4 | 86.9 | 95.9 | .. |
| Gas | | 25.1 | 47.2 | 85.8 | 85.9 | 84.8 | 97.1 | .. |
| Comb. Renewables & Waste[2] | | - | 0.6 | 2.3 | 2.7 | 8.9 | 12.9 | .. |
| Nuclear | | 7.3 | 17.1 | 22.9 | 23.1 | 18.2 | 7.7 | .. |
| Hydro | | 0.3 | 0.4 | 0.4 | 0.3 | 0.5 | 0.7 | .. |
| Geothermal | | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Solar/Wind/Other[3] | | - | 0.0 | 0.1 | 0.1 | 1.0 | 1.5 | .. |
| Electricity Trade[5] | | 0.0 | 1.0 | 0.7 | 0.2 | 0.7 | 0.7 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *34.6* | *29.7* | *15.6* | *16.5* | *15.8* | *12.1* | .. |
| *Oil* | | *50.5* | *38.9* | *35.2* | *35.1* | *36.4* | *38.9* | .. |
| *Gas* | | *11.4* | *22.2* | *37.6* | *37.0* | *35.5* | *39.4* | .. |
| *Comb. Renewables & Waste* | | - | *0.3* | *1.0* | *1.2* | *3.7* | *5.2* | .. |
| *Nuclear* | | *3.3* | *8.1* | *10.0* | *10.0* | *7.6* | *3.1* | .. |
| *Hydro* | | *0.2* | *0.2* | *0.2* | *0.1* | *0.2* | *0.3* | .. |
| *Geothermal* | | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | | - | - | *0.1* | *0.1* | *0.4* | *0.6* | .. |
| *Electricity Trade* | | - | *0.5* | *0.3* | *0.1* | *0.3* | *0.3* | .. |

0 is negligible. - is nil, .. is not available

Please note: In the course of preparing UK energy projections, some off model adjustments to take account of prospective measures in the UK's Climate Change Programme have not necessarily been fully included in the $CO_2$ emissions projections .

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **147.1** | **145.4** | **158.2** | **160.6** | **169.5** | **185.2** | **..** |
| Coal[1] | 26.5 | 10.8 | 3.4 | 2.4 | 6.3 | 6.3 | .. |
| Oil | 77.0 | 68.8 | 73.0 | 74.9 | 80.6 | 89.8 | .. |
| Gas | 23.6 | 41.8 | 50.5 | 51.9 | 52.4 | 56.3 | .. |
| Comb. Renewables & Waste[2] | - | 0.4 | 0.5 | 0.6 | - | - | .. |
| Geothermal | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Electricity | 20.0 | 23.6 | 28.7 | 29.0 | 30.2 | 32.8 | .. |
| Heat | - | - | 2.1 | 1.8 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *18.0* | *7.4* | *2.1* | *1.5* | *3.7* | *3.4* | .. |
| *Oil* | *52.3* | *47.3* | *46.1* | *46.6* | *47.6* | *48.5* | .. |
| *Gas* | *16.1* | *28.7* | *31.9* | *32.3* | *30.9* | *30.4* | .. |
| *Comb. Renewables & Waste* | - | *0.3* | *0.3* | *0.4* | - | - | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *13.6* | *16.2* | *18.1* | *18.1* | *17.8* | *17.7* | .. |
| *Heat* | - | - | *1.3* | *1.1* | .. | .. | .. |
| **TOTAL INDUSTRY[6]** | **65.0** | **42.8** | **42.5** | **44.5** | **48.8** | **52.2** | **..** |
| Coal[1] | 13.3 | 6.4 | 1.9 | 1.5 | 6.1 | 6.0 | .. |
| Oil | 33.7 | 15.7 | 15.8 | 17.7 | 17.1 | 16.9 | .. |
| Gas | 10.1 | 12.0 | 13.6 | 14.1 | 15.4 | 17.6 | .. |
| Comb. Renewables & Waste[2] | - | 0.1 | 0.2 | 0.2 | - | - | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 7.8 | 8.7 | 9.7 | 9.8 | 10.2 | 11.7 | .. |
| Heat | - | - | 1.3 | 1.1 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *20.5* | *14.9* | *4.5* | *3.4* | *12.5* | *11.5* | .. |
| *Oil* | *51.8* | *36.8* | *37.2* | *39.8* | *35.0* | *32.4* | .. |
| *Gas* | *15.6* | *27.9* | *32.1* | *31.8* | *31.6* | *33.7* | .. |
| *Comb. Renewables & Waste* | - | *0.2* | *0.4* | *0.5* | - | - | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *12.1* | *20.2* | *22.7* | *22.0* | *20.9* | *22.4* | .. |
| *Heat* | - | - | *3.1* | *2.6* | .. | .. | .. |
| **TRANSPORT[7]** | **31.0** | **46.5** | **52.9** | **53.5** | **59.4** | **68.2** | **..** |
| **TOTAL OTHER SECTORS[8]** | **51.2** | **56.1** | **62.8** | **62.6** | **61.3** | **64.8** | **..** |
| Coal[1] | 13.1 | 4.4 | 1.5 | 0.9 | 0.2 | 0.3 | .. |
| Oil | 12.6 | 7.0 | 5.1 | 4.5 | 4.9 | 5.5 | .. |
| Gas | 13.5 | 29.8 | 36.9 | 37.7 | 37.0 | 38.7 | .. |
| Comb. Renewables & Waste[2] | - | 0.3 | 0.4 | 0.4 | - | - | .. |
| Geothermal | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Solar/Wind/Other | - | 0.0 | 0.0 | 0.0 | - | - | .. |
| Electricity | 12.0 | 14.5 | 18.3 | 18.5 | 19.2 | 20.3 | .. |
| Heat | - | - | 0.8 | 0.7 | .. | .. | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *25.5* | *7.8* | *2.3* | *1.4* | *0.3* | *0.5* | .. |
| *Oil* | *24.7* | *12.5* | *8.0* | *7.2* | *8.0* | *8.5* | .. |
| *Gas* | *26.4* | *53.2* | *58.7* | *60.2* | *60.4* | *59.7* | .. |
| *Comb. Renewables & Waste* | - | *0.6* | *0.6* | *0.6* | - | - | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *23.4* | *25.8* | *29.1* | *29.5* | *31.3* | *31.3* | .. |
| *Heat* | - | - | *1.2* | *1.1* | .. | .. | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **ELECTRICITY GENERATION[9]** | | | | | | | |
| **INPUT (Mtoe)** | **72.5** | **74.4** | **83.1** | **85.8** | **81.6** | **79.2** | .. |
| **OUTPUT (Mtoe)** | **24.2** | **27.3** | **33.1** | **34.0** | **34.4** | **37.1** | .. |
| (TWh gross) | 281.4 | 317.8 | 384.9 | 395.9 | 400.4 | 432.0 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *62.1* | *65.0* | *32.7* | *35.4* | *25.7* | *17.0* | .. |
| *Oil* | *25.6* | *10.9* | *1.8* | *1.8* | *2.3* | *2.1* | .. |
| *Gas* | *1.0* | *1.6* | *39.6* | *37.5* | *44.4* | *60.6* | .. |
| *Comb. Renewables & Waste* | - | *0.2* | *1.5* | *1.7* | *5.7* | *7.5* | .. |
| *Nuclear* | *10.0* | *20.7* | *22.8* | *22.4* | *17.5* | *6.8* | .. |
| *Hydro* | *1.4* | *1.6* | *1.2* | *0.8* | *1.4* | *1.9* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | *0.0* | *0.3* | *0.3* | *3.0* | *4.1* | .. |
| **TOTAL LOSSES** | **75.2** | **67.5** | **70.1** | **71.2** | **69.1** | **61.2** | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 48.3 | 47.1 | 47.9 | 50.0 | 47.2 | 42.0 | .. |
| Other Transformation | 9.7 | 4.1 | 2.8 | 2.3 | 6.8 | 6.7 | .. |
| Own Use and Losses[11] | 17.3 | 16.3 | 19.5 | 18.9 | 15.1 | 12.5 | .. |
| **Statistical Differences** | **-1.7** | **-0.7** | **0.2** | **0.1** | - | - | .. |

| INDICATORS | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 813.80 | 1132.21 | 1497.34 | 1530.97 | 1882.90 | 2410.27 | .. |
| Population (millions) | 56.22 | 57.24 | 59.21 | 59.38 | 61.40 | 63.80 | .. |
| TPES/GDP[12] | 0.27 | 0.19 | 0.15 | 0.15 | 0.13 | 0.10 | .. |
| Energy Production/TPES | 0.49 | 0.98 | 1.13 | 1.06 | .. | .. | .. |
| Per Capita TPES[13] | 3.93 | 3.71 | 3.86 | 3.91 | 3.89 | 3.86 | .. |
| Oil Supply/GDP[12] | 0.14 | 0.07 | 0.05 | 0.05 | 0.05 | 0.04 | .. |
| TFC/GDP[12] | 0.18 | 0.13 | 0.11 | 0.10 | 0.09 | 0.08 | .. |
| Per Capita TFC[13] | 2.62 | 2.54 | 2.67 | 2.71 | 2.76 | 2.90 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 640.1 | 560.3 | 528.1 | 540.3 | 550.1 | 570.8 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 25.4 | 20.9 | 28.7 | 29.0 | 29.0 | 29.0 | .. |

| GROWTH RATES (% per year) | 73-79 | 79-90 | 90-02 | 02-03 | 03-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| TPES | -0.1 | -0.3 | 0.6 | 1.5 | 0.4 | 0.3 | .. |
| Coal | -0.5 | -1.5 | -4.6 | 7.2 | -0.2 | -2.3 | .. |
| Oil | -2.6 | -1.3 | -0.2 | 1.1 | 0.9 | 1.0 | .. |
| Gas | 8.3 | 1.4 | 5.1 | 0.0 | -0.2 | 1.4 | .. |
| Comb. Renewables & Waste | - | - | 11.6 | 17.5 | 18.3 | 3.8 | .. |
| Nuclear | 5.4 | 5.0 | 2.4 | 1.0 | -3.3 | -8.3 | .. |
| Hydro | 1.6 | 1.9 | -0.7 | -32.5 | 8.1 | 3.8 | .. |
| Geothermal | - | - | - | - | - | - | .. |
| Solar/Wind/Other | - | - | 22.5 | 4.8 | 34.5 | 3.8 | .. |
| TFC | 0.1 | -0.2 | 0.7 | 1.5 | 0.8 | 0.9 | .. |
| Electricity Consumption | 0.9 | 1.0 | 1.6 | 1.3 | 0.6 | 0.8 | .. |
| Energy Production | 10.1 | 0.7 | 1.8 | -4.5 | .. | .. | .. |
| Net Oil Imports | -27.1 | - | 9.8 | -29.4 | .. | .. | .. |
| GDP | 1.5 | 2.2 | 2.4 | 2.2 | 3.0 | 2.5 | .. |
| Growth in the TPES/GDP Ratio | -1.6 | -2.5 | -1.7 | -0.7 | -2.5 | -2.1 | .. |
| Growth in the TFC/GDP Ratio | -1.4 | -2.3 | -1.6 | -0.7 | -2.2 | -1.6 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

| SUPPLY | | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **TOTAL PRODUCTION** | | **1455** | **1650** | **1666** | **1632** | **1928** | **1994** | **..** |
| Coal[1] | | 333 | 539 | 555 | 526 | 633 | 681 | .. |
| Oil | | 534 | 433 | 360 | 351 | 411 | 366 | .. |
| Gas | | 503 | 419 | 442 | 447 | 530 | 568 | .. |
| Comb. Renewables & Waste[2] | | 37 | 62 | 65 | 68 | 88 | 97 | .. |
| Nuclear | | 23 | 159 | 210 | 205 | 225 | 229 | .. |
| Hydro | | 23 | 23 | 23 | 24 | 27 | 27 | .. |
| Geothermal | | 2 | 14 | 8 | 9 | 11 | 21 | .. |
| Solar/Wind/Other[3] | | - | 0 | 2 | 2 | 4 | 5 | .. |
| **TOTAL NET IMPORTS[4]** | | **289** | **315** | **607** | **644** | **832** | **1126** | **..** |
| Coal[1] | Exports | 31 | 67 | 24 | 26 | 27 | 23 | .. |
| | Imports | 1 | 2 | 12 | 17 | 22 | 28 | .. |
| | Net Imports | -30 | -65 | -11 | -9 | -4 | 5 | .. |
| Oil | Exports | 11 | 39 | 48 | 51 | 54 | 57 | .. |
| | Imports | 316 | 413 | 606 | 645 | 775 | 986 | .. |
| | Bunkers | 9 | 29 | 23 | 19 | 13 | 13 | .. |
| | Net Imports | 296 | 346 | 535 | 576 | 708 | 916 | .. |
| Gas | Exports | 2 | 2 | 12 | 16 | 16 | 22 | .. |
| | Imports | 24 | 35 | 93 | 93 | 144 | 225 | .. |
| | Net Imports | 22 | 33 | 81 | 77 | 128 | 204 | .. |
| Electricity | Exports | 0 | 2 | 1 | 2 | 2 | 1 | .. |
| | Imports | 1 | 2 | 3 | 3 | 3 | 3 | .. |
| | Net Imports | 1 | 0 | 2 | 1 | 1 | 1 | .. |
| **TOTAL STOCK CHANGES** | | **-8** | **-38** | **16** | **5** | **-** | **-** | **..** |
| **TOTAL SUPPLY (TPES)** | | **1736** | **1928** | **2289** | **2281** | **2760** | **3120** | **..** |
| Coal[1] | | 311 | 458 | 542 | 531 | 628 | 686 | .. |
| Oil | | 824 | 770 | 901 | 921 | 1119 | 1282 | .. |
| Gas | | 515 | 439 | 536 | 519 | 658 | 772 | .. |
| Comb. Renewables & Waste[2] | | 37 | 62 | 65 | 68 | 88 | 97 | .. |
| Nuclear | | 23 | 159 | 210 | 205 | 225 | 229 | .. |
| Hydro | | 23 | 23 | 23 | 24 | 27 | 27 | .. |
| Geothermal | | 2 | 14 | 8 | 9 | 11 | 21 | .. |
| Solar/Wind/Other[3] | | - | 0 | 2 | 2 | 4 | 5 | .. |
| Electricity Trade[5] | | 1 | 0 | 2 | 1 | 1 | 1 | .. |
| ***Shares (%)*** | | | | | | | | |
| *Coal* | | *17.9* | *23.8* | *23.7* | *23.3* | *22.8* | *22.0* | .. |
| *Oil* | | *47.5* | *40.0* | *39.3* | *40.4* | *40.5* | *41.1* | .. |
| *Gas* | | *29.6* | *22.8* | *23.4* | *22.8* | *23.8* | *24.7* | .. |
| *Comb. Renewables & Waste* | | *2.2* | *3.2* | *2.9* | *3.0* | *3.2* | *3.1* | .. |
| *Nuclear* | | *1.3* | *8.3* | *9.2* | *9.0* | *8.1* | *7.4* | .. |
| *Hydro* | | *1.3* | *1.2* | *1.0* | *1.1* | *1.0* | *0.9* | .. |
| *Geothermal* | | *0.1* | *0.7* | *0.4* | *0.4* | *0.4* | *0.7* | .. |
| *Solar/Wind/Other* | | - | - | *0.1* | *0.1* | *0.1* | *0.1* | .. |
| *Electricity Trade* | | *0.1* | - | *0.1* | - | - | - | .. |

0 is negligible. - is nil, .. is not available

Please note: Care should be taken when evaluating consumption by sector since inputs of fuel to autoproducers are included in final consumption for some years and not for others.

Unit: Mtoe

## DEMAND

### FINAL CONSUMPTION BY SECTOR

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| **TFC** | **1323** | **1307** | **1551** | **1571** | **1852** | **2097** | **..** |
| Coal[1] | 74 | 54 | 30 | 32 | 32 | 32 | .. |
| Oil | 701 | 698 | 833 | 848 | 1015 | 1168 | .. |
| Gas | 367 | 303 | 344 | 345 | 385 | 414 | .. |
| Comb. Renewables & Waste[2] | 37 | 23 | 38 | 40 | 56 | 62 | .. |
| Geothermal | - | 0 | 1 | 1 | 0 | 0 | .. |
| Solar/Wind/Other | - | - | 1 | 1 | 1 | 2 | .. |
| Electricity | 143 | 226 | 298 | 299 | 345 | 408 | .. |
| Heat | - | 2 | 6 | 6 | 17 | 11 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *5.6* | *4.2* | *2.0* | *2.0* | *1.7* | *1.5* | .. |
| *Oil* | *53.0* | *53.4* | *53.7* | *54.0* | *54.8* | *55.7* | .. |
| *Gas* | *27.8* | *23.2* | *22.2* | *21.9* | *20.8* | *19.8* | .. |
| *Comb. Renewables & Waste* | *2.8* | *1.7* | *2.4* | *2.5* | *3.0* | *3.0* | .. |
| *Geothermal* | - | - | - | *0.1* | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | *0.1* | *0.1* | .. |
| *Electricity* | *10.8* | *17.3* | *19.2* | *19.0* | *18.6* | *19.5* | .. |
| *Heat* | - | *0.2* | *0.4* | *0.4* | *0.9* | *0.5* | .. |
| **TOTAL INDUSTRY[6]** | **483** | **401** | **462** | **459** | **504** | **538** | **..** |
| Coal[1] | 60 | 45 | 28 | 29 | 29 | 29 | .. |
| Oil | 161 | 149 | 168 | 169 | 184 | 200 | .. |
| Gas | 177 | 124 | 142 | 135 | 149 | 157 | .. |
| Comb. Renewables & Waste[2] | 29 | 9 | 27 | 29 | 37 | 42 | .. |
| Geothermal | - | - | 0 | 0 | - | - | .. |
| Solar/Wind/Other | - | - | - | - | - | - | .. |
| Electricity | 56 | 75 | 93 | 92 | 91 | 100 | .. |
| Heat | - | - | 5 | 5 | 14 | 9 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *12.5* | *11.2* | *6.0* | *6.4* | *5.8* | *5.4* | .. |
| *Oil* | *33.4* | *37.1* | *36.4* | *36.9* | *36.5* | *37.1* | .. |
| *Gas* | *36.7* | *30.9* | *30.7* | *29.4* | *29.6* | *29.3* | .. |
| *Comb. Renewables & Waste* | *5.9* | *2.3* | *5.8* | *6.2* | *7.4* | *7.8* | .. |
| *Geothermal* | - | - | - | - | - | - | .. |
| *Solar/Wind/Other* | - | - | - | - | - | - | .. |
| *Electricity* | *11.5* | *18.6* | *20.1* | *20.1* | *18.0* | *18.7* | .. |
| *Heat* | - | - | *1.0* | *1.0* | *2.7* | *1.7* | .. |
| **TRANSPORT[7]** | **420** | **502** | **623** | **634** | **799** | **940** | **..** |
| **TOTAL OTHER SECTORS[8]** | **420** | **404** | **466** | **477** | **548** | **620** | **..** |
| Coal[1] | 14 | 10 | 2 | 2 | 2 | 2 | .. |
| Oil | 137 | 63 | 61 | 62 | 61 | 63 | .. |
| Gas | 173 | 164 | 187 | 193 | 216 | 234 | .. |
| Comb. Renewables & Waste[2] | 9 | 14 | 9 | 10 | 11 | 11 | .. |
| Geothermal | - | 0 | 0 | 1 | 0 | 0 | .. |
| Solar/Wind/Other | - | - | 1 | 1 | 1 | 2 | .. |
| Electricity | 87 | 152 | 204 | 206 | 253 | 305 | .. |
| Heat | - | 2 | 1 | 1 | 4 | 2 | .. |
| ***Shares (%)*** | | | | | | | |
| *Coal* | *3.2* | *2.4* | *0.5* | *0.5* | *0.4* | *0.4* | .. |
| *Oil* | *32.6* | *15.6* | *13.0* | *13.0* | *11.1* | *10.2* | .. |
| *Gas* | *41.2* | *40.6* | *40.0* | *40.5* | *39.5* | *37.7* | .. |
| *Comb. Renewables & Waste* | *2.1* | *3.4* | *1.9* | *2.1* | *2.0* | *1.7* | .. |
| *Geothermal* | - | *0.1* | *0.1* | *0.2* | - | - | .. |
| *Solar/Wind/Other* | - | - | *0.3* | *0.3* | *0.2* | *0.3* | .. |
| *Electricity* | *20.8* | *37.5* | *43.8* | *43.2* | *46.0* | *49.3* | .. |
| *Heat* | - | *0.5* | *0.3* | *0.2* | *0.6* | *0.4* | .. |

Unit: Mtoe

## DEMAND

### ENERGY TRANSFORMATION AND LOSSES

| | 1973 | 1990 | 2002 | 2003 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| ELECTRICITY GENERATION[9] | | | | | | | |
| **INPUT (Mtoe)** | **430** | **745** | **929** | **924** | **1136** | **1298** | .. |
| **OUTPUT (Mtoe)** | **169** | **275** | **346** | **349** | **415** | **487** | .. |
| (TWh gross) | 1966 | 3203 | 4026 | 4054 | 4823 | 5665 | .. |
| ***Output Shares (%)*** | | | | | | | |
| *Coal* | *46.2* | *53.1* | *50.6* | *51.4* | *49.3* | *47.1* | .. |
| *Oil* | *17.1* | *4.1* | *2.7* | *3.4* | *3.0* | *2.9* | .. |
| *Gas* | *18.6* | *11.9* | *17.7* | *16.5* | *20.4* | *26.0* | .. |
| *Comb. Renewables & Waste* | *0.0* | *2.7* | *1.7* | *1.7* | *2.1* | *2.0* | .. |
| *Nuclear* | *4.5* | *19.1* | *20.0* | *19.4* | *17.9* | *15.5* | .. |
| *Hydro* | *13.5* | *8.5* | *6.6* | *6.9* | *6.4* | *5.5* | .. |
| *Geothermal* | *0.1* | *0.5* | *0.4* | *0.4* | *0.3* | *0.4* | .. |
| *Solar/Wind/Other* | - | *0.1* | *0.3* | *0.3* | *0.6* | *0.6* | .. |
| **TOTAL LOSSES** | **429** | **631** | **719** | **708** | **908** | **1023** | .. |
| of which: | | | | | | | |
| Electricity and Heat Generation[10] | 261 | 467 | 575 | 567 | 696 | 794 | .. |
| Other Transformation | 7 | 15 | -4 | -8 | 44 | 46 | .. |
| Own Use and Losses[11] | 160 | 149 | 149 | 149 | 168 | 183 | .. |
| **Statistical Differences** | **-15** | **-10** | **19** | **1** | - | - | .. |

| **INDICATORS** | **1973** | **1990** | **2002** | **2003** | **2010** | **2020** | **2030** |
|---|---|---|---|---|---|---|---|
| GDP (billion 2000 USD) | 4304.80 | 7055.00 | 10023.50 | 10330.00 | 13019.50 | 17546.96 | .. |
| Population (millions) | 211.94 | 250.18 | 288.24 | 291.09 | 310.12 | 336.99 | .. |
| TPES/GDP[12] | 0.40 | 0.27 | 0.23 | 0.22 | 0.21 | 0.18 | .. |
| Energy Production/TPES | 0.84 | 0.86 | 0.73 | 0.72 | 0.70 | 0.64 | .. |
| Per Capita TPES[13] | 8.19 | 7.70 | 7.94 | 7.84 | 8.90 | 9.26 | .. |
| Oil Supply/GDP[12] | 0.19 | 0.11 | 0.09 | 0.09 | 0.09 | 0.07 | .. |
| TFC/GDP[12] | 0.31 | 0.19 | 0.15 | 0.15 | 0.14 | 0.12 | .. |
| Per Capita TFC[13] | 6.24 | 5.22 | 5.38 | 5.40 | 5.97 | 6.22 | .. |
| Energy-related $CO_2$ Emissions (Mt $CO_2$)[14] | 4703.9 | 4841.7 | 5664.6 | 5728.5 | 6848.8 | 7777.4 | .. |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 45.2 | 129.8 | 123.9 | 110.3 | 90.3 | 90.9 | .. |

| **GROWTH RATES (% per year)** | **73-79** | **79-90** | **90-02** | **02-03** | **03-10** | **10-20** | **20-30** |
|---|---|---|---|---|---|---|---|
| TPES | 1.3 | 0.2 | 1.4 | -0.4 | 2.8 | 1.2 | .. |
| Coal | 2.8 | 2.0 | 1.4 | -2.0 | 2.4 | 0.9 | .. |
| Oil | 1.2 | -1.2 | 1.3 | 2.3 | 2.8 | 1.4 | .. |
| Gas | -1.3 | -0.7 | 1.7 | -3.1 | 3.4 | 1.6 | .. |
| Comb. Renewables & Waste | 5.9 | 1.5 | 0.4 | 4.3 | 3.6 | 1.0 | .. |
| Nuclear | 20.3 | 7.7 | 2.3 | -2.1 | 1.3 | 0.2 | .. |
| Hydro | 1.1 | -0.3 | -0.2 | 4.3 | 1.5 | 0.0 | .. |
| Geothermal | 9.0 | 13.4 | -4.3 | 3.9 | 4.1 | 6.4 | .. |
| Solar/Wind/Other | - | - | 18.1 | 1.2 | 6.7 | 2.0 | .. |
| TFC | 0.7 | -0.5 | 1.4 | 1.3 | 2.4 | 1.3 | .. |
| Electricity Consumption | 3.1 | 2.5 | 2.3 | 0.4 | 2.1 | 1.7 | .. |
| Energy Production | 0.8 | 0.7 | 0.1 | -2.0 | 2.4 | 0.3 | .. |
| Net Oil Imports | 5.1 | -1.3 | 3.7 | 7.6 | 3.0 | 2.6 | .. |
| GDP | 3.0 | 2.9 | 3.0 | 3.1 | 3.4 | 3.0 | .. |
| Growth in the TPES/GDP Ratio | -1.6 | -2.6 | -1.5 | -3.3 | -0.6 | -1.7 | .. |
| Growth in the TFC/GDP Ratio | -2.2 | -3.3 | -1.5 | -1.7 | -1.0 | -1.7 | .. |

Please note: Rounding may cause totals to differ from the sum of the elements.

# ENERGY POLICIES OF IEA COUNTRIES

Table A1

## GDP Growth Rates for IEA Countries[1]

(annual average percentage change)

| | 1973-1979 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| Canada | 3.6 | 5.6 | 5.3 | 1.8 | 3.4 | 2.0 | 3.0 |
| United States | 3.0 | 4.5 | 3.7 | 0.8 | 1.9 | 3.1 | 4.4 |
| **North America** | **3.0** | **4.6** | **3.8** | **0.8** | **2.0** | **3.0** | **4.3** |
| Australia | 2.6 | 3.8 | 2.1 | 3.9 | 3.2 | 3.8 | 3.6 |
| Japan | 3.5 | 0.1 | 2.8 | 0.4 | -0.4 | 2.7 | 4.0 |
| Korea | 8.5 | 9.5 | 8.5 | 3.8 | 7.0 | 3.1 | 5.0 |
| New Zealand | 0.0 | 5.2 | 2.3 | 3.4 | 4.5 | 3.6 | 5.0 |
| **Pacific** | **3.6** | **1.1** | **3.3** | **1.0** | **0.6** | **2.8** | **4.0** |
| Austria | 3.0 | 3.3 | 3.4 | 0.7 | 1.2 | 0.8 | 2.0 |
| Belgium | 2.4 | 3.2 | 3.9 | 0.7 | 0.9 | 1.3 | 2.7 |
| Czech Republic | 2.5 | 1.2 | 3.9 | 2.6 | 1.5 | 3.7 | 4.0 |
| Denmark | 1.5 | 2.6 | 2.8 | 1.6 | 1.0 | 0.4 | 2.1 |
| Finland | 2.5 | 3.4 | 5.1 | 1.1 | 2.3 | 2.0 | 4.0 |
| France | 2.8 | 3.2 | 3.8 | 2.1 | 1.2 | 0.5 | 2.1 |
| Germany | 2.4 | 2.0 | 2.9 | 0.8 | 0.1 | -0.1 | 1.6 |
| Greece | 3.3 | 3.4 | 4.5 | 4.3 | 3.6 | 4.5 | 4.5 |
| Hungary | 4.3 | 4.2 | 5.2 | 3.8 | 3.5 | 3.0 | 4.1 |
| Ireland | 4.9 | 11.1 | 9.9 | 6.0 | 6.1 | 3.7 | 4.9 |
| Italy | 3.5 | 1.7 | 3.0 | 1.8 | 0.4 | 0.3 | 1.2 |
| Luxembourg | 1.3 | 7.8 | 9.0 | 1.6 | 2.5 | 2.9 | 4.3 |
| Netherlands | 2.6 | 4.0 | 3.5 | 1.4 | 0.6 | -0.9 | 1.4 |
| Norway | 4.9 | 2.1 | 2.8 | 2.7 | 1.4 | 0.4 | 2.6 |
| Portugal | 2.9 | 3.8 | 3.4 | 1.6 | 0.4 | -1.2 | 1.2 |
| Spain | 2.3 | 4.2 | 4.4 | 2.8 | 2.2 | 2.5 | 2.7 |
| Sweden | 1.8 | 4.6 | 4.3 | 1.0 | 2.0 | 1.5 | 3.5 |
| Switzerland | -0.4 | 1.3 | 3.6 | 1.0 | 0.3 | -0.4 | 1.8 |
| Turkey | 4.5 | -4.7 | 7.4 | -7.5 | 7.9 | 5.8 | 9.8 |
| United Kingdom | 1.5 | 2.9 | 3.9 | 2.3 | 1.8 | 2.2 | 3.1 |
| **IEA Europe** | **2.4** | **2.6** | **3.7** | **1.5** | **1.2** | **1.0** | **2.4** |
| **IEA Total** | **2.9** | **3.1** | **3.6** | **1.1** | **1.4** | **2.2** | **3.6** |

1. Data are in 2000 dollars at 2000 prices.

Source: *National Accounts, Volume 1*, OECD Paris, 2005.

## Table A2

## TPES/GDP Ratios for IEA Countries[1]

| | 1973 | 1979 | 2002 | 2003 | 2004[2] | Average Annual Growth Rates (%) 1992-1997 | 1998-2003 |
|---|---|---|---|---|---|---|---|
| Canada | 0.49 | 0.48 | 0.33 | 0.34 | 0.33 | -0.8 | -1.7 |
| United States | 0.40 | 0.37 | 0.23 | 0.22 | 0.22 | -1.7 | -1.8 |
| **North America** | **0.41** | **0.37** | **0.24** | **0.23** | **0.22** | **-1.6** | **-1.8** |
| Australia | 0.34 | 0.35 | 0.27 | 0.26 | 0.26 | -1.1 | -1.6 |
| Japan | 0.15 | 0.13 | 0.11 | 0.11 | 0.11 | 0.7 | -1.0 |
| Korea | 0.28 | 0.31 | 0.35 | 0.35 | 0.34 | 2.5 | -1.4 |
| New Zealand | 0.26 | 0.28 | 0.32 | 0.30 | 0.29 | -0.9 | -3.1 |
| **Pacific** | **0.17** | **0.15** | **0.15** | **0.14** | **0.14** | **1.6** | **-0.4** |
| Austria | 0.22 | 0.20 | 0.16 | 0.17 | 0.16 | 0.4 | 0.7 |
| Belgium | 0.37 | 0.34 | 0.24 | 0.25 | 0.24 | 0.0 | -1.6 |
| Czech Republic | 1.13 | 1.04 | 0.72 | 0.73 | 0.71 | -2.6 | -1.1 |
| Denmark | 0.20 | 0.20 | 0.12 | 0.13 | 0.12 | -0.6 | -1.7 |
| Finland | 0.35 | 0.35 | 0.29 | 0.30 | 0.29 | 0.3 | -0.4 |
| France | 0.26 | 0.23 | 0.20 | 0.20 | 0.20 | -0.3 | -0.9 |
| Germany | 0.32 | 0.30 | 0.18 | 0.18 | 0.18 | -0.5 | -1.2 |
| Greece | 0.18 | 0.19 | 0.24 | 0.23 | 0.23 | 0.2 | -1.5 |
| Hungary | 0.71 | 0.73 | 0.51 | 0.51 | 0.48 | -1.5 | -3.1 |
| Ireland | 0.30 | 0.28 | 0.14 | 0.14 | 0.13 | -3.0 | -4.3 |
| Italy | 0.22 | 0.19 | 0.16 | 0.16 | 0.17 | -0.1 | 0.2 |
| Luxembourg | 0.69 | 0.55 | 0.20 | 0.20 | 0.22 | -6.3 | 0.4 |
| Netherlands | 0.33 | 0.31 | 0.21 | 0.22 | 0.22 | -1.4 | -0.0 |
| Norway | 0.23 | 0.22 | 0.17 | 0.13 | 0.15 | -2.7 | -3.6 |
| Portugal | 0.15 | 0.18 | 0.24 | 0.24 | 0.25 | 0.3 | 0.4 |
| Spain | 0.19 | 0.21 | 0.22 | 0.22 | 0.23 | 0.1 | 0.5 |
| Sweden | 0.28 | 0.28 | 0.21 | 0.21 | 0.21 | -0.3 | -2.7 |
| Switzerland | 0.11 | 0.12 | 0.11 | 0.11 | 0.11 | -0.2 | -0.9 |
| Turkey | 0.37 | 0.35 | 0.38 | 0.38 | 0.36 | 0.9 | 0.2 |
| United Kingdom | 0.27 | 0.25 | 0.15 | 0.15 | 0.15 | -2.3 | -2.4 |
| **IEA Europe** | **0.28** | **0.26** | **0.19** | **0.19** | **0.19** | **-0.6** | **-1.0** |
| **IEA Total** | **0.31** | **0.28** | **0.20** | **0.20** | **0.19** | **-0.7** | **-1.2** |

1. Measured in toe per USD 1 000 of GDP at 2000 prices and exchange rates; changes in energy intensity reflect the combined effects of efficiency improvements, structural changes, fuel substitution and exchange rates.

2. Preliminary data.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris 2005 and *National Accounts, Volume 1*, OECD Paris, 2005.

Table A3

## TPES per Inhabitant for IEA Countries

(toe per capita)

| | 1973 | 1979 | 2002 | 2003 | 2004[1] | Average Annual Growth Rates (%) 1992-1997 | 1998-2003 |
|---|---|---|---|---|---|---|---|
| Canada | 7.11 | 7.88 | 7.95 | 8.24 | 8.19 | 1.2 | 0.8 |
| United States | 8.19 | 8.36 | 7.94 | 7.84 | 7.91 | 0.55 | -0.2 |
| **North America** | **8.09** | **8.31** | **7.94** | **7.88** | **7.94** | **0.62** | **-0.1** |
| Australia | 4.23 | 4.70 | 5.66 | 5.63 | 5.67 | 1.82 | 0.4 |
| Japan | 2.98 | 3.06 | 4.09 | 4.05 | 4.21 | 2.1 | -0.1 |
| Korea | 0.63 | 1.07 | 4.22 | 4.28 | 4.37 | 8.5 | 4.1 |
| New Zealand | 2.78 | 2.88 | 4.49 | 4.30 | 4.31 | 1.85 | -0.5 |
| **Pacific** | **2.58** | **2.76** | **4.28** | **4.27** | **4.40** | **3.26** | **0.9** |
| Austria | 2.87 | 3.18 | 3.87 | 4.10 | 4.05 | 2.0 | 2.3 |
| Belgium | 4.76 | 5.01 | 5.47 | 5.70 | 5.53 | 1.6 | 0.0 |
| Czech Republic | 4.58 | 4.73 | 4.09 | 4.32 | 4.37 | -0.3 | 1.6 |
| Denmark | 3.95 | 4.16 | 3.66 | 3.85 | 3.73 | 1.7 | -0.4 |
| Finland | 4.57 | 5.12 | 6.85 | 7.20 | 7.20 | 3.1 | 2.1 |
| France | 3.46 | 3.54 | 4.34 | 4.41 | 4.47 | 0.5 | 0.8 |
| Germany | 4.28 | 4.73 | 4.19 | 4.21 | 4.22 | 0.1 | -0.2 |
| Greece | 1.36 | 1.65 | 2.65 | 2.72 | 2.76 | 1.3 | 2.2 |
| Hungary | 2.05 | 2.65 | 2.54 | 2.60 | 2.57 | 0.4 | 1.0 |
| Ireland | 2.34 | 2.63 | 3.90 | 3.78 | 3.81 | 3.5 | 1.2 |
| Italy | 2.35 | 2.36 | 2.99 | 3.12 | 3.20 | 1.2 | 1.4 |
| Luxembourg | 12.83 | 10.69 | 9.06 | 9.47 | 10.46 | -3.7 | 4.0 |
| Netherlands | 4.65 | 4.91 | 4.87 | 4.98 | 5.03 | 0.7 | 1.0 |
| Norway | 3.70 | 4.54 | 6.35 | 5.11 | 5.84 | 1.2 | -2.4 |
| Portugal | 0.84 | 1.03 | 2.55 | 2.47 | 2.55 | 2.1 | 1.4 |
| Spain | 1.50 | 1.80 | 3.25 | 3.34 | 3.48 | 2.0 | 3.0 |
| Sweden | 4.83 | 5.27 | 5.92 | 5.75 | 5.91 | 1.2 | -0.4 |
| Switzerland | 3.06 | 3.15 | 3.70 | 3.66 | 3.65 | 0.1 | -0.5 |
| Turkey | 0.63 | 0.70 | 1.08 | 1.12 | 1.15 | 3.8 | 0.0 |
| United Kingdom | 3.93 | 3.91 | 3.86 | 3.91 | 3.92 | 0.6 | -0.2 |
| **IEA Europe** | **3.10** | **3.25** | **3.51** | **3.55** | **3.60** | **0.79** | **0.5** |
| **IEA Total** | **4.44** | **4.64** | **5.08** | **5.08** | **5.15** | **1.23** | **0.4** |

1. Preliminary data.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005 and *National Accounts, Volume 1*, OECD Paris, 2005.

Table A4

## TFC/GDP Ratios for IEA Countries[1]

| | 1973 | 1979 | 2001 | 2002 | 2003 | Average Annual Growth Rates (%) 1992-1997 | 1998-2003 |
|---|---|---|---|---|---|---|---|
| Canada | 0.41 | 0.39 | 0.25 | 0.25 | 0.26 | -0.5 | -1.6 |
| United States | 0.31 | 0.27 | 0.16 | 0.15 | 0.15 | -1.4 | -1.2 |
| **North America** | **0.31** | **0.28** | **0.16** | **0.16** | **0.16** | **-1.3** | **-1.2** |
| Australia | 0.24 | 0.24 | 0.18 | 0.17 | 0.17 | -1.0 | -2.3 |
| Japan | 0.11 | 0.09 | 0.07 | 0.08 | 0.07 | 1.0 | -0.4 |
| Korea | 0.22 | 0.24 | 0.24 | 0.24 | 0.24 | 1.4 | -1.1 |
| New Zealand | 0.19 | 0.21 | 0.25 | 0.25 | 0.23 | -0.4 | -2.2 |
| **Pacific** | **0.12** | **0.11** | **0.10** | **0.10** | **0.10** | **1.6** | **-0.0** |
| Austria | 0.17 | 0.16 | 0.13 | 0.13 | 0.14 | 0.4 | 1.3 |
| Belgium | 0.27 | 0.25 | 0.19 | 0.18 | 0.18 | 0.7 | -1.3 |
| Czech Republic | 0.78 | 0.80 | 0.45 | 0.43 | 0.44 | -3.8 | -1.8 |
| Denmark | 0.16 | 0.16 | 0.10 | 0.09 | 0.09 | -1.2 | -1.8 |
| Finland | 0.32 | 0.28 | 0.21 | 0.21 | 0.21 | -2.1 | -1.5 |
| France | 0.21 | 0.18 | 0.13 | 0.13 | 0.13 | -0.6 | -1.5 |
| Germany | 0.23 | 0.22 | 0.13 | 0.13 | 0.13 | -0.2 | -1.3 |
| Greece | 0.13 | 0.14 | 0.17 | 0.17 | 0.17 | 1.1 | -1.5 |
| Hungary | 0.57 | 0.58 | 0.37 | 0.37 | 0.37 | -2.1 | -2.0 |
| Ireland | 0.22 | 0.22 | 0.12 | 0.11 | 0.11 | -3.3 | -3.8 |
| Italy | 0.17 | 0.15 | 0.12 | 0.12 | 0.13 | -0.5 | 0.1 |
| Luxembourg | 0.45 | 0.42 | 0.19 | 0.19 | 0.19 | -4.1 | -0.3 |
| Netherlands | 0.26 | 0.25 | 0.16 | 0.16 | 0.17 | -1.7 | 0.1 |
| Norway | 0.22 | 0.20 | 0.12 | 0.12 | 0.12 | -2.4 | -1.1 |
| Portugal | 0.13 | 0.14 | 0.19 | 0.19 | 0.19 | 1.3 | 0.7 |
| Spain | 0.14 | 0.16 | 0.16 | 0.16 | 0.17 | 0.8 | 1.0 |
| Sweden | 0.25 | 0.23 | 0.15 | 0.15 | 0.14 | -0.5 | -2.5 |
| Switzerland | 0.10 | 0.10 | 0.09 | 0.08 | 0.09 | -1.0 | -0.7 |
| Turkey | 0.30 | 0.30 | 0.28 | 0.28 | 0.29 | 0.1 | 0.5 |
| United Kingdom | 0.18 | 0.17 | 0.11 | 0.11 | 0.10 | -2.1 | -2.2 |
| **IEA Europe** | **0.21** | **0.20** | **0.14** | **0.14** | **0.14** | **-0.7** | **-0.9** |
| **IEA Total** | **0.23** | **0.21** | **0.14** | **0.14** | **0.14** | **-0.5** | **-0.8** |

1. Measured in toe per USD 1 000 of GDP at 2000 prices and exchange rates.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005 and *National Accounts*, *Volume 1*, OECD Paris, 2005.

## Table A5

# Total Energy Demand in IEA Countries

(Mtoe and %)

| | 1973 | | | | | | 1979 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TPES | Shares of TPES | | | | | TPES | Shares of TPES | | | | |
| | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[1] % | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[1] % |
| Canada | 159.8 | 9.5 | 50.0 | 23.3 | 2.5 | 14.6 | 190.8 | 10.4 | 48.2 | 22.9 | 5.1 | 13.4 |
| United States | 1736.4 | 17.9 | 47.5 | 29.6 | 1.3 | 3.7 | 1881.2 | 19.5 | 47.0 | 25.4 | 3.7 | 4.4 |
| **North America** | **1896.3** | **17.2** | **47.7** | **29.1** | **1.4** | **4.6** | **2072.0** | **18.7** | **47.1** | **25.1** | **3.9** | **5.2** |
| Australia | 57.6 | 39.2 | 47.1 | 5.9 | - | 7.8 | 68.7 | 36.0 | 46.8 | 10.1 | - | 7.1 |
| Japan | 323.5 | 17.9 | 77.9 | 1.6 | 0.8 | 1.8 | 354.6 | 14.4 | 73.0 | 5.2 | 5.2 | 2.2 |
| Korea | 21.6 | 37.6 | 61.9 | - | - | 0.5 | 40.0 | 30.2 | 67.2 | - | 2.1 | 0.5 |
| New Zealand | 8.3 | 15.3 | 53.5 | 3.4 | - | 27.8 | 9.0 | 10.6 | 46.4 | 9.5 | - | 33.5 |
| **Pacific** | **411.1** | **21.9** | **72.3** | **2.1** | **0.6** | **3.1** | **472.3** | **18.8** | **68.2** | **5.6** | **4.1** | **3.4** |
| Austria | 21.7 | 17.9 | 56.7 | 15.3 | - | 10.1 | 23.9 | 15.2 | 53.9 | 18.1 | - | 12.9 |
| Belgium | 46.3 | 24.1 | 60.5 | 15.4 | 0.0 | -0.1 | 49.3 | 23.1 | 52.0 | 18.9 | 6.0 | -0.0 |
| Czech Republic | 45.4 | 78.4 | 19.6 | 2.2 | - | -0.2 | 48.7 | 71.9 | 23.5 | 4.6 | - | 0.0 |
| Denmark | 19.8 | 9.7 | 88.6 | - | - | 1.7 | 21.3 | 20.3 | 75.9 | - | - | 3.7 |
| Finland | 21.3 | 12.0 | 63.6 | - | - | 24.4 | 24.4 | 17.4 | 54.0 | 3.3 | 7.2 | 18.0 |
| France | 184.7 | 15.8 | 67.3 | 7.3 | 2.1 | 7.4 | 193.9 | 16.7 | 59.0 | 10.7 | 5.4 | 8.1 |
| Germany | 337.9 | 41.2 | 47.9 | 8.5 | 0.9 | 1.4 | 369.6 | 37.4 | 43.6 | 13.9 | 3.7 | 1.4 |
| Greece | 12.4 | 17.0 | 77.7 | - | - | 5.2 | 16.0 | 21.6 | 73.6 | - | - | 4.8 |
| Hungary | 21.3 | 37.1 | 38.5 | 19.6 | - | 4.9 | 28.4 | 30.0 | 40.2 | 26.0 | - | 3.8 |
| Ireland | 7.2 | 22.0 | 77.1 | - | - | 0.8 | 8.9 | 22.5 | 71.5 | 5.2 | - | 0.8 |
| Italy | 128.9 | 6.3 | 77.6 | 11.0 | 0.6 | 4.4 | 132.8 | 7.9 | 69.0 | 17.1 | 0.5 | 5.6 |
| Luxembourg | 4.5 | 54.1 | 37.1 | 4.9 | - | 4.0 | 3.9 | 47.4 | 33.8 | 12.1 | - | 6.6 |
| Netherlands | 62.4 | 4.6 | 49.5 | 45.6 | 0.5 | -0.2 | 68.9 | 4.8 | 45.9 | 47.6 | 1.3 | 0.4 |
| Norway | 14.6 | 6.2 | 54.0 | - | - | 39.8 | 18.5 | 5.4 | 48.7 | 3.8 | - | 42.1 |
| Portugal | 7.2 | 7.0 | 75.4 | - | - | 17.5 | 10.0 | 4.4 | 78.3 | - | - | 17.3 |
| Spain | 52.4 | 17.2 | 73.3 | 1.8 | 3.3 | 4.4 | 66.8 | 16.1 | 73.3 | 2.1 | 2.6 | 5.9 |
| Sweden | 39.3 | 4.1 | 72.2 | - | 1.4 | 22.3 | 43.7 | 4.1 | 62.1 | - | 12.5 | 21.3 |
| Switzerland | 19.7 | 1.7 | 77.4 | 0.8 | 8.3 | 11.9 | 20.0 | 1.1 | 66.9 | 3.8 | 15.4 | 12.8 |
| Turkey | 24.4 | 21.1 | 51.3 | - | - | 27.6 | 30.3 | 21.6 | 49.5 | - | - | 28.9 |
| United Kingdom | 220.7 | 34.6 | 50.5 | 11.4 | 3.3 | 0.2 | 220.0 | 33.7 | 43.2 | 18.4 | 4.5 | 0.2 |
| **IEA Europe** | **1292.2** | **26.5** | **57.4** | **9.8** | **1.5** | **4.7** | **1399.2** | **25.3** | **51.8** | **14.0** | **3.6** | **5.3** |
| **IEA Total** | **3599.6** | **21.1** | **54.0** | **19.1** | **1.4** | **4.5** | **3943.5** | **21.0** | **51.3** | **18.8** | **3.8** | **5.0** |

1. Includes hydro, geothermal, combustible renewables, waste, solar, wind, tide, wave, ambient heat used in heat pumps, and electricity and heat trade.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table A5 *(continued)*

## Total Energy Demand in IEA Countries

(Mtoe and %)

| | 2003 | | | | | | 2004[1] | | | | | | 2003-2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TPES | Shares of TPES | | | | | TPES | Shares of TPES | | | | | Change in TPES |
| | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[2] % | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[2] % | % |
| Canada | 260.6 | 11.5 | 35.2 | 30.4 | 7.5 | 15.4 | 260.7 | 10.2 | 37.3 | 28.2 | 9.0 | 15.3 | 0.0 |
| United States | 2280.8 | 23.3 | 40.4 | 22.8 | 9.0 | 4.5 | 2324.5 | 23.5 | 40.7 | 22.2 | 9.1 | 4.5 | 1.9 |
| **North America** | **2541.4** | **22.1** | **39.9** | **23.5** | **8.8** | **5.7** | **2585.2** | **22.1** | **40.4** | **22.8** | **9.1** | **5.6** | **1.7** |
| Australia | 112.6 | 42.6 | 31.9 | 19.7 | - | 5.8 | 114.5 | 44.0 | 30.9 | 19.6 | - | 5.4 | 1.7 |
| Japan | 517.1 | 20.8 | 49.7 | 13.7 | 12.1 | 3.7 | 537.1 | 22.3 | 47.2 | 13.1 | 13.9 | 3.5 | 3.9 |
| Korea | 205.3 | 22.9 | 49.3 | 10.7 | 16.5 | 0.6 | 210.6 | 23.4 | 47.8 | 12.0 | 16.2 | 0.7 | 2.6 |
| New Zealand | 17.4 | 10.4 | 39.1 | 22.2 | - | 28.2 | 17.7 | 10.7 | 39.3 | 19.9 | - | 30.1 | 1.7 |
| **Pacific** | **852.4** | **24.0** | **47.0** | **14.0** | **11.3** | **3.7** | **879.8** | **25.2** | **45.1** | **13.8** | **12.3** | **3.6** | **3.2** |
| Austria | 33.2 | 12.0 | 42.9 | 22.8 | - | 22.4 | 32.8 | 10.1 | 43.4 | 23.4 | - | 23.1 | -1.0 |
| Belgium | 59.2 | 10.0 | 41.8 | 24.3 | 20.9 | 2.9 | 57.5 | 10.6 | 39.0 | 25.1 | 21.9 | 3.5 | -2.8 |
| Czech Republic | 44.1 | 47.3 | 19.9 | 17.8 | 15.3 | -0.2 | 44.5 | 45.3 | 21.4 | 17.5 | 15.4 | 0.4 | 1.0 |
| Denmark | 20.8 | 27.3 | 40.3 | 22.4 | - | 9.9 | 20.1 | 21.7 | 41.3 | 23.0 | - | 13.9 | -3.1 |
| Finland | 37.6 | 21.9 | 28.6 | 10.9 | 15.8 | 22.8 | 37.6 | 19.8 | 29.0 | 10.5 | 15.7 | 24.9 | 0.1 |
| France | 271.3 | 5.3 | 33.6 | 14.5 | 42.4 | 4.3 | 274.5 | 5.1 | 33.4 | 14.6 | 42.6 | 4.3 | 1.2 |
| Germany | 347.1 | 24.5 | 36.4 | 22.8 | 12.4 | 3.8 | 348.3 | 24.6 | 35.9 | 22.6 | 12.5 | 4.4 | 0.3 |
| Greece | 29.9 | 29.8 | 57.5 | 6.8 | - | 5.9 | 30.3 | 29.4 | 57.4 | 7.3 | - | 5.8 | 1.4 |
| Hungary | 26.3 | 14.2 | 23.9 | 45.1 | 11.0 | 5.8 | 26.0 | 13.2 | 23.9 | 44.7 | 12.0 | 6.2 | -1.2 |
| Ireland | 15.1 | 17.2 | 56.3 | 24.2 | - | 2.4 | 15.3 | 17.1 | 56.3 | 23.8 | - | 2.7 | 1.4 |
| Italy | 181.0 | 8.2 | 48.3 | 35.0 | - | 8.5 | 186.0 | 9.2 | 46.7 | 35.5 | - | 8.5 | 2.7 |
| Luxembourg | 4.3 | 1.8 | 64.3 | 25.0 | - | 8.9 | 4.7 | 2.0 | 65.2 | 25.3 | - | 7.6 | 11.4 |
| Netherlands | 80.8 | 10.8 | 39.0 | 44.5 | 1.3 | 4.4 | 82.0 | 10.5 | 39.0 | 44.8 | 1.2 | 4.5 | 1.4 |
| Norway | 23.3 | 3.4 | 20.9 | 27.3 | - | 48.4 | 26.8 | 3.4 | 31.6 | 20.8 | - | 44.2 | 14.8 |
| Portugal | 25.8 | 12.7 | 59.3 | 10.2 | - | 17.8 | 26.6 | 12.7 | 58.3 | 12.4 | - | 16.7 | 3.3 |
| Spain | 136.1 | 14.8 | 50.7 | 15.7 | 11.8 | 7.0 | 142.9 | 15.1 | 49.5 | 17.6 | 11.6 | 6.2 | 5.0 |
| Sweden | 51.5 | 5.2 | 30.2 | 1.7 | 34.1 | 28.8 | 53.2 | 5.5 | 29.3 | 1.7 | 37.9 | 25.7 | 3.1 |
| Switzerland | 27.1 | 0.5 | 46.5 | 9.7 | 26.5 | 16.8 | 27.0 | 0.5 | 46.2 | 10.0 | 26.1 | 17.2 | -0.1 |
| Turkey | 79.0 | 27.1 | 37.7 | 22.4 | - | 12.8 | 82.5 | 27.4 | 36.8 | 22.7 | - | 13.1 | 4.4 |
| United Kingdom | 232.0 | 16.5 | 35.1 | 37.0 | 10.0 | 1.4 | 233.9 | 16.0 | 36.8 | 37.3 | 8.2 | 1.7 | 0.8 |
| **IEA Europe** | **1725.4** | **15.6** | **38.6** | **23.9** | **14.5** | **7.3** | **1752.6** | **15.5** | **38.5** | **24.1** | **14.4** | **7.5** | **1.6** |
| **IEA Total** | **5119.2** | **20.2** | **40.6** | **22.1** | **11.2** | **5.9** | **5217.6** | **20.4** | **40.6** | **21.7** | **11.4** | **5.9** | **1.9** |

1. Preliminary data.
2. Includes hydro, geothermal, combustible renewables, waste, solar, wind, tide, wave, ambient heat used in heat pumps, and electricity and heat trade.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table A5 *(continued)*

## Total Energy Demand in IEA Countries

(Mtoe and %)

| | 2010 | | | | | | 2020 | | | | | | 2010-2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TPES | Shares of TPES | | | | | TPES | Shares of TPES | | | | | Change in TPES |
| | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[1] % | Mtoe | Coal % | Oil % | Natural Gas % | Nuclear % | Other[1] % | % |
| Canada | 307.5 | 8.3 | 31.7 | 36.4 | 7.6 | 15.8 | 350.5 | 5.1 | 30.8 | 42.6 | 6.3 | 15.0 | 14.0 |
| United States | 2759.8 | 22.8 | 40.5 | 23.8 | 8.1 | 4.7 | 3119.9 | 22.0 | 41.1 | 24.7 | 7.4 | 4.8 | 13.0 |
| **North America** | **3067.3** | **21.3** | **39.7** | **25.1** | **8.1** | **5.8** | **3470.4** | **20.3** | **40.0** | **26.6** | **7.2** | **5.8** | **13.1** |
| Australia | 146.5 | 38.4 | 32.7 | 22.5 | - | 6.4 | 179.5 | 37.2 | 33.1 | 24.3 | - | 5.4 | 22.5 |
| Japan | 536.5 | 17.4 | 43.1 | 14.3 | 18.8 | 6.4 | .. | .. | .. | .. | .. | .. | .. |
| Korea | 263.4 | 23.4 | 47.0 | 11.8 | 15.7 | 2.3 | 311.8 | 20.1 | 44.8 | 14.9 | 17.4 | 2.9 | .. |
| New Zealand | 20.0 | 6.9 | 37.9 | 17.0 | - | 38.2 | 22.8 | 5.9 | 36.6 | 17.4 | - | 40.1 | 14.2 |
| **Pacific** | **966.3** | **22.0** | **42.5** | **14.9** | **14.7** | **5.9** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |
| Austria | 32.3 | 9.2 | 38.9 | 28.0 | - | 24.0 | 34.9 | 6.0 | 40.3 | 29.5 | - | 24.3 | 8.2 |
| Belgium | 61.5 | 6.8 | 37.7 | 32.6 | 19.6 | 3.4 | 63.1 | 5.0 | 38.0 | 38.6 | 14.6 | 3.8 | .. |
| Czech Republic | 42.1 | 33.5 | 21.4 | 26.4 | 15.9 | 2.8 | 44.0 | 28.0 | 21.4 | 30.2 | 15.2 | 5.2 | 4.6 |
| Denmark | 22.3 | 18.9 | 40.4 | 25.0 | - | 15.7 | 23.4 | 11.6 | 41.8 | 29.7 | .. | 16.9 | .. |
| Finland | 37.7 | 16.3 | 24.5 | 12.8 | 21.5 | 24.9 | 39.9 | 18.0 | 22.4 | 13.0 | 22.6 | 24.0 | 5.9 |
| France | 298.8 | 3.4 | 34.8 | 15.8 | 40.3 | 5.7 | 319.9 | 3.6 | 33.4 | 18.4 | 36.8 | 7.7 | 7.0 |
| Germany | 337.4 | 22.3 | 37.9 | 24.5 | 10.0 | 5.2 | 308.6 | 22.7 | 38.4 | 27.9 | 2.7 | 8.3 | .. |
| Greece | 40.5 | 23.6 | 54.1 | 17.4 | - | 4.9 | .. | .. | .. | .. | .. | .. | .. |
| Hungary | 26.6 | 8.7 | 27.2 | 43.1 | 14.4 | 6.7 | 27.9 | 7.6 | 26.6 | 43.2 | 13.7 | 8.9 | 4.8 |
| Ireland | 16.8 | 11.3 | 50.3 | 35.2 | - | 3.2 | .. | .. | .. | .. | .. | .. | .. |
| Italy | 195.2 | 7.4 | 42.1 | 38.7 | - | 11.8 | 231.3 | 6.2 | 39.1 | 42.1 | - | 12.6 | 18.5 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 81.7 | 11.4 | 37.1 | 44.8 | 1.2 | 5.6 | 91.9 | 12.4 | 39.6 | 40.1 | 1.1 | 6.9 | 12.5 |
| Norway | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Portugal | 30.0 | 10.2 | 53.9 | 17.1 | - | 18.8 | .. | .. | .. | .. | .. | .. | .. |
| Spain | 170.2e | 8.9 | 48.0 | 21.8 | 9.7 | 11.7 | .. | .. | .. | .. | .. | .. | .. |
| Sweden | 53.7 | 4.9 | 30.6 | 1.4 | 32.1 | 31.0 | .. | .. | .. | .. | .. | .. | .. |
| Switzerland | 27.1 | 0.4 | 48.2 | 10.5 | 23.2 | 17.7 | 26.7 | 0.4 | 48.5 | 11.2 | 20.7 | 19.3 | -1.4 |
| Turkey | 125.6 | 27.9 | 32.8 | 29.6 | - | 9.7 | 222.3 | 36.1 | 27.4 | 23.2 | 3.7 | 9.6 | 77.0 |
| United Kingdom | 238.6 | 15.8 | 36.4 | 35.5 | 7.6 | 4.7 | 246.4 | 12.1 | 38.9 | 39.4 | 3.1 | 6.4 | 3.2 |
| **IEA Europe** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |
| **IEA Total** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |

1. Includes hydro, geothermal, combustible renewables, waste, solar, wind, tide, wave, ambient heat used in heat pumps and electricity trade.

Note: The IEA Secretariat has estimated data for certain countries. Please see Energy Balances and Key Statistical Data for details.

Source: Country submissions.

## Table A6

## Development of IEA Energy Self-sufficiency by Product

(Mtoe and %)

| | 1973 | | | 1979 | | | 2002 | | | 2003 | | | 2004[1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TPES | Production | % | TPES | Production | % | TPES | Production | % | TPES | Production | % | TPES | Production | % |
| **North America** | | | | | | | | | | | | | | | |
| Coal | 326.3 | 345.1 | 105.7 | 386.8 | 443.6 | 114.7 | 571.9 | 587.6 | 102.8 | 561.2 | 556.4 | 99.1 | 571.7 | 576.7 | 100.9 |
| Oil | 903.9 | 630.2 | 69.7 | 975.6 | 581.7 | 59.6 | 986.7 | 496.4 | 50.3 | 1013.1 | 495.0 | 48.9 | 1043.8 | 496.2 | 47.5 |
| Natural Gas | 551.8 | 564.0 | 102.2 | 520.6 | 521.8 | 100.2 | 609.2 | 595.9 | 97.8 | 598.3 | 597.2 | 99.8 | 589.2 | 588.6 | 99.9 |
| **Total** | **1896.3** | **1653.5** | **87.2** | **2072.0** | **1736.1** | **83.8** | **2538.2** | **2050.0** | **80.8** | **2541.4** | **2017.3** | **79.4** | **2585.2** | **2041.7** | **79.0** |
| **Pacific** | | | | | | | | | | | | | | | |
| Coal | 89.8 | 66.1 | 73.6 | 89.0 | 70.3 | 79.0 | 200.2 | 188.5 | 94.1 | 204.6 | 189.5 | 92.6 | 221.5 | 196.3 | 88.6 |
| Oil | 297.1 | 20.7 | 7.0 | 321.9 | 23.7 | 7.4 | 398.4 | 35.8 | 9.0 | 400.9 | 33.2 | 8.3 | 396.5 | 28.3 | 7.1 |
| Natural Gas | 8.7 | 6.0 | 68.1 | 26.4 | 9.9 | 37.6 | 114.1 | 37.8 | 33.1 | 119.0 | 37.6 | 31.6 | 121.7 | 38.2 | 31.4 |
| **Total** | **411.1** | **108.2** | **26.3** | **472.3** | **138.9** | **29.4** | **851.5** | **400.8** | **47.1** | **852.4** | **388.3** | **45.5** | **879.8** | **403.0** | **45.8** |
| **IEA Europe** | | | | | | | | | | | | | | | |
| Coal | 342.7 | 303.2 | 88.5 | 353.6 | 296.7 | 83.9 | 261.7 | 137.6 | 52.6 | 269.7 | 134.8 | 50.0 | 270.8 | 130.5 | 48.2 |
| Oil | 742.0 | 22.8 | 3.1 | 725.3 | 117.9 | 16.3 | 669.8 | 321.3 | 48.0 | 666.6 | 304.4 | 45.7 | 675.4 | 294.6 | 43.6 |
| Natural Gas | 127.0 | 119.9 | 94.4 | 195.9 | 167.2 | 85.3 | 391.9 | 249.4 | 63.6 | 412.5 | 252.3 | 61.2 | 422.5 | 259.4 | 61.4 |
| **Total** | **1292.2** | **525.9** | **40.7** | **1399.2** | **705.3** | **50.4** | **1694.0** | **1075.7** | **63.5** | **1725.4** | **1064.4** | **61.7** | **1752.6** | **1065.0** | **60.8** |
| **IEA Total** | | | | | | | | | | | | | | | |
| Coal | 758.9 | 714.4 | 94.1 | 829.4 | 810.7 | 97.7 | 1033.8 | 913.7 | 88.4 | 1035.5 | 880.7 | 85.1 | 1064.0 | 903.4 | 84.9 |
| Oil | 1943.0 | 673.7 | 34.7 | 2022.9 | 723.3 | 35.8 | 2054.9 | 853.5 | 41.5 | 2080.6 | 832.6 | 40.0 | 2115.8 | 819.1 | 38.7 |
| Natural Gas | 687.5 | 689.8 | 100.3 | 743.0 | 698.9 | 94.1 | 1115.2 | 883.0 | 79.2 | 1129.8 | 887.1 | 78.5 | 1133.3 | 886.2 | 78.2 |
| **Total** | **3599.6** | **2287.6** | **63.6** | **3943.5** | **2580.3** | **65.4** | **5083.7** | **3526.6** | **69.4** | **5119.2** | **3470.0** | **67.8** | **5217.6** | **3509.6** | **67.3** |

1. Preliminary data.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Table A7

## Indigenous Production/Primary Energy Supply in IEA Countries, 2003

| | Total Energy[1] | Coal[1] | Oil[1] | Gas[1] | Electricity[2] |
|---|---|---|---|---|---|
| Canada | 1.478 | 1.007 | 1.573 | 1.902 | 1.012 |
| United States | 0.716 | 0.991 | 0.381 | 0.860 | 0.998 |
| **North America** | **0.794** | **0.991** | **0.489** | **0.998** | **1.000** |
| Australia | 2.251 | 3.853 | 0.854 | 1.413 | 1.000 |
| Japan | 0.164 | – | 0.003 | 0.035 | 1.000 |
| Korea | 0.180 | 0.030 | 0.005 | – | 1.000 |
| New Zealand | 0.758 | 1.717 | 0.191 | 1.000 | 1.000 |
| **Pacific** | **0.455** | **0.926** | **0.083** | **0.316** | **1.000** |
| Austria | 0.302 | 0.068 | 0.072 | 0.235 | 0.916 |
| Belgium | 0.227 | 0.012 | – | – | 0.929 |
| Czech Republic | 0.748 | 1.166 | 0.053 | 0.017 | 1.243 |
| Denmark | 1.373 | – | 2.225 | 1.545 | 1.227 |
| Finland | 0.425 | 0.223 | 0.006 | – | 0.945 |
| France | 0.502 | 0.097 | 0.015 | 0.033 | 1.133 |
| Germany | 0.388 | 0.680 | 0.035 | 0.201 | 1.001 |
| Greece | 0.332 | 0.918 | 0.007 | 0.015 | 0.965 |
| Hungary | 0.395 | 0.723 | 0.255 | 0.192 | 0.831 |
| Ireland | 0.126 | 0.422 | – | 0.149 | 0.955 |
| Italy | 0.153 | 0.011 | 0.066 | 0.180 | 0.848 |
| Luxembourg | 0.014 | – | – | – | 0.429 |
| Netherlands | 0.723 | – | 0.100 | 1.450 | 0.851 |
| Norway | 9.989 | 2.504 | 31.658 | 10.400 | 0.931 |
| Portugal | 0.168 | – | – | – | 0.943 |
| Spain | 0.242 | 0.347 | 0.005 | 0.009 | 0.995 |
| Sweden | 0.614 | 0.133 | – | – | 0.912 |
| Switzerland | 0.443 | – | – | – | 1.050 |
| Turkey | 0.299 | 0.506 | 0.078 | 0.026 | 0.996 |
| United Kingdom | 1.062 | 0.439 | 1.360 | 1.079 | 0.995 |
| **IEA Europe** | **0.617** | **0.500** | **0.457** | **0.612** | **0.990** |
| **IEA Total** | **0.678** | **0.851** | **0.400** | **0.785** | **0.997** |

1. Calculated as production divided by primary energy supply.
2. Calculated as the ratio between domestic generation and total apparent consumption, or TFC plus own-use in the energy sector and distribution losses. Includes CHP units.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table A8

# Recent Energy and Oil Supply Trends for IEA Countries

(Mtoe and %)

| | TPES | | | | | Oil Supply | | | | | Net Oil Imports[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | % Chg. | 2004[2] | % Chg. | 2002 | 2003 | % Chg. | 2004[2] | % Chg. | 2002 | 2003 | % Chg. | 2004[2] | % Chg. |
| Canada | 249.2 | 260.6 | 4.6 | 260.7 | 0.0 | 86.1 | 91.7 | 6.5 | 97.1 | 5.9 | -50.2 | -50.2 | -0.1 | -52.4 | 4.4 |
| United States | 2289.0 | 2280.8 | -0.4 | 2324.5 | 1.9 | 900.6 | 921.4 | 2.3 | 946.7 | 2.7 | 535.1 | 575.5 | 7.6 | 608.7 | 5.8 |
| **North America** | **2538.2** | **2541.4** | **0.1** | **2585.2** | **1.7** | **986.7** | **1013.1** | **2.7** | **1043.8** | **3.0** | **484.9** | **525.3** | **8.3** | **556.4** | **5.9** |
| Australia | 111.9 | 112.6 | 0.7 | 114.5 | 1.7 | 34.6 | 35.9 | 3.9 | 35.4 | -1.4 | 1.1e | 5.1 | 379.1 | 8.9 | 74.7 |
| Japan | 520.7 | 517.1 | -0.7 | 537.1 | 3.9 | 255.4 | 257.0 | 0.6 | 253.6 | -1.3 | 253.4 | 255.7 | 0.9 | 251.6 | -1.6 |
| Korea | 201.0 | 205.3 | 2.1 | 210.6 | 2.6 | 102.0 | 101.2 | -0.8 | 100.6 | -0.6 | 100.8 | 102.4 | 1.6 | 100.1 | -2.2 |
| New Zealand | 17.9 | 17.4 | -2.8 | 17.7 | 1.7 | 6.5 | 6.8 | 4.8 | 6.9 | 2.1 | 4.7 | 5.5 | 16.5 | 5.9 | 7.7 |
| **Pacific** | **851.5** | **852.4** | **0.1** | **879.8** | **3.2** | **398.4** | **400.9** | **0.6** | **396.5** | **-1.1** | **360.0** | **368.7** | **2.4** | **366.6** | **-0.6** |
| Austria | 31.1 | 33.2 | 6.6 | 32.8 | -1.0 | 13.3 | 14.2 | 6.9 | 14.3 | 0.0 | 12.6 | 13.3 | 5.9 | 13.6 | 1.8 |
| Belgium | 56.5 | 59.2 | 4.6 | 57.5 | -2.8 | 22.9 | 24.8 | 8.1 | 22.4 | -9.3 | 22.6 | 25.0 | 10.8 | 22.4 | -10.5 |
| Czech Republic | 41.7 | 44.1 | 5.7 | 44.5 | 1.0 | 8.5 | 8.8 | 2.9 | 9.5 | 8.7 | 8.0 | 8.4 | 5.4 | 8.9 | 6.1 |
| Denmark | 19.7 | 20.8 | 5.3 | 20.1 | -3.1 | 8.5 | 8.4 | -1.9 | 8.3 | -0.8 | -10.4 | -10.3 | -0.7 | -11.6 | 12.5 |
| Finland | 35.6 | 37.6 | 5.4 | 37.6 | 0.1 | 10.5 | 10.7 | 2.3 | 10.9 | 1.4 | 9.8 | 10.9 | 11.6 | 10.6 | -3.3 |
| France | 266.0 | 271.3 | 2.0 | 274.5 | 1.2 | 91.3 | 91.0 | -0.2 | 91.6 | 0.6 | 90.8 | 91.0 | 0.2 | 90.4 | -0.7 |
| Germany | 346.0 | 347.1 | 0.3 | 348.3 | 0.3 | 128.8 | 126.5 | -1.8 | 125.1 | -1.2 | 122.1 | 123.7 | 1.3 | 119.7 | -3.2 |
| Greece | 29.0 | 29.9 | 3.0 | 30.3 | 1.4 | 16.6 | 17.2 | 3.8 | 17.4 | 1.2 | 17.2 | 16.5 | -4.4 | 18.4 | 11.6 |
| Hungary | 25.8 | 26.3 | 2.0 | 26.0 | -1.2 | 6.5 | 6.3 | -2.5 | 6.2 | -1.2 | 4.7 | 4.8 | 2.2 | 4.9 | 2.7 |
| Ireland | 15.3 | 15.1 | -1.5 | 15.3 | 1.4 | 8.7 | 8.5 | -2.4 | 8.6 | 1.6 | 8.8 | 8.5 | -3.2 | 8.6 | 1.1 |
| Italy | 173.6 | 181.0 | 4.3 | 186.0 | 2.7 | 87.5 | 87.4 | -0.1 | 86.9 | -0.6 | 82.5 | 80.7 | -2.1 | 80.4 | -0.5 |
| Luxembourg | 4.0 | 4.3 | 5.5 | 4.7 | 11.4 | 2.5 | 2.7 | 7.8 | 3.1 | 12.8 | 2.6 | 2.7 | 7.3 | 3.1 | 12.1 |
| Netherlands | 78.6 | 80.8 | 2.9 | 82.0 | 1.4 | 29.8 | 31.5 | 5.6 | 32.0 | 1.3 | 26.0 | 27.7 | 6.6 | 29.8 | 7.6 |
| Norway | 28.8 | 23.3 | -19.0 | 26.8 | 14.8 | 10.1 | 4.9 | -51.8 | 8.5 | 73.4 | -150.9e | -148.5 | -1.6 | -146.1 | -1.6 |
| Portugal | 26.5 | 25.8 | -2.6 | 26.6 | 3.3 | 16.4 | 15.3 | -7.1 | 15.5 | 1.6 | 15.8 | 15.8 | -0.1 | 15.3 | -3.3 |
| Spain | 131.6 | 136.1 | 3.4 | 142.9 | 5.0 | 67.3 | 69.0 | 2.6 | 70.8 | 2.5 | 68.1 | 68.7 | 0.9 | 70.3 | 2.2 |
| Sweden | 52.8 | 51.5 | -2.5 | 53.2 | 3.1 | 16.5 | 15.5 | -5.9 | 15.6 | 0.0 | 15.0 | 16.6 | 10.8 | 15.0 | -9.6 |
| Switzerland | 27.1 | 27.1 | -0.2 | 27.0 | -0.1 | 13.0 | 12.6 | -3.0 | 12.5 | -0.6 | 13.0 | 12.5 | -4.1 | 12.5 | 0.3 |
| Turkey | 75.6 | 79.0 | 4.5 | 82.5 | 4.4 | 30.5 | 29.8 | -2.5 | 30.4 | 2.0 | 27.9 | 27.7 | -0.6 | 28.2 | 1.8 |
| United Kingdom | 228.5 | 232.0 | 1.5 | 233.9 | 0.8 | 80.5 | 81.4 | 1.1 | 86.0 | 5.6 | -41.8 | -29.5 | -29.4 | -14.3 | -51.5 |
| **IEA Europe** | **1694.0** | **1725.4** | **1.9** | **1752.6** | **1.6** | **669.8** | **666.6** | **-0.5** | **675.4** | **1.3** | **344.4** | **366.5** | **6.4** | **380.2** | **3.7** |
| **IEA Total** | **5083.7** | **5119.2** | **0.7** | **5217.6** | **1.9** | **2054.9** | **2080.6** | **1.3** | **2115.8** | **1.7** | **1189.3** | **1260.5** | **6.0** | **1303.1** | **3.4** |

1. Includes requirements for marine bunkers.
2. Preliminary data.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table A9

# Share of Oil Use by Sector in IEA Countries

(%)

| | TFC | | | | Industry[1] | | | | Residential/Commercial[2] | | | | Transport | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| Canada | 57.9 | 53.3 | 43.5 | 44.3 | 40.4 | 37.3 | 30.2 | 31.6 | 47.4 | 35.4 | 19.2 | 20.4 | 98.8 | 95.2 | 90.5 | 91.9 |
| United States | 53.0 | 54.6 | 53.7 | 54.0 | 33.4 | 41.4 | 36.4 | 36.9 | 32.6 | 25.0 | 13.0 | 13.0 | 95.9 | 96.9 | 97.1 | 97.2 |
| **North America** | **53.4** | **54.5** | **52.6** | **52.9** | **34.1** | **40.9** | **35.5** | **36.1** | **34.0** | **26.1** | **13.8** | **13.9** | **96.1** | **96.7** | **96.6** | **96.8** |
| Australia | 61.7 | 59.7 | 50.9 | 51.7 | 43.8 | 40.6 | 22.8 | 23.2 | 39.7 | 26.7 | 14.6 | 15.8 | 99.4 | 99.6 | 98.0 | 98.1 |
| Japan | 73.2 | 70.3 | 62.8 | 61.9 | 67.7 | 62.2 | 52.4 | 51.1 | 68.5 | 63.6 | 47.0 | 46.1 | 96.9 | 97.6 | 98.3 | 98.3 |
| Korea | 56.4 | 62.0 | 62.9 | 62.3 | 84.4 | 77.7 | 57.8 | 58.3 | 13.7 | 25.1 | 40.8 | 37.7 | 99.1 | 99.4 | 99.2 | 99.0 |
| New Zealand | 60.6 | 55.1 | 44.3 | 48.5 | 43.9 | 35.0 | 9.5 | 11.2 | 32.8 | 22.8 | 12.0 | 14.0 | 99.9 | 99.9 | 99.3 | 99.3 |
| **Pacific** | **70.4** | **67.8** | **60.9** | **60.4** | **65.6** | **60.5** | **49.7** | **49.3** | **58.1** | **53.2** | **41.9** | **40.6** | **97.6** | **98.2** | **98.5** | **98.5** |
| Austria | 60.4 | 54.9 | 46.3 | 46.7 | 51.7 | 40.1 | 30.4 | 31.5 | 48.6 | 44.7 | 26.2 | 26.5 | 92.9 | 94.8 | 93.1 | 93.6 |
| Belgium | 60.7 | 56.4 | 51.7 | 52.9 | 46.8 | 38.3 | 37.0 | 35.2 | 64.2 | 57.4 | 36.8 | 41.3 | 98.4 | 98.6 | 98.7 | 98.8 |
| Czech Republic | 25.5 | 25.9 | 31.3 | 31.6 | 28.2 | 26.9 | 24.0 | 23.3 | 5.8 | 9.4 | 2.1 | 2.0 | 88.5 | 89.1 | 95.4 | 95.8 |
| Denmark | 87.7 | 80.2 | 48.4 | 48.5 | 83.3 | 70.5 | 32.8 | 33.2 | 84.9 | 76.2 | 20.7 | 19.4 | 99.7 | 99.7 | 99.3 | 99.4 |
| Finland | 59.2 | 54.8 | 34.2 | 34.3 | 66.2 | 54.3 | 17.2 | 18.1 | 42.3 | 41.1 | 24.6 | 22.9 | 99.3 | 99.5 | 98.5 | 98.3 |
| France | 68.3 | 64.0 | 52.2 | 51.2 | 62.3 | 58.6 | 37.8 | 38.4 | 60.8 | 50.7 | 26.8 | 25.9 | 97.7 | 98.1 | 97.5 | 97.5 |
| Germany | 56.0 | 53.2 | 50.0 | 47.9 | 44.3 | 39.5 | 35.4 | 34.9 | 53.6 | 47.8 | 30.1 | 27.7 | 93.5 | 97.1 | 97.1 | 96.9 |
| Greece | 77.6 | 77.4 | 69.7 | 70.7 | 68.7 | 69.4 | 51.4 | 52.1 | 68.6 | 61.6 | 52.4 | 54.7 | 99.2 | 99.7 | 99.6 | 99.6 |
| Hungary | 39.1 | 42.2 | 31.2 | 30.1 | 29.6 | 32.7 | 30.4 | 29.4 | 35.7 | 36.5 | 6.7 | 5.5 | 81.2 | 90.6 | 97.4 | 97.5 |
| Ireland | 71.2 | 64.3 | 65.4 | 66.8 | 86.6 | 73.8 | 42.3 | 50.0 | 37.7 | 30.5 | 45.3 | 43.7 | 100.0 | 100.0 | 100.0 | 100.0 |
| Italy | 73.0 | 65.1 | 49.7 | 48.8 | 62.3 | 52.1 | 31.1 | 31.3 | 73.5 | 58.5 | 22.2 | 21.0 | 97.1 | 97.3 | 97.4 | 97.3 |
| Luxembourg | 52.1 | 43.8 | 66.8 | 68.0 | 38.6 | 19.9 | 6.8 | 7.0 | 78.4 | 67.8 | 42.3 | 40.6 | 99.0 | 99.2 | 99.6 | 99.6 |
| Netherlands | 50.5 | 42.6 | 42.1 | 43.1 | 48.8 | 46.7 | 42.2 | 44.9 | 34.2 | 16.8 | 3.8 | 3.9 | 99.0 | 99.0 | 99.1 | 99.1 |
| Norway | 55.9 | 52.6 | 41.9 | 44.0 | 43.2 | 43.3 | 31.9 | 33.5 | 50.6 | 37.3 | 18.4 | 21.3 | 98.3 | 98.3 | 96.6 | 96.9 |
| Portugal | 75.1 | 73.7 | 63.4 | 62.7 | 66.9 | 66.9 | 52.6 | 50.6 | 59.7 | 52.9 | 34.4 | 32.2 | 98.0 | 99.0 | 99.4 | 99.3 |
| Spain | 75.6 | 78.6 | 61.0 | 60.1 | 64.7 | 70.0 | 41.0 | 39.1 | 68.2 | 64.4 | 33.9 | 34.0 | 98.8 | 99.1 | 98.5 | 98.4 |
| Sweden | 70.4 | 62.8 | 39.5 | 39.4 | 53.4 | 48.1 | 27.7 | 27.0 | 78.7 | 62.6 | 17.1 | 16.9 | 96.8 | 96.9 | 96.8 | 96.8 |
| Switzerland | 81.4 | 75.3 | 60.6 | 59.8 | 77.4 | 64.0 | 33.2 | 32.9 | 76.3 | 70.7 | 46.8 | 46.5 | 95.9 | 95.8 | 96.6 | 96.3 |
| Turkey | 48.5 | 49.4 | 47.5 | 44.3 | 60.5 | 56.7 | 37.5 | 34.7 | 28.0 | 23.8 | 27.0 | 23.7 | 88.1 | 96.3 | 99.1 | 99.1 |
| United Kingdom | 52.3 | 48.5 | 46.1 | 46.6 | 51.8 | 45.6 | 37.2 | 39.8 | 24.7 | 21.6 | 8.0 | 7.2 | 99.1 | 99.1 | 98.6 | 98.6 |
| **IEA Europe** | **60.3** | **56.4** | **49.6** | **48.9** | **52.5** | **47.6** | **35.6** | **35.7** | **51.5** | **43.7** | **23.6** | **22.8** | **96.5** | **97.8** | **97.8** | **97.8** |
| **IEA Total** | **57.7** | **56.7** | **52.9** | **52.7** | **45.7** | **46.2** | **38.4** | **38.7** | **43.0** | **35.9** | **21.9** | **21.3** | **96.3** | **97.2** | **97.2** | **97.3** |

1. Includes non-energy use.
2. Includes public and agricultural use.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Table A10

## Historical and Projected Oil Production in IEA Countries

(Mtoe)

| | 1973 | 1979 | 2003 | 2004[1] | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| Canada | 96.3 | 86.6 | 144.2 | 149.7 | 263.2 | 220.4 | .. |
| United States | 533.8 | 495.1 | 350.8 | 346.5 | 410.9 | 365.8 | .. |
| **North America** | **630.2** | **581.7** | **495.0** | **496.2** | **674.1** | **586.2** | **..** |
| Australia | 19.8 | 22.7 | 30.7 | 26.0 | 30.6 | 32.7 | .. |
| Japan | 0.7 | 0.5 | 0.7 | 0.7 | .. | .. | .. |
| Korea | – | – | 0.5 | 0.4 | .. | .. | .. |
| New Zealand | 0.2 | 0.4 | 1.3 | 1.2 | 1.2 | 1.4 | 1.1 |
| **Pacific** | **20.7** | **23.7** | **33.2** | **28.3** | **..** | **..** | **..** |
| Austria | 2.7 | 1.8 | 1.0 | 1.0 | 1.0 | 1.1 | .. |
| Belgium | – | – | – | – | – | – | – |
| Czech Republic | 0.0 | 0.3 | 0.5 | 0.6 | 0.4 | 0.4 | 0.4 |
| Denmark | 0.1 | 0.4 | 18.6 | 19.8 | 20.0 | 13.3 | 12.4 |
| Finland | – | – | 0.1 | 0.0 | – | – | .. |
| France | 2.1 | 2.0 | 1.4 | 1.3 | – | – | – |
| Germany | 6.8 | 4.9 | 4.4 | 4.6 | 3.0 | 1.8 | 0.6 |
| Greece | – | – | 0.1 | 0.1 | 0.3 | .. | .. |
| Hungary | 2.0 | 2.4 | 1.6 | 1.4 | 1.0 | 0.8 | 0.7 |
| Ireland | – | – | – | – | – | .. | .. |
| Italy | 1.1 | 1.6 | 5.8 | 6.6 | 5.7 | 4.9 | 4.8 |
| Luxembourg | – | – | – | – | .. | .. | .. |
| Netherlands | 1.6 | 1.6 | 3.2 | 3.0 | 1.7 | 1.3 | 0.3 |
| Norway | 1.5 | 18.6 | 154.4 | 154.1 | .. | .. | .. |
| Portugal | – | – | – | – | – | .. | .. |
| Spain | 0.7 | 1.4 | 0.3 | 0.3 | .. | .. | .. |
| Sweden | – | 0.0 | – | – | – | .. | .. |
| Switzerland | – | – | – | – | – | – | – |
| Turkey | 3.6 | 2.9 | 2.3 | 2.2 | 1.6 | 0.7 | .. |
| United Kingdom | 0.5 | 79.9 | 110.7 | 99.5 | .. | .. | .. |
| **IEA Europe** | **22.8** | **117.9** | **304.4** | **294.6** | **..** | **..** | **..** |
| **IEA Total** | **673.7** | **723.3** | **832.6** | **819.1** | **..** | **..** | **..** |

1. Preliminary data.

Note: The IEA Secretariat has estimated data for certain countries. Please see Energy Balances and Key Statistical Data for details.

Sources: *Energy Balances of OECD Countries*, Paris IEA/OECD, 2005, for 1973, 1979 and 2003; and country submissions for 2010, 2020 and 2030.

Table A11

## Historical and Projected Net Oil Imports of IEA Countries[1]

(Mtoe)

| | 1979 | 2002 | 2003 | 2004[2] | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| Canada | 6.3 | -50.2 | -50.2 | -52.4 | -165.6 | -112.4 | .. |
| United States | 399.2 | 535.1 | 575.5 | 608.7 | 708.0 | 916.0 | .. |
| **North America** | **405.5** | **484.9** | **525.3** | **556.4** | **542.4** | **803.6** | **..** |
| Australia | 9.5 | 1.1e | 5.1 | 8.9 | 16.8 | 26.7 | .. |
| Japan | 264.4 | 253.4 | 255.7 | 251.6 | 231.2 | .. | 236.8 |
| Korea | 26.9 | 100.8 | 102.4 | 100.1 | .. | .. | .. |
| New Zealand | 3.7 | 4.7 | 5.5 | 5.9 | 6.3 | 6.9 | 8.3 |
| **Pacific** | **304.4** | **360.0** | **368.7** | **366.6** | **..** | **..** | **..** |
| Austria | 11.4 | 12.6 | 13.3 | 13.6 | 11.8 | 13.2 | .. |
| Belgium | 27.0 | 22.6 | 25.0 | 22.4 | 23.2 | 24.0 | 24.1 |
| Czech Republic | 11.2 | 8.0 | 8.4 | 8.9 | 8.6 | 9.0 | 9.3 |
| Denmark | 15.3 | -10.4 | -10.3 | -11.6 | -10.9 | -3.5 | -2.1 |
| Finland | 14.7 | 9.8 | 10.9 | 10.6 | 9.2 | 8.9 | .. |
| France | 115.9 | 90.8 | 91.0 | 90.4 | 104.0 | 106.7 | 107.5 |
| Germany | 159.3 | 122.1 | 123.7 | 119.7 | 124.9 | 116.7 | 109.5 |
| Greece | 12.4 | 17.2 | 16.5 | 18.4 | 21.6 | .. | .. |
| Hungary | 9.8 | 4.7 | 4.8 | 4.9 | 6.2 | 6.6 | 7.3 |
| Ireland | 6.4 | 8.8 | 8.5 | 8.6 | 8.4 | .. | .. |
| Italy | 89.4 | 82.5 | 80.7 | 80.4 | 76.6 | 85.5 | 92.0 |
| Luxembourg | 1.4 | 2.6 | 2.7 | 3.1 | .. | .. | .. |
| Netherlands | 31.7 | 26.0 | 27.7 | 29.8 | 28.6 | 35.1 | 40.3 |
| Norway | -9.6 | -150.9e | -148.5 | -146.1 | .. | .. | .. |
| Portugal | 8.6 | 15.8 | 15.8 | 15.3 | 16.2 | .. | .. |
| Spain | 47.8 | 68.1 | 68.7 | 70.3 | .. | .. | .. |
| Sweden | 28.3 | 15.0 | 16.6 | 15.0 | 16.4 | .. | .. |
| Switzerland | 13.8 | 13.0 | 12.5 | 12.5 | 13.0 | 12.9 | 12.6 |
| Turkey | 11.7 | 27.9 | 27.7 | 28.2 | 39.6 | 60.2 | .. |
| United Kingdom | 16.6 | -41.8 | -29.5 | -14.3 | .. | .. | .. |
| **IEA Europe** | **623.2** | **344.4** | **366.5** | **380.2** | **..** | **..** | **..** |
| **IEA Total** | **1333.1** | **1189.3** | **1260.5** | **1303.1** | **..** | **..** | **..** |

1. Includes requirements for marine bunkers.
2. Preliminary data.

Note: The IEA Secretariat has estimated data for certain countries. Please see Energy Balances and Key Statistical Data for details.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005, for 1979, 2002 and 2003 and country submissions for 2010, 2020 and 2030.

Table A12

## Total IEA Electricity Generation by Fuel

(TWh and %)

| | 1973 | | 1979 | | 2003 | | 2004[1] | |
|---|---|---|---|---|---|---|---|---|
| | Output TWh | Share % | Output TWh | Share % | Output TWh | Share % | Output TWh | Share % |
| Coal | 1 606.5 | *37.2* | 2 019.6 | *37.8* | 3 662.4 | *38.7* | 3 643.3 | *37.9* |
| Oil | 1 105.7 | *25.6* | 1 052.3 | *19.7* | 487.3 | *5.2* | 434.0 | *4.5* |
| Natural Gas | 512.9 | *11.9* | 598.5 | *11.2* | 1 645.8 | *17.4* | 1 733.6 | *18.0* |
| Comb. Renewables & Waste | 6.9 | *0.2* | 11.7 | *0.2* | 166.2 | *1.8* | 168.6 | *1.8* |
| Nuclear | 188.3 | *4.4* | 573.4 | *10.7* | 2 195.0 | *23.2* | 2 290.4 | *23.8* |
| Hydro | 891.2 | *20.6* | 1 073.7 | *20.1* | 1 209.7 | *12.8* | 1 232.5 | *12.8* |
| Geothermal | 6.4 | *0.1* | 8.6 | *0.2* | 26.6 | *0.3* | 26.4 | *0.3* |
| Solar/Wind | 0.6 | *0.0* | 0.5 | *0.0* | 61.7 | *0.7* | 79.7 | *0.8* |
| **Total** | **4 318.4** | ***100.0*** | **5 338.4** | ***100.0*** | **9 454.7** | ***100.0*** | **9 608.5** | ***100.0*** |

1. Preliminary data.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Table A13

## Electricity Generation in IEA Countries, 2003

| | Energy Inputs[1] (Mtoe) | Electricity Output in TWh | Shares of Fuel in Electricity Generation (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Coal | Oil | Gas | Nuclear | Hydro | Other[2] |
| Canada | 88.3e | 586.9 | 19.3 | 3.0 | 5.8 | 12.8 | 57.5 | 1.7 |
| United States | 924.0e | 4054.4 | 51.4 | 3.4 | 16.5 | 19.4 | 6.9 | 2.4 |
| **North America** | **1012.3** | **4641.2** | **47.3** | **3.3** | **15.2** | **18.6** | **13.3** | **2.3** |
| Australia | 54.3 | 227.9 | 77.2 | 1.0 | 13.8 | – | 7.0 | 0.9 |
| Japan | 210.7 | 1037.7 | 28.2 | 13.2 | 24.3 | 23.1 | 9.1 | 2.1 |
| Korea | 79.3e | 344.9 | 38.9 | 9.2 | 12.3 | 37.6 | 1.4 | 0.6 |
| New Zealand | 6.4 | 41.1 | 8.1 | 0.0 | 24.4 | – | 57.5 | 9.9 |
| **Pacific** | **350.7** | **1651.5** | **36.7** | **10.3** | **20.3** | **22.4** | **8.4** | **1.8** |
| Austria | 9.2 | 61.2 | 15.4 | 2.9 | 18.3 | – | 59.4 | 3.9 |
| Belgium | 19.9e | 83.6 | 13.9 | 1.2 | 25.9 | 56.7 | 0.3 | 2.0 |
| Czech Republic | 23.3 | 82.8 | 62.3 | 0.4 | 3.7 | 31.2 | 1.7 | 0.6 |
| Denmark | 10.4 | 46.3 | 54.7 | 5.1 | 21.2 | – | 0.0 | 19.0 |
| Finland | 19.8 | 84.2 | 31.8 | 1.1 | 16.6 | 27.0 | 11.4 | 12.2 |
| France | 134.0e | 561.7 | 5.3 | 1.5 | 3.1 | 78.5 | 10.5 | 1.1 |
| Germany | 141.6e | 594.3 | 52.9 | 0.8 | 9.8 | 27.8 | 3.2 | 5.5 |
| Greece | 12.6 | 57.9 | 60.7 | 15.1 | 13.8 | – | 8.2 | 2.2 |
| Hungary | 9.8 | 34.1 | 27.1 | 4.8 | 34.8 | 32.3 | 0.5 | 1 |
| Ireland | 4.9e | 24.9 | 33.1 | 9.9 | 52.5 | – | 2.4 | 2.2 |
| Italy | 56.7e | 283.4 | 15.6 | 26.8 | 41.4 | – | 11.9 | 4.3 |
| Luxembourg | 0.5 | 2.8 | .. | .. | 93.9 | – | 2.8 | 3.3 |
| Netherlands | 21.2 | 96.8 | 28.4 | 3.0 | 58.8 | 4.2 | 0.1 | 5.7 |
| Norway | 9.5 | 106.7 | 0.1 | 0.0 | 0.3 | – | 98.9 | 0.7 |
| Portugal | 7.8 | 46.5 | 31.2 | 13.2 | 16.6 | – | 33.8 | 5.1 |
| Spain | 49.4e | 257.9 | 29.5 | 9.3 | 15.3 | 24.0 | 15.9 | 6.1 |
| Sweden | 28.1 | 135.6 | 3.1 | 2.9 | 0.4 | 49.7 | 39.3 | 4.7 |
| Switzerland | 11.1e | 64.9 | – | 0.1 | 1.4 | 42.3 | 53.6 | 2.5 |
| Turkey | 24.9e | 140.6 | 22.9 | 6.5 | 45.2 | – | 25.1 | 0.2 |
| United Kingdom | 85.8 | 395.9 | 35.4 | 1.8 | 37.5 | 22.4 | 0.8 | 2.0 |
| **IEA Europe** | **680.5** | **3161.9** | **27.2** | **5.1** | **19.2** | **30.4** | **14.4** | **3.7** |
| **IEA Total** | **2043.5** | **9454.7** | **38.7** | **5.2** | **17.4** | **23.2** | **12.8** | **2.7** |

1. Includes CHP units.
2. Includes combustible renewables, waste, geothermal, solar, wind, tide and wave.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

## Table A14

## Electricity Intensity of IEA Countries[1]

| | 1973 | 1979 | 2001 | 2002 | 2003 | Average Annual Growth Rates (%) 1992-1997 | 1998-2003 |
|---|---|---|---|---|---|---|---|
| Canada | 0.79 | 0.82 | 0.78 | 0.77 | 0.76 | –1.4 | –1.9 |
| United States | 0.46 | 0.46 | 0.39 | 0.40 | 0.39 | –1.1 | –1.6 |
| **North America** | **0.48** | **0.49** | **0.42** | **0.43** | **0.42** | **–1.2** | **–1.5** |
| Australia | 0.38 | 0.46 | 0.54 | 0.54 | 0.53 | –1.3 | –0.2 |
| Japan | 0.21 | 0.22 | 0.22 | 0.22 | 0.21 | 1.19 | –0.6 |
| Korea | 0.19 | 0.28 | 0.53 | 0.58 | 0.59 | 5.12 | 3.22 |
| New Zealand | 0.57 | 0.68 | 0.73 | 0.73 | 0.70 | –2.1 | –1.2 |
| **Pacific** | **0.23** | **0.24** | **0.27** | **0.28** | **0.28** | **1.75** | **0.76** |
| Austria | 0.30 | 0.31 | 0.31 | 0.31 | 0.34 | –0.2 | 2.04 |
| Belgium | 0.32 | 0.35 | 0.38 | 0.38 | 0.38 | 0.69 | –0.5 |
| Czech Republic | 0.97 | 1.05 | 1.13 | 1.11 | 1.11 | 0.06 | –1.2 |
| Denmark | 0.19 | 0.23 | 0.23 | 0.23 | 0.23 | –1.2 | –1.2 |
| Finland | 0.50 | 0.57 | 0.70 | 0.70 | 0.70 | –0.2 | –0.4 |
| France | 0.25 | 0.29 | 0.36 | 0.35 | 0.37 | 0.21 | –0.2 |
| Germany | 0.37 | 0.39 | 0.31 | 0.31 | 0.32 | –0.4 | 0.34 |
| Greece | 0.22 | 0.27 | 0.47 | 0.46 | 0.47 | 2.08 | 0.58 |
| Hungary | 0.74 | 0.79 | 0.82 | 0.81 | 0.79 | –0.6 | –2.3 |
| Ireland | 0.31 | 0.33 | 0.24 | 0.24 | 0.23 | –2.7 | –2.7 |
| Italy | 0.25 | 0.26 | 0.29 | 0.30 | 0.30 | 0.57 | 1.15 |
| Luxembourg | 0.53 | 0.54 | 0.31 | 0.31 | 0.31 | –0.4 | –2.3 |
| Netherlands | 0.27 | 0.29 | 0.30 | 0.30 | 0.30 | 0.27 | 0.30 |
| Norway | 1.06 | 0.99 | 0.71 | 0.69 | 0.65 | –3.2 | –2.7 |
| Portugal | 0.21 | 0.28 | 0.43 | 0.44 | 0.46 | 1.48 | 3.07 |
| Spain | 0.27 | 0.33 | 0.41 | 0.42 | 0.43 | 1.29 | 2.35 |
| Sweden | 0.56 | 0.62 | 0.62 | 0.60 | 0.58 | –1.0 | –2.4 |
| Switzerland | 0.19 | 0.23 | 0.24 | 0.24 | 0.25 | –0.2 | 0.90 |
| Turkey | 0.19 | 0.27 | 0.69 | 0.67 | 0.67 | 4.50 | 2.75 |
| United Kingdom | 0.35 | 0.34 | 0.27 | 0.26 | 0.26 | –1.4 | –1.3 |
| **IEA Europe** | **0.33** | **0.35** | **0.35** | **0.35** | **0.36** | **–0.0** | **0.12** |
| **IEA Total** | **0.37** | **0.38** | **0.36** | **0.37** | **0.36** | **–0.2** | **–0.5** |

1. Calculated as production plus net imports divided by GDP and measured in kWh per dollar of GDP at 2000 prices and exchange rates; includes CHP units.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris 2005 and *National Accounts, Volume 1*, OECD Paris, 2005.

Table A15

## Electricity Generation in IEA Countries, 2003

(GW net)

| | Total Capacity | | | | | | |
|---|---|---|---|---|---|---|---|
| | Coal | Oil | Natural Gas | Nuclear | Hydro | Other | Total |
| Canada | .. | .. | .. | 10.62 | 70.37 | 3.87 | 118.27 |
| United States[1] | 337.99 | 49.85e | 419.57e | 105.42 | 92.39 | 21.16 | 1026.37 |
| **North America** | **..** | **..** | **..** | **116.03** | **162.77** | **25.04** | **..** |
| Australia | 27.66 | 1.93e | 10.09e | – | 9.28e | 1.09 | 50.03 |
| Japan[2, 3] | 35.75 | 44.22e | 60.42 | 45.74 | 45.32 | 0.50 | 231.95 |
| Korea | .. | .. | .. | .. | .. | .. | .. |
| New Zealand | 0.66e | 0.09 | 1.95e | – | 5.32 | 0.63 | 8.64 |
| **Pacific** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |
| Austria | 1.65 | 0.27 | 3.85e | – | 13.75 | 0.76 | 20.28 |
| Belgium | .. | .. | .. | .. | .. | .. | .. |
| Czech Republic | 10.40 | 0.07 | 0.76 | 3.76 | 2.15 | 0.21 | 17.34 |
| Denmark | 4.91 | 1.83 | 2.78 | – | 0.01 | 3.78 | 13.32 |
| Finland | 4.72e | 1.37e | 2.64e | 2.67 | 2.96 | 2.21 | 16.57 |
| France | .. | .. | .. | .. | .. | .. | .. |
| Germany | 52.68 | 5.06 | 19.44e | 21.44 | 8.26 | 18.18 | 125.06 |
| Greece | 4.81 | 2.16 | 1.61 | – | 3.08 | 0.43 | 12.08 |
| Hungary | 1.85 | 0.45 | 4.00e | 1.87 | 0.05 | 0.09 | 8.31 |
| Ireland[2] | 1.16 | 0.92 | 2.66 | – | 0.53 | 0.18 | 5.46 |
| Italy | 13.65e | 13.88e | 27.41e | – | 20.66 | 2.71 | 78.31 |
| Luxembourg | – | – | 0.44 | – | 1.14 | 0.05 | 1.63 |
| Netherlands | .. | .. | .. | 0.45 | 0.04 | 1.00 | 20.90 |
| Norway | 0.05e | 0.02e | 0.04e | – | 27.92e | 0.27e | 28.29 |
| Portugal | 1.78 | 2.52 | 2.00e | – | 4.59 | 0.74 | 11.62 |
| Spain | 13.64e | 9.26e | 13.22e | 7.58 | 18.04 | 7.16 | 68.91 |
| Sweden | 1.12 | 4.41 | 0.35 | 9.44 | 16.14 | 1.90 | 33.36 |
| Switzerland | – | 0.14e | 0.37e | 3.22 | 14.97 | 0.43e | 19.12 |
| Turkey | 8.24 | 3.20 | 11.51 | – | 12.58 | 0.06 | 35.59 |
| United Kingdom | 26.53 | 6.44 | 27.83 | 12.10 | 4.26 | 1.83 | 78.98 |
| **IEA Europe** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |
| **IEA Total** | **..** | **..** | **..** | **..** | **..** | **..** | **..** |

1. Capacity is net summer capacity.
2. Only gross capacity data are available.
3. Does not include autoproducer capacity.

Source: Country submissions.

## Table A16

# Percentage Change in Real Energy Prices for End-users in IEA Countries, 2003-2004

| | Total Energy | | Oil Products | | Electricity | | Gas | | Coal | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Industry | Residential/ Commercial | Industry | Residential/ Commercial | Industry | Residential/ Commercial | Industry | Residential/ Commercial | Industry | Residential/ Commercial |
| Canada | -2.0 | 5.5 | 7.0 | 8.4 | .. | .. | .. | .. | .. | .. |
| United States | 7.0 | 9.7 | 15.9 | 15.0 | -0.8 | -0.1 | 3.1 | 9.8 | 11.2 | .. |
| Australia | 0.5 | 4.0 | 5.6 | 6.6 | -3.8 | .. | 2.3 | 3.9 | .. | .. |
| Japan | 1.9 | 2.6 | 6.5 | 5.8 | .. | .. | .. | .. | 32.2 | .. |
| Korea | 2.5 | 4.7 | 7.1 | 4.0 | -4.4 | 7.4 | .. | .. | -7.0 | .. |
| New Zealand | 9.5 | 7.7 | 13.8 | 8.2 | 1.4 | 6.7 | 12.0 | 9.0 | .. | .. |
| Austria | 15.4 | 6.2 | 6.5 | 8.9 | .. | 3.4 | 0.7 | 3.5 | .. | 13.2 |
| Belgium | 9.6 | 4.2 | 12.1 | 12.0 | .. | .. | .. | .. | .. | 0.4 |
| Czech Republic | 4.2 | 2.4 | 9.9 | 4.7 | 1.6 | 1.8 | -7.9 | -2.8 | .. | .. |
| Denmark | -2.0 | 1.1 | -0.3 | 1.6 | -5.6 | -0.7 | .. | 5.8 | -1.2 | .. |
| Finland | 2.0 | 3.2 | 3.7 | 5.5 | 0.4 | -0.1 | -2.2 | -2.4 | 14.8 | .. |
| France | 7.0 | 0.2 | 10.2 | 4.4 | 0.2 | -0.9 | -2.6 | -7.0 | -5.7 | .. |
| Germany | 3.1 | 3.0 | 3.7 | 3.4 | .. | .. | .. | .. | .. | .. |
| Greece | 5.2 | 5.9 | 8.5 | 8.0 | -0.9 | -1.5 | -9.0 | 16.7 | .. | .. |
| Hungary | 1.6 | 5.4 | -1.7 | -5.2 | 4.8 | 11.0 | 7.5 | 19.8 | .. | 1.9 |
| Ireland | 7.4 | 6.1 | 11.6 | 7.2 | -5.2 | 5.3 | 16.8 | 0.8 | .. | .. |
| Italy | 0.6 | 0.4 | 3.8 | 4.0 | .. | .. | .. | .. | 8.8 | .. |
| Luxembourg | -1.3 | 10.7 | -0.6 | 14.1 | 0.0 | .. | -8.1 | .. | .. | -1.8 |
| Netherlands | 1.5 | 4.2 | 7.0 | 6.8 | .. | 2.6 | -10.7 | 1.8 | .. | .. |
| Norway | -9.1 | -11.3 | -2.6 | 6.0 | -14.9 | -27.0 | .. | .. | .. | .. |
| Portugal | 4.9 | 2.8 | 7.3 | 4.6 | -1.1 | -0.2 | .. | .. | 17.4 | .. |
| Spain | 2.8 | 2.2 | 4.9 | 3.7 | .. | .. | -8.1 | -4.9 | .. | .. |
| Sweden | 4.0 | 4.7 | 5.5 | 6.3 | .. | .. | .. | .. | .. | .. |
| Switzerland | 2.2 | 4.7 | 8.6 | 7.6 | -3.5 | -2.0 | 0.4 | -0.1 | .. | .. |
| Turkey | -5.8 | -5.4 | -0.7 | -1.9 | -13.8 | -9.9 | -12.1 | -16.0 | -1.3 | 7.9 |
| United Kingdom | 3.1 | 3.0 | 3.1 | 2.6 | 3.2 | 3.0 | 1.8 | 4.2 | 9.2 | 2.2 |

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Table A17

## Tax as a Percentage of Oil Product Prices in IEA Countries

| | High Sulphur Fuel Oil Industry | | | | Heating Oil Residential | | | | Diesel Commercial Transport | | | | Premium Unleaded Gasoline (95 RON)[1] Transport | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2001 | 2002 | 2003 | 2004 | 2001 | 2002 | 2003 | 2004 | 2001 | 2002 | 2003 | 2004 |
| Canada | .. | .. | .. | .. | 10.2 | 10.2 | 10.2 | 10.2 | 32.4 | 34.5 | 32.4 | 30.0 | 42.3 | 42.4 | 40.7 | 37.5 |
| United States | .. | .. | .. | .. | .. | 6.5 | 5.5 | 4.8 | 31.8 | 33.9 | 29.9 | 25.1 | 23.1 | 24.6 | 21.7 | 18.9 |
| Australia | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 52.8 | 53.6 | 51.7 | 48.2 |
| Japan | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 52.4 | 53.3 | 51.6 | 48.4 | 53.6 | 56.4 | 55.4 | 52.7 |
| Korea | 9.6 | 10.7 | 11.6 | 12.1 | 26.9 | 32.8 | 34.1 | 33.9 | 41.5 | 48.7 | 49.8 | 49.4 | 67.2 | 67.7 | 66.5 | 63.6 |
| New Zealand | .. | .. | .. | .. | .. | .. | .. | .. | 0.6 | 0.6 | 0.7 | 0.6 | 43.0 | 47.4 | 47.9 | 45.5 |
| Austria | .. | .. | .. | .. | 35.0 | 36.6 | 36.2 | 38.9 | 46.5 | 48.3 | 47.9 | 46.0 | 62.6 | 64.1 | 63.8 | 61.5 |
| Belgium | 10.7 | 10.9 | .. | .. | 21.5 | 22.0 | 21.6 | 22.2 | 46.1 | 50.8 | 47.0 | 45.0 | 67.7 | 69.2 | 67.2 | 66.0 |
| Czech Republic | .. | .. | .. | 11.0 | 29.4 | 31.6 | 30.9 | 31.4 | 41.3 | 45.8 | 45.4 | 47.9 | 57.7 | 62.1 | 61.7 | 60.8 |
| Denmark | .. | .. | .. | .. | 56.3 | 57.4 | 56.8 | 54.9 | 48.7 | 50.6 | 50.7 | 50.4 | 68.4 | 69.7 | 69.5 | 68.5 |
| Finland | .. | .. | .. | .. | 34.9 | 36.5 | 36.1 | 33.9 | 45.3 | 47.3 | 48.2 | 45.9 | 68.4 | 70.0 | 71.7 | 69.6 |
| France | 10.8 | 10.0 | 10.0 | 10.6 | 26.5 | 29.8 | 30.9 | 28.9 | 56.1 | 59.4 | 59.1 | 56.4 | 71.6 | 73.7 | 74.3 | 71.9 |
| Germany | .. | .. | .. | .. | 30.2 | 31.3 | 31.2 | 29.5 | 57.7 | 60.8 | 61.5 | 58.2 | 71.7 | 73.4 | 73.7 | 71.5 |
| Greece | .. | .. | 8.9 | 9.4 | 46.5 | 40.7 | 42.6 | 39.2 | 45.4 | 46.5 | 45.4 | 39.1 | 54.5 | 55.5 | 55.3 | 51.7 |
| Hungary | .. | .. | .. | .. | .. | .. | .. | .. | 48.1 | 51.3 | 50.6 | .. | 61.3 | 64.1 | 64.5 | .. |
| Ireland | 6.1 | 5.2 | 5.1 | 5.1 | 21.7 | 22.1 | 22.3 | 21.3 | 36.5 | 47.5 | 49.8 | 50.5 | 55.8 | 64.2 | 63.8 | 63.8 |
| Italy | 28.9 | 27.2 | .. | .. | 61.4 | 65.0 | 64.1 | 61.1 | 53.2 | 56.5 | 55.1 | 51.5 | 66.4 | 68.4 | 67.8 | 66.3 |
| Luxembourg | .. | .. | .. | .. | 12.4 | 12.4 | 12.3 | 13.5 | 44.3 | 46.1 | 45.6 | 42.2 | 57.5 | 58.8 | 58.5 | 59.6 |
| Netherlands | .. | .. | .. | .. | 46.3 | 50.5 | 49.7 | 47.4 | 49.6 | 51.8 | 51.5 | 48.6 | 68.8 | 70.9 | 71.0 | 69.2 |
| Norway | .. | .. | .. | .. | 36.7 | 37.7 | 35.8 | 35.1 | 48.2 | 49.6 | 49.2 | 48.4 | 67.6 | 70.0 | 68.9 | 66.6 |
| Portugal | 11.5 | 11.6 | .. | .. | .. | .. | .. | .. | 47.5 | 53.4 | 53.1 | 51.1 | 46.2 | 68.9 | 68.1 | 66.5 |
| Spain | 7.5 | 7.4 | 7.1 | .. | 34.0 | 36.7 | 35.7 | 33.4 | 45.2 | 49.5 | 49.2 | 45.2 | 59.9 | 62.4 | 62.3 | 59.4 |
| Sweden | .. | .. | .. | .. | 56.9 | 60.6 | 62.4 | 62.3 | 44.0 | 46.5 | 49.0 | 48.7 | 67.6 | 69.6 | 70.1 | 68.1 |
| Switzerland | .. | .. | .. | .. | 9.5 | 9.3 | 9.1 | 8.9 | 65.9 | 69.2 | 66.9 | 62.0 | 62.1 | 64.3 | 63.3 | 59.6 |
| Turkey | 27.7 | 34.4 | 36.3 | 41.0 | 56.8 | 63.1 | 64.8 | 61.8 | 54.0 | 64.3 | 65.5 | 62.4 | 62.8 | 70.1 | 71.2 | 68.4 |
| United Kingdom | 22.4 | 20.5 | .. | .. | 21.1 | 24.4 | 26.0 | 24.4 | 69.9 | 71.3 | 69.5 | 67.6 | 76.1 | 77.4 | 75.5 | 73.6 |

1. Regular unleaded gasoline for Australia, Canada and Japan 2001 to 2004.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

## Table A18

# Energy Balances and Key Statistical Data for IEA and Regions

| | | IEA Total | | | | IEA North America | | | | IEA Pacific | | | | IEA Europe | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| | | | | | | | | SUPPLY | | | | | | | | | Unit: Mtoe |
| **TOTAL PRODUCTION** | | **2287.6** | **2580.3** | **3526.6** | **3470.0** | **1653.5** | **1736.1** | **2050.0** | **2017.3** | **108.2** | **138.9** | **400.8** | **388.3** | **525.9** | **705.3** | **1075.7** | **1064.4** |
| Coal[1] | | 714.4 | 810.7 | 913.7 | 880.7 | 345.1 | 443.6 | 587.6 | 556.4 | 66.1 | 70.3 | 188.5 | 189.5 | 303.2 | 296.7 | 137.6 | 134.8 |
| Oil | | 673.7 | 723.3 | 853.5 | 832.6 | 630.2 | 581.7 | 496.4 | 495.0 | 20.7 | 23.7 | 35.8 | 33.2 | 22.8 | 117.9 | 321.3 | 304.4 |
| Gas | | 689.8 | 698.9 | 883.0 | 887.1 | 564.0 | 521.8 | 595.9 | 597.2 | 6.0 | 9.9 | 37.8 | 37.6 | 119.9 | 167.2 | 249.4 | 252.3 |
| Comb. Renewables & Waste[2] | | 78.3 | 97.6 | 157.9 | 164.7 | 45.3 | 59.9 | 77.0 | 79.9 | 3.5 | 4.0 | 13.7 | 13.4 | 29.4 | 33.7 | 67.2 | 71.4 |
| Nuclear | | 49.2 | 150.0 | 586.0 | 572.1 | 27.3 | 80.3 | 229.3 | 224.8 | 2.5 | 19.2 | 107.9 | 96.3 | 19.3 | 50.6 | 248.7 | 250.9 |
| Hydro | | 76.6 | 92.3 | 105.4 | 104.0 | 39.6 | 45.3 | 53.1 | 53.0 | 8.1 | 10.1 | 10.9 | 12.0 | 29.0 | 37.0 | 41.4 | 39.1 |
| Geothermal | | 5.6 | 7.5 | 19.1 | 20.1 | 2.1 | 3.5 | 8.3 | 8.6 | 1.3 | 1.7 | 5.2 | 5.2 | 2.2 | 2.2 | 5.6 | 6.3 |
| Solar/Wind/Other[3] | | 0.0 | 0.1 | 8.0 | 8.8 | - | - | 2.4 | 2.5 | - | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 4.6 | 5.3 |
| **TOTAL NET IMPORTS[4]** | | **1331.5** | **1418.6** | **1536.2** | **1639.0** | **252.6** | **374.4** | **469.3** | **514.5** | **307.7** | **338.7** | **451.1** | **466.7** | **771.2** | **705.5** | **615.8** | **657.8** |
| Coal[1] | Exports | 84.1 | 113.5 | 190.9 | 196.0 | 38.7 | 51.5 | 39.9 | 42.4 | 18.2 | 26.7 | 135.3 | 139.0 | 27.2 | 35.2 | 15.7 | 14.6 |
| | Imports | 114.4 | 145.5 | 311.4 | 329.3 | 11.2 | 15.5 | 25.6 | 29.9 | 41.8 | 44.4 | 150.0 | 155.0 | 61.4 | 85.6 | 135.8 | 144.4 |
| | Net Imports | 30.3 | 32.0 | 120.5 | 133.3 | -27.5 | -36.1 | -14.3 | -12.5 | 23.6 | 17.7 | 14.7 | 16.0 | 34.2 | 50.4 | 120.1 | 129.8 |
| Oil | Exports | 233.1 | 251.9 | 692.4 | 686.9 | 74.1 | 40.4 | 150.6 | 156.9 | 7.3 | 4.2 | 63.4 | 55.5 | 151.6 | 207.3 | 478.4 | 474.5 |
| | Imports | 1596.3 | 1659.0 | 1963.5 | 2026.0 | 365.3 | 471.9 | 659.7 | 702.3 | 308.1 | 323.1 | 435.1 | 436.4 | 923.0 | 864.0 | 868.6 | 887.3 |
| | Bunkers | 72.1 | 74.0 | 81.8 | 78.6 | 10.4 | 26.0 | 24.3 | 20.1 | 19.4 | 14.5 | 11.7 | 12.3 | 42.3 | 33.6 | 45.9 | 46.2 |
| | Net Imports | 1291.1 | 1333.1 | 1189.3 | 1260.5 | 280.8 | 405.5 | 484.9 | 525.3 | 281.3 | 304.4 | 360.0 | 368.7 | 729.0 | 623.2 | 344.4 | 366.5 |
| Gas | Exports | 50.3 | 82.5 | 221.2 | 226.8 | 24.9 | 24.0 | 100.0 | 99.1 | - | - | 8.9 | 9.1 | 25.5 | 58.5 | 112.3 | 118.5 |
| | Imports | 60.0 | 135.3 | 444.1 | 468.3 | 24.2 | 29.0 | 98.4 | 100.8 | 2.8 | 16.7 | 85.3 | 91.1 | 33.0 | 89.6 | 260.4 | 276.3 |
| | Net Imports | 9.7 | 52.8 | 222.9 | 241.5 | -0.7 | 5.0 | -1.5 | 1.7 | 2.8 | 16.7 | 76.4 | 82.0 | 7.5 | 31.1 | 148.1 | 157.8 |
| Electricity | Exports | 6.7 | 10.3 | 27.3 | 28.1 | 1.6 | 2.9 | 4.3 | 4.7 | - | - | - | - | 5.0 | 7.4 | 23.0 | 23.3 |
| | Imports | 7.1 | 10.9 | 29.9 | 30.8 | 1.6 | 2.9 | 4.5 | 4.7 | - | - | - | - | 5.4 | 8.1 | 25.4 | 26.1 |
| | Net Imports | 0.4 | 0.6 | 2.6 | 2.7 | 0.0 | -0.0 | 0.2 | -0.0 | - | - | - | - | 0.4 | 0.7 | 2.4 | 2.7 |
| **TOTAL STOCK CHANGES** | | **-19.5** | **-55.4** | **20.9** | **10.2** | **-9.8** | **-38.5** | **18.9** | **9.6** | **-4.8** | **-5.3** | **-0.5** | **-2.6** | **-4.8** | **-11.6** | **2.5** | **3.2** |
| **TOTAL SUPPLY (TPES)** | | **3599.6** | **3943.5** | **5083.7** | **5119.2** | **1896.3** | **2072.0** | **2538.2** | **2541.4** | **411.1** | **472.3** | **851.5** | **852.4** | **1292.2** | **1399.2** | **1694.0** | **1725.4** |
| Coal[1] | | 758.9 | 829.4 | 1033.8 | 1035.5 | 326.3 | 386.8 | 571.9 | 561.2 | 89.8 | 89.0 | 200.2 | 204.6 | 342.7 | 353.6 | 261.7 | 269.7 |
| Oil | | 1943.0 | 2022.9 | 2054.9 | 2080.6 | 903.9 | 975.6 | 986.7 | 1013.1 | 297.1 | 321.9 | 398.4 | 400.9 | 742.0 | 725.3 | 669.8 | 666.6 |
| Gas | | 687.5 | 743.0 | 1115.2 | 1129.8 | 551.8 | 520.6 | 609.2 | 598.3 | 8.7 | 26.4 | 114.1 | 119.0 | 127.0 | 195.9 | 391.9 | 412.5 |
| Comb. Renewables & Waste[2] | | 78.4 | 97.7 | 158.7 | 165.6 | 45.3 | 59.9 | 77.1 | 79.9 | 3.5 | 4.0 | 13.7 | 13.4 | 29.5 | 33.8 | 68.0 | 72.3 |
| Nuclear | | 49.2 | 150.0 | 586.0 | 572.1 | 27.3 | 80.3 | 229.3 | 224.8 | 2.5 | 19.2 | 107.9 | 96.3 | 19.3 | 50.6 | 248.7 | 250.9 |
| Hydro | | 76.6 | 92.3 | 105.4 | 104.0 | 39.6 | 45.3 | 53.1 | 53.0 | 8.1 | 10.1 | 10.9 | 12.0 | 29.0 | 37.0 | 41.4 | 39.1 |
| Geothermal | | 5.6 | 7.5 | 19.1 | 20.1 | 2.1 | 3.5 | 8.3 | 8.6 | 1.3 | 1.7 | 5.2 | 5.2 | 2.2 | 2.2 | 5.6 | 6.3 |
| Solar/Wind/Other[3] | | 0.0 | 0.1 | 8.0 | 8.8 | - | - | 2.4 | 2.5 | - | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 4.6 | 5.3 |
| Electricity Trade[5] | | 0.4 | 0.7 | 2.6 | 2.7 | 0.0 | -0.0 | 0.2 | -0.0 | - | - | - | - | 0.4 | 0.7 | 2.4 | 2.7 |

## Table A18 *(continued)*

## Energy Balances and Key Statistical Data for IEA and Regions

| | IEA Total | | | | IEA North America | | | | IEA Pacific | | | | IEA Europe | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| **SUPPLY** | | | | | | | | | | | | | | | | Unit: Mtoe |
| ***Fuel Shares (%)*** | | | | | | | | | | | | | | | | |
| *Coal* | *21.1* | *21.0* | *20.3* | *20.2* | *17.2* | *18.7* | *22.5* | *22.1* | *21.9* | *18.8* | *23.5* | *24.0* | *26.5* | *25.3* | *15.4* | *15.6* |
| *Oil* | *54.0* | *51.3* | *40.4* | *40.6* | *47.7* | *47.1* | *38.9* | *39.9* | *72.3* | *68.2* | *46.8* | *47.0* | *57.4* | *51.8* | *39.5* | *38.6* |
| *Gas* | *19.1* | *18.8* | *21.9* | *22.1* | *29.1* | *25.1* | *24.0* | *23.5* | *2.1* | *5.6* | *13.4* | *14.0* | *9.8* | *14.0* | *23.1* | *23.9* |
| *Comb. Renewables & Waste* | *2.2* | *2.5* | *3.1* | *3.2* | *2.4* | *2.9* | *3.0* | *3.1* | *0.9* | *0.9* | *1.6* | *1.6* | *2.3* | *2.4* | *4.0* | *4.2* |
| *Nuclear* | *1.4* | *3.8* | *11.5* | *11.2* | *1.4* | *3.9* | *9.0* | *8.8* | *0.6* | *4.1* | *12.7* | *11.3* | *1.5* | *3.6* | *14.7* | *14.5* |
| *Hydro* | *2.1* | *2.3* | *2.1* | *2.0* | *2.1* | *2.2* | *2.1* | *2.1* | *2.0* | *2.1* | *1.3* | *1.4* | *2.2* | *2.6* | *2.4* | *2.3* |
| *Geothermal* | *0.2* | *0.2* | *0.4* | *0.4* | *0.1* | *0.2* | *0.3* | *0.3* | *0.3* | *0.4* | *0.6* | *0.6* | *0.2* | *0.2* | *0.3* | *0.4* |
| *Solar/Wind/Other* | - | - | *0.2* | *0.2* | - | - | *0.1* | *0.1* | - | - | *0.1* | *0.1* | - | - | *0.3* | *0.3* |
| *Electricity Trade* | - | - | *0.1* | *0.1* | - | - | - | - | - | - | - | - | - | - | *0.1* | *0.2* |
| **DEMAND** | | | | | | | | | | | | | | | | Unit: Mtoe |
| FINAL CONSUMPTION BY SECTOR | | | | | | | | | | | | | | | | |
| **TFC** | **2725.8** | **2917.7** | **3520.2** | **3583.4** | **1455.0** | **1533.1** | **1741.0** | **1768.6** | **297.8** | **332.2** | **579.1** | **579.7** | **972.9** | **1052.5** | **1200.1** | **1235.2** |
| Coal[1] | 252.5 | 226.3 | 109.6 | 113.5 | 79.0 | 72.0 | 33.5 | 34.9 | 32.5 | 33.1 | 35.2 | 36.4 | 141.1 | 121.2 | 40.9 | 42.2 |
| Oil | 1574.0 | 1654.6 | 1863.4 | 1889.9 | 777.5 | 835.7 | 915.9 | 935.7 | 209.6 | 225.1 | 352.6 | 350.4 | 586.8 | 593.9 | 594.8 | 603.9 |
| Gas | 501.4 | 539.8 | 706.5 | 724.2 | 391.0 | 368.0 | 396.1 | 397.5 | 9.5 | 14.3 | 51.1 | 52.3 | 100.8 | 157.5 | 259.3 | 274.4 |
| Comb. Renewables & Waste[2] | 75.8 | 93.1 | 102.4 | 106.1 | 45.0 | 59.6 | 47.1 | 49.5 | 3.5 | 3.8 | 8.5 | 8.4 | 27.3 | 29.7 | 46.8 | 48.1 |
| Geothermal | 0.0 | 0.1 | 2.6 | 3.0 | - | - | 0.6 | 1.0 | - | - | 0.5 | 0.6 | 0.0 | 0.1 | 1.4 | 1.5 |
| Solar/Wind/Other | - | 0.0 | 3.0 | 3.0 | - | - | 1.3 | 1.3 | - | 0.0 | 0.9 | 0.8 | - | 0.0 | 0.8 | 0.9 |
| Electricity | 314.2 | 389.3 | 694.4 | 703.2 | 162.3 | 196.8 | 339.9 | 342.2 | 42.7 | 55.7 | 126.4 | 127.0 | 109.2 | 136.9 | 228.1 | 234.0 |
| Heat | 7.9 | 14.4 | 38.4 | 40.6 | 0.1 | 1.0 | 6.6 | 6.5 | 0.0 | 0.1 | 3.9 | 3.9 | 7.7 | 13.3 | 27.9 | 30.2 |
| ***Fuel Shares (%)*** | | | | | | | | | | | | | | | | |
| *Coal* | *9.3* | *7.8* | *3.1* | *3.2* | *5.4* | *4.7* | *1.9* | *2.0* | *10.9* | *10.0* | *6.1* | *6.3* | *14.5* | *11.5* | *3.4* | *3.4* |
| *Oil* | *57.7* | *56.7* | *52.9* | *52.7* | *53.4* | *54.5* | *52.6* | *52.9* | *70.4* | *67.8* | *60.9* | *60.4* | *60.3* | *56.4* | *49.6* | *48.9* |
| *Gas* | *18.4* | *18.5* | *20.1* | *20.2* | *26.9* | *24.0* | *22.7* | *22.5* | *3.2* | *4.3* | *8.8* | *9.0* | *10.4* | *15.0* | *21.6* | *22.2* |
| *Comb. Renewables & Waste* | *2.8* | *3.2* | *2.9* | *3.0* | *3.1* | *3.9* | *2.7* | *2.8* | *1.2* | *1.2* | *1.5* | *1.4* | *2.8* | *2.8* | *3.9* | *3.9* |
| *Geothermal* | - | - | *0.1* | *0.1* | - | - | - | *0.1* | - | - | *0.1* | *0.1* | - | - | *0.1* | *0.1* |
| *Solar/Wind/Other* | - | - | *0.1* | *0.1* | - | - | *0.1* | *0.1* | - | - | *0.1* | *0.1* | - | - | *0.1* | *0.1* |
| *Electricity* | *11.5* | *13.3* | *19.7* | *19.6* | *11.2* | *12.8* | *19.5* | *19.3* | *14.3* | *16.8* | *21.8* | *21.9* | *11.2* | *13.0* | *19.0* | *18.9* |
| *Heat* | *0.3* | *0.5* | *1.1* | *1.1* | - | *0.1* | *0.4* | *0.4* | - | - | *0.7* | *0.7* | *0.8* | *1.3* | *2.3* | *2.4* |

## Table A18 *(continued)*

## Energy Balances and Key Statistical Data for IEA and Regions

| | IEA Total | | | | IEA North America | | | | IEA Pacific | | | | IEA Europe | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| DEMAND | | | | | | | | | | | | | | | | Unit: Mtoe |
| **TOTAL INDUSTRY[6]** | **1123.3** | **1157.3** | **1179.0** | **1190.2** | **535.4** | **561.3** | **535.1** | **536.0** | **167.4** | **168.0** | **242.2** | **244.5** | **420.6** | **428.0** | **401.7** | **409.8** |
| Coal[1] | 168.2 | 151.7 | 99.5 | 103.6 | 64.8 | 57.5 | 31.0 | 32.5 | 23.9 | 24.0 | 34.1 | 35.4 | 79.4 | 70.1 | 34.4 | 35.7 |
| Oil | 513.1 | 535.1 | 453.3 | 460.2 | 182.4 | 229.7 | 190.0 | 193.6 | 109.8 | 101.6 | 120.4 | 120.5 | 221.0 | 203.7 | 142.9 | 146.1 |
| Gas | 246.9 | 238.9 | 292.6 | 289.9 | 189.2 | 156.4 | 163.6 | 158.1 | 3.9 | 6.0 | 23.4 | 23.9 | 53.9 | 76.5 | 105.6 | 107.8 |
| Comb. Renewables & Waste[2] | 40.3 | 47.1 | 56.6 | 58.1 | 34.3 | 39.5 | 34.3 | 36.3 | 1.5 | 2.1 | 6.4 | 6.4 | 4.6 | 5.5 | 15.9 | 15.4 |
| Geothermal | - | - | 0.4 | 0.4 | - | - | 0.1 | 0.1 | - | - | 0.3 | 0.3 | - | - | 0.0 | 0.0 |
| Solar/Wind/Other | - | - | 0.1 | 0.1 | - | - | - | - | - | - | - | - | - | - | 0.1 | 0.1 |
| Electricity | 152.2 | 180.2 | 262.1 | 263.0 | 64.6 | 77.2 | 110.6 | 110.0 | 28.3 | 34.2 | 55.6 | 56.1 | 59.3 | 68.9 | 95.8 | 96.9 |
| Heat | 2.5 | 4.4 | 14.5 | 15.0 | 0.1 | 1.0 | 5.4 | 5.4 | - | - | 2.1 | 2.0 | 2.5 | 3.4 | 7.0 | 7.7 |
| ***Fuel Shares (%)*** | | | | | | | | | | | | | | | | |
| *Coal* | *15.0* | *13.1* | *8.4* | *8.7* | *12.1* | *10.3* | *5.8* | *6.1* | *14.3* | *14.3* | *14.1* | *14.5* | *18.9* | *16.4* | *8.6* | *8.7* |
| *Oil* | *45.7* | *46.2* | *38.4* | *38.7* | *34.1* | *40.9* | *35.5* | *36.1* | *65.6* | *60.5* | *49.7* | *49.3* | *52.5* | *47.6* | *35.6* | *35.7* |
| *Gas* | *22.0* | *20.6* | *24.8* | *24.4* | *35.3* | *27.9* | *30.6* | *29.5* | *2.3* | *3.6* | *9.7* | *9.8* | *12.8* | *17.9* | *26.3* | *26.3* |
| *Comb. Renewables & Waste* | *3.6* | *4.1* | *4.8* | *4.9* | *6.4* | *7.0* | *6.4* | *6.8* | *0.9* | *1.3* | *2.6* | *2.6* | *1.1* | *1.3* | *4.0* | *3.8* |
| *Geothermal* | - | - | - | - | - | - | - | - | - | - | *0.1* | *0.1* | - | - | - | - |
| *Solar/Wind/Other* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Electricity* | *13.6* | *15.6* | *22.2* | *22.1* | *12.1* | *13.7* | *20.7* | *20.5* | *16.9* | *20.3* | *23.0* | *22.9* | *14.1* | *16.1* | *23.8* | *23.7* |
| *Heat* | *0.2* | *0.4* | *1.2* | *1.3* | - | *0.2* | *1.0* | *1.0* | - | - | *0.8* | *0.8* | *0.6* | *0.8* | *1.7* | *1.9* |
| **TRANSPORT[7]** | **696.4** | **796.0** | **1192.3** | **1209.8** | **454.6** | **498.7** | **676.2** | **688.5** | **60.9** | **80.3** | **161.1** | **162.1** | **180.9** | **217.0** | **355.1** | **359.2** |
| **TOTAL OTHER SECTORS[8]** | **906.1** | **964.4** | **1148.9** | **1183.4** | **464.9** | **473.1** | **529.8** | **544.1** | **69.6** | **83.9** | **175.8** | **173.1** | **371.5** | **407.5** | **443.3** | **466.2** |
| Coal[1] | 80.7 | 73.7 | 10.0 | 9.8 | 14.0 | 14.5 | 2.5 | 2.4 | 8.3 | 9.1 | 1.0 | 1.0 | 58.4 | 50.2 | 6.5 | 6.5 |
| Oil | 390.0 | 346.2 | 251.2 | 252.3 | 158.1 | 123.6 | 72.9 | 75.4 | 40.5 | 44.6 | 73.7 | 70.3 | 191.4 | 178.0 | 104.6 | 106.5 |
| Gas | 237.5 | 284.7 | 392.4 | 413.3 | 185.0 | 195.7 | 212.0 | 219.6 | 5.7 | 8.3 | 27.3 | 27.9 | 46.8 | 80.7 | 153.0 | 165.9 |
| Comb. Renewables & Waste[2] | 35.4 | 46.0 | 42.9 | 45.7 | 10.8 | 20.1 | 10.8 | 12.0 | 2.0 | 1.7 | 2.1 | 2.0 | 22.7 | 24.2 | 30.0 | 31.7 |
| Geothermal | 0.0 | 0.1 | 2.2 | 2.6 | - | - | 0.5 | 0.8 | - | - | 0.3 | 0.3 | 0.0 | 0.1 | 1.4 | 1.5 |
| Solar/Wind/Other | - | 0.0 | 2.9 | 2.8 | - | - | 1.3 | 1.3 | - | 0.0 | 0.9 | 0.8 | - | 0.0 | 0.7 | 0.8 |
| Electricity | 157.1 | 203.7 | 423.6 | 431.4 | 97.0 | 119.2 | 228.5 | 231.4 | 13.2 | 20.1 | 68.7 | 69.0 | 46.8 | 64.5 | 126.3 | 131.0 |
| Heat | 5.3 | 10.0 | 23.9 | 25.6 | - | 0.0 | 1.2 | 1.2 | 0.0 | 0.1 | 1.8 | 2.0 | 5.3 | 9.9 | 20.9 | 22.5 |

Table A18 *(continued)*

## Energy Balances and Key Statistical Data for IEA and Regions

| | IEA Total | | | | IEA North America | | | | IEA Pacific | | | | IEA Europe | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| **DEMAND** | | | | | | | | | | | | | | | | Unit: Mtoe |
| ***Fuel Shares (%)*** | | | | | | | | | | | | | | | | |
| *Coal* | *8.9* | *7.6* | *0.9* | *0.8* | *3.0* | *3.1* | *0.5* | *0.4* | *11.9* | *10.8* | *0.6* | *0.6* | *15.7* | *12.3* | *1.5* | *1.4* |
| *Oil* | *43.0* | *35.9* | *21.9* | *21.3* | *34.0* | *26.1* | *13.8* | *13.9* | *58.1* | *53.2* | *41.9* | *40.6* | *51.5* | *43.7* | *23.6* | *22.8* |
| *Gas* | *26.2* | *29.5* | *34.2* | *34.9* | *39.8* | *41.4* | *40.0* | *40.4* | *8.1* | *9.9* | *15.5* | *16.1* | *12.6* | *19.8* | *34.5* | *35.6* |
| *Comb. Renewables & Waste* | *3.9* | *4.8* | *3.7* | *3.9* | *2.3* | *4.3* | *2.0* | *2.2* | *2.9* | *2.0* | *1.2* | *1.2* | *6.1* | *5.9* | *6.8* | *6.8* |
| *Geothermal* | - | - | *0.2* | *0.2* | - | - | *0.1* | *0.2* | - | - | *0.2* | *0.2* | - | - | *0.3* | *0.3* |
| *Solar/Wind/Other* | - | - | *0.3* | *0.2* | - | - | *0.3* | *0.2* | - | - | *0.5* | *0.4* | - | - | *0.2* | *0.2* |
| *Electricity* | *17.3* | *21.1* | *36.9* | *36.5* | *20.9* | *25.2* | *43.1* | *42.5* | *18.9* | *24.0* | *39.1* | *39.8* | *12.6* | *15.8* | *28.5* | *28.1* |
| *Heat* | *0.6* | *1.0* | *2.1* | *2.2* | - | - | *0.2* | *0.2* | - | *0.1* | *1.0* | *1.1* | *1.4* | *2.4* | *4.7* | *4.8* |
| **ENERGY TRANSFORMATION AND LOSSES** | | | | | | | | | | | | | | | | |
| **ELECTRICITY GENERATION**[9] | | | | | | | | | | | | | | | | |
| **INPUT (Mtoe)** | **907.5** | **1136.4** | **2032.5** | **2043.5** | **466.3** | **577.3** | **1017.9** | **1012.3** | **113.1** | **152.5** | **352.5** | **350.7** | **328.1** | **406.6** | **662.1** | **680.5** |
| **OUTPUT (Mtoe)** | **371.4** | **459.1** | **805.0** | **813.1** | **192.3** | **233.8** | **397.9** | **399.1** | **48.4** | **63.1** | **141.6** | **142.0** | **130.7** | **162.2** | **265.5** | **271.9** |
| (TWh gross) | 4318.4 | 5338.4 | 9360.8 | 9454.7 | 2235.6 | 2718.8 | 4627.2 | 4641.2 | 563.2 | 733.7 | 1646.5 | 1651.5 | 1519.7 | 1885.9 | 3087.1 | 3161.9 |
| ***Output Shares (%)*** | | | | | | | | | | | | | | | | |
| *Coal* | *37.2* | *37.8* | *37.9* | *38.7* | *42.1* | *43.3* | *46.6* | *47.3* | *15.7* | *15.7* | *35.5* | *36.7* | *37.9* | *38.5* | *26.2* | *27.2* |
| *Oil* | *25.6* | *19.7* | *5.1* | *5.2* | *15.4* | *12.5* | *2.6* | *3.3* | *63.2* | *46.9* | *10.1* | *10.3* | *26.6* | *19.5* | *6.0* | *5.1* |
| *Gas* | *11.9* | *11.2* | *17.4* | *17.4* | *17.0* | *13.4* | *16.1* | *15.2* | *2.4* | *11.0* | *19.8* | *20.3* | *7.8* | *8.2* | *18.0* | *19.2* |
| *Comb. Renewables & Waste* | *0.2* | *0.2* | *1.7* | *1.8* | *0.0* | *0.1* | *1.7* | *1.7* | *0.1* | *0.1* | *1.3* | *1.3* | *0.4* | *0.5* | *1.9* | *2.0* |
| *Nuclear* | *4.4* | *10.7* | *24.0* | *23.2* | *4.7* | *11.2* | *19.0* | *18.6* | *1.7* | *10.0* | *25.2* | *22.4* | *4.9* | *10.3* | *30.9* | *30.4* |
| *Hydro* | *20.6* | *20.1* | *13.1* | *12.8* | *20.6* | *19.4* | *13.3* | *13.3* | *16.7* | *16.0* | *7.7* | *8.4* | *22.2* | *22.8* | *15.6* | *14.4* |
| *Geothermal* | *0.1* | *0.2* | *0.3* | *0.3* | *0.1* | *0.2* | *0.3* | *0.3* | *0.3* | *0.3* | *0.4* | *0.4* | *0.2* | *0.1* | *0.2* | *0.2* |
| *Solar/Wind/Other* | *0.0* | *0.0* | *0.6* | *0.7* | - | - | *0.2* | *0.3* | - | *0.0* | *0.1* | *0.1* | *0.0* | *0.0* | *1.2* | *1.5* |
| **TOTAL LOSSES (Mtoe)** | **902.5** | **1025.2** | **1548.7** | **1546.9** | **460.0** | **533.3** | **781.4** | **769.9** | **118.7** | **142.1** | **279.8** | **279.3** | **323.9** | **349.8** | **487.5** | **497.6** |
| *of which:* | | | | | | | | | | | | | | | | |
| Electricity and Heat Generation[10] | 527.1 | 661.4 | 1183.7 | 1184.1 | 274.0 | 342.5 | 610.7 | 604.0 | 64.6 | 89.2 | 206.8 | 204.7 | 188.6 | 229.8 | 366.2 | 375.4 |
| Other Transformation | 94.8 | 90.1 | 43.6 | 38.8 | 9.1 | 33.4 | -9.2 | -15.0 | 31.9 | 24.9 | 34.1 | 36.1 | 53.8 | 31.9 | 18.6 | 17.7 |
| Own Use and Losses[11] | 280.6 | 273.7 | 321.4 | 323.9 | 176.9 | 157.4 | 180.0 | 180.9 | 22.2 | 28.1 | 38.8 | 38.5 | 81.5 | 88.2 | 102.7 | 104.5 |
| **Statistical Differences** | **-28.7** | **0.6** | **14.7** | **-11.1** | **-18.6** | **5.6** | **15.8** | **2.9** | **-5.5** | **-1.9** | **-7.5** | **-6.6** | **-4.6** | **-3.1** | **6.4** | **-7.4** |

## Table A18 *(continued)*

## Energy Balances and Key Statistical Data for IEA and Regions

| | IEA Total | | | | IEA North America | | | | IEA Pacific | | | | IEA Europe | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 | 1973 | 1979 | 2002 | 2003 |
| **INDICATORS** | | | | | | | | | | | | | | | | |
| GDP (billion 2000 USD) | 11782 | 14004 | 25421 | 25991 | 4628 | 5540 | 10776 | 11097 | 2491 | 3072 | 5790 | 5952 | 4663 | 5392 | 8855 | 8942 |
| Population (millions) | 811 | 851 | 1002 | 1008 | 234 | 249 | 320 | 323 | 159 | 171 | 199 | 200 | 417 | 430 | 483 | 486 |
| TPES/GDP[12] | 0.31 | 0.28 | 0.20 | 0.20 | 0.41 | 0.37 | 0.24 | 0.23 | 0.17 | 0.15 | 0.15 | 0.14 | 0.28 | 0.26 | 0.19 | 0.19 |
| Energy Production/TPES | 0.64 | 0.65 | 0.69 | 0.68 | 0.87 | 0.84 | 0.81 | 0.79 | 0.26 | 0.29 | 0.47 | 0.46 | 0.41 | 0.50 | 0.64 | 0.62 |
| Per Capita TPES[13] | 4.44 | 4.64 | 5.08 | 5.08 | 8.09 | 8.31 | 7.94 | 7.88 | 2.58 | 2.76 | 4.28 | 4.27 | 3.10 | 3.25 | 3.51 | 3.55 |
| Oil Supply/GDP[12] | 0.16 | 0.14 | 0.08 | 0.08 | 0.20 | 0.18 | 0.09 | 0.09 | 0.12 | 0.10 | 0.07 | 0.07 | 0.16 | 0.13 | 0.08 | 0.07 |
| TFC/GDP[12] | 0.23 | 0.21 | 0.14 | 0.14 | 0.31 | 0.28 | 0.16 | 0.16 | 0.12 | 0.11 | 0.10 | 0.10 | 0.21 | 0.20 | 0.14 | 0.14 |
| Per Capita TFC[13] | 3.36 | 3.43 | 3.51 | 3.56 | 6.21 | 6.15 | 5.45 | 5.48 | 1.87 | 1.94 | 2.91 | 2.90 | 2.33 | 2.45 | 2.48 | 2.54 |
| Energy-Related $CO_2$ Emissions (Mt CO2)[14] | 9832.2 | 10365.0 | 11860.1 | 12085.4 | 5080.2 | 5298.8 | 6196.3 | 6281.8 | 1131.9 | 1249.3 | 2002.7 | 2029.5 | 3620.1 | 3816.9 | 3661.1 | 3774.0 |
| $CO_2$ Emissions from Bunkers (Mt $CO_2$) | 298.3 | 313.0 | 458.4 | 450.7 | 50.4 | 105.2 | 130.3 | 115.2 | 69.6 | 53.3 | 69.5 | 72.1 | 178.3 | 154.5 | 258.6 | 263.4 |
| **GROWTH RATES (% per year)** | | | | | | | | | | | | | | | | |
| | 73-79 | 79-03 | 93-03 | 02-03 | 73-79 | 79-03 | 93-03 | 02-03 | 73-79 | 79-03 | 93-03 | 02-03 | 73-79 | 79-03 | 93-03 | 02-03 |
| **TPES** | **1.5** | **1.1** | **1.4** | **0.7** | **1.5** | **0.9** | **1.3** | **0.1** | **2.3** | **2.5** | **2.0** | **0.1** | **1.3** | **0.9** | **1.3** | **1.9** |
| Coal | 1.5 | 0.9 | 1.1 | 0.2 | 2.9 | 1.6 | 1.2 | -1.9 | -0.2 | 3.5 | 3.8 | 2.2 | 0.5 | -1.1 | -0.8 | 3.1 |
| Oil | 0.7 | 0.1 | 1.1 | 1.3 | 1.3 | 0.2 | 1.6 | 2.7 | 1.3 | 0.9 | 0.7 | 0.6 | -0.4 | -0.4 | 0.6 | -0.5 |
| Gas | 1.3 | 1.8 | 2.4 | 1.3 | -1.0 | 0.6 | 1.0 | -1.8 | 20.3 | 6.5 | 5.0 | 4.3 | 7.5 | 3.2 | 4.1 | 5.3 |
| Comb. Renewables & Waste | 3.7 | 2.2 | 1.7 | 4.3 | 4.8 | 1.2 | 0.6 | 3.7 | 2.3 | 5.1 | 2.1 | -2.2 | 2.3 | 3.2 | 3.0 | 6.4 |
| Nuclear | 20.4 | 5.7 | 1.5 | -2.4 | 19.7 | 4.4 | 1.5 | -2.0 | 40.1 | 7.0 | 1.9 | -10.7 | 17.4 | 6.9 | 1.3 | 0.9 |
| Hydro | 3.2 | 0.5 | -0.1 | -1.3 | 2.3 | 0.7 | 0.2 | -0.2 | 3.8 | 0.7 | -0.0 | 9.9 | 4.1 | 0.2 | -0.6 | -5.6 |
| Geothermal | 4.9 | 4.2 | -1.7 | 5.3 | 9.0 | 3.8 | -5.8 | 3.9 | 4.7 | 4.7 | 2.5 | 0.8 | 0.3 | 4.4 | 4.2 | 11.5 |
| Solar/Wind/Other | 7.2 | 21.9 | 15.1 | 11.3 | - | - | 21.7 | 2.7 | - | 15.9 | -1.5 | -1.1 | -1.4 | 21.8 | 24.2 | 19.2 |
| **TFC** | **1.1** | **0.9** | **1.6** | **1.8** | **0.9** | **0.6** | **1.6** | **1.6** | **1.8** | **2.3** | **2.2** | **0.1** | **1.3** | **0.7** | **1.3** | **2.9** |
| Electricity Consumption | 3.6 | 2.5 | 2.2 | 1.3 | 3.3 | 2.3 | 1.9 | 0.7 | 4.5 | 3.5 | 3.2 | 0.5 | 3.8 | 2.3 | 2.3 | 2.6 |
| Energy Production | 2.0 | 1.2 | 0.9 | -1.6 | 0.8 | 0.6 | 0.5 | -1.6 | 4.3 | 4.4 | 2.8 | -3.1 | 5.0 | 1.7 | 1.0 | -1.1 |
| Net Oil Imports | 0.5 | -0.2 | 1.7 | 6.0 | 6.3 | 1.1 | 4.1 | 8.3 | 1.3 | 0.8 | 0.7 | 2.4 | -2.6 | -2.2 | -0.1 | 6.4 |
| GDP | 2.9 | 2.6 | 2.6 | 2.2 | 3.0 | 2.9 | 3.3 | 3.0 | 3.6 | 2.8 | 1.8 | 2.8 | 2.4 | 2.1 | 2.3 | 1.0 |
| Growth in the TPES/GDP Ratio | -1.3 | -1.5 | -1.2 | -1.5 | -1.5 | -2.0 | -2.0 | -2.8 | -1.2 | -0.3 | 0.3 | -2.6 | -1.1 | -1.2 | -1.0 | 0.9 |
| Growth in the TFC/GDP Ratio | -1.7 | -1.7 | -0.9 | -0.4 | -2.1 | -2.3 | -1.6 | -1.4 | -1.7 | -0.4 | 0.4 | -2.6 | -1.1 | -1.4 | -0.9 | 1.9 |

## Table A18 (Footnotes)

1. Includes lignite and peat, except for Finland, Ireland and Sweden. In these three cases, peat is shown separately.
2. Comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Other includes tide, wave and ambient heat used in heat pumps.
4. Total net imports include combustible renewables and waste.
5. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
6. Includes non-energy use.
7. Includes less than 1% non-oil fuels.
8. Includes residential, commercial, public service and agricultural sectors.
9. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
10. Losses arising in the production of electricity and heat at main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear, 10% for geothermal and 100% for hydro.
11. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
12. Toe per thousand US dollars at 2000 prices and exchange rates.
13. Toe per person.
14. "Energy-related $CO_2$ emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2003 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

e = estimate.

# ANNEX B

## GOVERNMENT ENERGY R&D BUDGETS

## Table B1

# IEA Government R&D Budgets in National Currencies

(millions except for Japanese and Korean currencies. which are in billions)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 315.7 | 322.0 | 322.0 | 300.6 | 265.9 | 249.6 | 248.6 | 266.5 | 293.2 | 321.2 | 364.0 | 342.2 |
| United States | 2 172.6 | 2 441.6 | 2 409.1 | 2 149.9 | 1 965.7 | 2 024.6 | 2 293.8 | 2 266.7 | 2 814.4 | 2 847.3 | 2 750.0 | 2 850.4 |
| Australia | 110.4 | .. | 116.3 | .. | 157.6 | .. | 136.5 | .. | 155.5 | .. | 151.7 | .. |
| Japan | 404.7 | 433.9 | 445.7 | 459.1 | 437.7 | 441.8 | 433.2 | 436.3 | 433.5 | 516.7 | 464.8 | 428.4 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 110.3 | .. | .. |
| New Zealand | 4.7 | 3.8 | 4.4 | 5.3 | 5.1 | 6.4 | 6.1 | 6.4 | 8.9 | 10.1 | 11.5 | 13.5 |
| Austria | 20.8 | 23.6 | 24.1 | 24.3 | 25.7 | 27.4 | 26.5 | 23.3 | 29.9 | 29.2 | 25.0 | .. |
| Belgium | .. | 41.4 | 43.8 | 56.4 | 54.5 | 70.4 | 49.7 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 178.4 | 130.0 |
| Denmark | 302.0 | 259.0 | 245.1 | 217.6 | 258.3 | 316.2 | 312.6 | 327.1 | 328.0 | 167.9 | 177.2 | 214.7 |
| Finland | 39.8 | 48.2 | 58.2 | 56.1 | 79.4 | 81.9 | 77.9 | 65.5 | 62.7 | 70.5 | 53.6 | .. |
| France | 448.9 | 424.3 | 501.9 | 483.2 | 488.2 | 527.1 | 617.1 | 586.7 | 441.6 | 403.5 | .. | .. |
| Germany | 366.0 | 300.0 | 262.2 | 285.0 | 259.2 | 280.1 | 187.7 | 268.6 | 292.5 | 264.5 | 377.6 | 371.2 |
| Greece | 3.3 | 3.3 | 6.1 | 7.5 | 14.3 | .. | .. | 5.7 | 7.0 | 8.8 | .. | .. |
| Hungary | .. | .. | .. | .. | .. | .. | .. | 584.6 | 562.9 | 788.6 | 688.7 | 976.4 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3.9 | 7.0 | 8.9 |
| Italy | 229.7 | 225.4 | 243.8 | 237.8 | 221.9 | 222.1 | .. | 262.7 | 283.0 | 300.1 | 291.3 | 285.0 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 153.6 | 165.9 | 121.2 | 127.1 | 146.2 | 140.1 | 140.7 | 126.4 | 159.3 | 140.2 | 128.2 | 131.4 |
| Norway | 366.5 | 355.7 | 304.4 | 288.3 | 281.8 | 277.4 | 371.6 | 370.0 | 384.5 | 392.9 | 384.3 | 470.8 |
| Portugal | 3.2 | 2.7 | 1.4 | 1.7 | 1.2 | 1.6 | 2.0 | 1.5 | 1.0 | 2.0 | 2.6 | 5.0 |
| Spain | 58.0 | 64.1 | 60.0 | 59.3 | 60.3 | 47.4 | 50.0 | 49.3 | 49.7 | 45.7 | 55.5 | 71.1 |
| Sweden | 553.1 | 598.0 | 452.9 | 413.1 | 467.0 | 440.0 | 590.0 | 647.0 | 763.0 | 853.0 | 870.6 | 956.9 |
| Switzerland | 223.3 | 220.8 | 215.1 | 206.7 | 196.9 | 182.6 | 179.9 | 166.8 | 172.8 | 179.4 | 183.8 | 187.5 |
| Turkey[2] | 0.0 | 0.0 | 0.2 | 0.3 | 1.6 | 1.4 | 1.4 | 2.2 | 3.7 | 4.1 | 5.1 | 8.5 |
| United Kingdom | 98.8 | 50.9 | 52.9 | 36.4 | 49.3 | 43.8 | 42.8 | 48.0 | 30.4 | 35.3 | 34.2 | 36.1 |
| European Commission[3] | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. Data for Turkey refer to New Turkish Lira. The strong increase in the budget is due to high inflation rate in Turkey and to new RD&D activities.
3. No information on R&D budgets has been provided by the European Commission.

Note: Budgets provided for recent years by some countries may have been estimated.

Source: Country submissions.

Table B2

## IEA Government R&D Budgets in 2004 National Currencies

(millions except for Japanese and Korean currencies. which are in billions)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 385.6 | 388.8 | 380.3 | 349.3 | 305.3 | 287.7 | 281.8 | 290.0 | 315.4 | 342.1 | 375.8 | 342.2 |
| United States | 2 659.2 | 2 925.6 | 2 830.2 | 2 477.4 | 2 229.5 | 2 270.1 | 2 535.2 | 2 452.6 | 2 973.8 | 2 959.4 | 2 807.1 | 2 850.4 |
| Australia | 140.4 | .. | 144.6 | .. | 188.9 | .. | 161.9 | .. | 170.8 | .. | 157.4 | .. |
| Japan | 368.9 | 395.2 | 408.2 | 423.8 | 402.8 | 407.1 | 404.6 | 413.6 | 416.4 | 502.9 | 459.5 | 428.4 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 116.3 | .. | .. |
| New Zealand | 5.7 | 4.6 | 5.2 | 6.2 | 5.9 | 7.3 | 7.0 | 7.1 | 9.5 | 10.7 | 12.0 | 13.5 |
| Austria | 24.1 | 26.6 | 26.6 | 26.6 | 28.1 | 29.9 | 28.8 | 24.9 | 31.3 | 30.2 | 25.5 | .. |
| Belgium | .. | 48.5 | 50.6 | 64.6 | 61.5 | 78.0 | 54.4 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 185.0 | 130.0 |
| Denmark | 373.6 | 314.9 | 292.9 | 253.7 | 294.8 | 357.1 | 346.8 | 352.5 | 345.3 | 174.3 | 180.1 | 214.7 |
| Finland | 48.2 | 57.3 | 66.2 | 64.0 | 88.8 | 88.4 | 84.2 | 68.7 | 63.8 | 70.9 | 54.0 | .. |
| France | 523.8 | 486.4 | 565.7 | 537.0 | 535.7 | 573.4 | 668.7 | 631.0 | 467.3 | 416.8 | .. | .. |
| Germany | 413.5 | 330.6 | 283.1 | 304.7 | 275.3 | 294.3 | 196.2 | 281.3 | 302.6 | 269.5 | 380.4 | 371.2 |
| Greece | 6.0 | 5.4 | 9.1 | 10.4 | 18.4 | .. | .. | 6.6 | 7.7 | 9.5 | .. | .. |
| Hungary | .. | .. | .. | .. | .. | .. | .. | 778.7 | 690.5 | 888.7 | 720.6 | 976.4 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4.1 | 7.3 | 8.9 |
| Italy | 320.5 | 304.0 | 313.1 | 290.0 | 264.3 | 257.6 | .. | 293.6 | 307.9 | 316.9 | 299.0 | 285.0 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 200.7 | 211.9 | 151.7 | 157.2 | 177.4 | 167.0 | 165.2 | 142.8 | 171.0 | 146.0 | 129.8 | 131.4 |
| Norway | 529.1 | 513.5 | 427.4 | 389.0 | 369.5 | 366.5 | 460.3 | 395.8 | 406.4 | 422.0 | 403.0 | 470.8 |
| Portugal | 4.9 | 3.8 | 1.8 | 2.3 | 1.5 | 2.0 | 2.4 | 1.7 | 1.1 | 2.1 | 2.7 | 5.0 |
| Spain | 86.3 | 91.6 | 81.8 | 78.1 | 77.6 | 59.5 | 61.1 | 58.3 | 56.4 | 49.7 | 57.9 | 71.1 |
| Sweden | 662.4 | 699.7 | 513.2 | 462.7 | 516.1 | 482.2 | 640.8 | 694.2 | 801.1 | 881.0 | 881.3 | 956.9 |
| Switzerland | 240.4 | 234.1 | 226.2 | 217.3 | 207.5 | 192.7 | 188.8 | 173.6 | 178.6 | 182.4 | 185.2 | 187.5 |
| Turkey[2] | 6.3 | 3.1 | 7.5 | 6.1 | 19.8 | 9.7 | 6.3 | 6.5 | 7.1 | 5.5 | 5.6 | 8.5 |
| United Kingdom | 129.6 | 65.8 | 66.7 | 44.3 | 58.4 | 50.5 | 48.3 | 53.3 | 33.0 | 37.2 | 34.9 | 36.1 |
| European Commission[3] | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. Data for Turkey refer to New Turkish Lira.
3. No information on R&D budgets has been provided by the European Commission.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B3

# IEA Government R&D Budgets

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e | 2004 exch. rates Unit per USD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 296.4 | 298.8 | 292.3 | 268.5 | 234.7 | 221.2 | 216.6 | 222.9 | 242.4 | 263.0 | 288.9 | 263.0 | 1.301 |
| United States | 2 659.2 | 2 925.6 | 2 830.2 | 2 477.4 | 2 229.5 | 2 270.1 | 2 535.2 | 2 452.6 | 2 973.8 | 2 959.4 | 2 807.1 | 2 850.4 | 1.0 |
| Australia | 103.3 | .. | 106.4 | .. | 139.0 | .. | 119.1 | .. | 125.7 | .. | 115.8 | .. | 1.359 |
| Japan | 3 412.6 | 3 655.5 | 3 776.2 | 3 920.3 | 3 726.5 | 3 765.6 | 3 742.6 | 3 826.5 | 3 851.9 | 4 652.2 | 4 250.3 | 3 963.1 | 108.10 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 101.6 | .. | .. | 1 145.0 |
| New Zealand | 3.8 | 3.1 | 3.4 | 4.1 | 3.9 | 4.8 | 4.6 | 4.7 | 6.3 | 7.1 | 7.9 | 8.9 | 1.509 |
| Austria | 29.9 | 33.0 | 33.1 | 33.0 | 34.9 | 37.1 | 35.7 | 30.9 | 38.9 | 37.5 | 31.6 | .. | 0.805 |
| Belgium | .. | 60.2 | 62.9 | 80.2 | 76.4 | 96.9 | 67.5 | .. | .. | .. | .. | .. | 0.805 |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 7.2 | 5.1 | 25.69 |
| Denmark | 62.4 | 52.6 | 48.9 | 42.4 | 49.2 | 59.6 | 57.9 | 58.9 | 57.7 | 29.1 | 30.1 | 35.9 | 5.988 |
| Finland | 59.9 | 71.2 | 82.2 | 79.6 | 110.3 | 109.9 | 104.5 | 85.4 | 79.3 | 88.0 | 67.1 | .. | 0.805 |
| France | 650.6 | 604.2 | 702.7 | 667.1 | 665.5 | 712.2 | 830.7 | 783.8 | 580.5 | 517.8 | .. | .. | 0.805 |
| Germany | 513.7 | 410.7 | 351.7 | 378.6 | 342.0 | 365.5 | 243.8 | 349.5 | 375.9 | 334.8 | 472.6 | 461.1 | 0.805 |
| Greece | 7.4 | 6.7 | 11.3 | 12.9 | 22.9 | .. | .. | 8.2 | 9.6 | 11.8 | .. | .. | 0.805 |
| Hungary | .. | .. | .. | .. | .. | .. | .. | 3.8 | 3.4 | 4.4 | 3.6 | 4.8 | 202.6 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 5.0 | 9.1 | 11.0 | 0.805 |
| Italy | 398.2 | 377.7 | 388.9 | 360.3 | 328.3 | 320.0 | .. | 364.7 | 382.5 | 393.6 | 371.4 | 354.0 | 0.805 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.805 |
| Netherlands | 249.3 | 263.2 | 188.4 | 195.3 | 220.3 | 207.5 | 205.2 | 177.4 | 212.4 | 181.4 | 161.2 | 163.2 | 0.805 |
| Norway | 78.5 | 76.2 | 63.4 | 57.7 | 54.8 | 54.4 | 68.3 | 58.7 | 60.3 | 62.6 | 59.8 | 69.9 | 6.739 |
| Portugal | 6.0 | 4.8 | 2.3 | 2.9 | 1.8 | 2.4 | 2.9 | 2.1 | 1.3 | 2.6 | 3.3 | 6.2 | 0.805 |
| Spain | 107.2 | 113.8 | 101.6 | 97.0 | 96.4 | 73.9 | 76.0 | 72.4 | 70.0 | 61.7 | 72.0 | 88.3 | 0.805 |
| Sweden | 90.2 | 95.3 | 69.9 | 63.0 | 70.3 | 65.6 | 87.2 | 94.5 | 109.1 | 119.9 | 120.0 | 130.3 | 7.35 |
| Switzerland | 193.4 | 188.3 | 182.0 | 174.9 | 166.9 | 155.1 | 151.9 | 139.7 | 143.7 | 146.7 | 149.0 | 150.8 | 1.243 |
| Turkey | 4.4 | 2.2 | 5.3 | 4.3 | 13.9 | 6.8 | 4.4 | 4.6 | 5.0 | 3.9 | 3.9 | 5.9 | 1.426 |
| United Kingdom | 237.4 | 120.5 | 122.1 | 81.2 | 107.0 | 92.5 | 88.4 | 97.7 | 60.5 | 68.1 | 63.9 | 66.2 | 0.546 |
| Estimated IEA Total[2] | 9 239.5 | 9 459.2 | 9 414.0 | 9 104.7 | 8 671.6 | 8 748.2 | 8 963.7 | 9 065.5 | 9 489.4 | 10 166.9 | 10 052.3 | 9 715.4 | |
| European Commission[3] | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.805 |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.
3. No information on R&D budgets has been provided by the European Commission.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B4

## IEA Government Budgets on Energy R&D

(per thousand units of GDP)

| R&D/GDP including nuclear research | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 0.36 | 0.30 | 0.27 | 0.25 | 0.25 | 0.26 | 0.28 | 0.30 | 0.26 |
| United States | 0.27 | 0.24 | 0.23 | 0.25 | 0.23 | 0.28 | 0.27 | 0.25 | 0.24 |
| Australia | .. | 0.29 | .. | 0.23 | .. | 0.23 | .. | 0.19 | .. |
| Japan | 0.90 | 0.84 | 0.86 | 0.85 | 0.85 | 0.86 | 1.04 | 0.93 | 0.85 |
| Korea | .. | .. | .. | .. | .. | .. | 0.16 | .. | .. |
| New Zealand | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 |
| Austria | 0.13 | 0.14 | 0.14 | 0.13 | 0.11 | 0.14 | 0.13 | 0.11 | .. |
| Belgium | 0.27 | 0.25 | 0.31 | 0.21 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | 0.07 | 0.05 |
| Denmark | 0.21 | 0.23 | 0.27 | 0.26 | 0.26 | 0.25 | 0.12 | 0.13 | 0.15 |
| Finland | 0.57 | 0.74 | 0.70 | 0.65 | 0.50 | 0.46 | 0.50 | 0.37 | .. |
| France | 0.40 | 0.39 | 0.40 | 0.46 | 0.41 | 0.30 | 0.26 | .. | .. |
| Germany | 0.16 | 0.14 | 0.15 | 0.10 | 0.13 | 0.14 | 0.13 | 0.18 | 0.17 |
| Greece | 0.09 | 0.15 | .. | .. | 0.05 | 0.05 | 0.06 | .. | .. |
| Hungary | .. | .. | .. | .. | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 |
| Ireland | .. | .. | .. | .. | .. | .. | 0.03 | 0.05 | 0.06 |
| Italy | 0.24 | 0.22 | 0.21 | .. | 0.23 | 0.23 | 0.24 | 0.22 | 0.21 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 0.40 | 0.44 | 0.40 | 0.38 | 0.31 | 0.37 | 0.31 | 0.28 | 0.28 |
| Norway | 0.28 | 0.25 | 0.25 | 0.30 | 0.25 | 0.25 | 0.26 | 0.25 | 0.28 |
| Portugal | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.04 |
| Spain | 0.13 | 0.12 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.09 |
| Sweden | 0.23 | 0.25 | 0.22 | 0.28 | 0.29 | 0.34 | 0.36 | 0.36 | 0.38 |
| Switzerland | 0.55 | 0.52 | 0.47 | 0.45 | 0.40 | 0.41 | 0.42 | 0.42 | 0.42 |
| Turkey | 0.02 | 0.06 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 |
| United Kingdom | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 0.03 | 0.03 | 0.03 | 0.03 |

| R&D/GDP excluding nuclear research | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 0.20 | 0.17 | 0.16 | 0.17 | 0.18 | 0.21 | 0.22 | 0.25 | 0.22 |
| United States | 0.24 | 0.20 | 0.20 | 0.22 | 0.20 | 0.25 | 0.24 | 0.22 | 0.21 |
| Australia | .. | 0.29 | .. | 0.22 | .. | 0.22 | .. | 0.19 | .. |
| Japan | 0.22 | 0.21 | 0.25 | 0.24 | 0.25 | 0.26 | 0.37 | 0.29 | 0.30 |
| Korea | .. | .. | .. | .. | .. | .. | 0.12 | .. | .. |
| New Zealand | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 |
| Austria | 0.13 | 0.13 | 0.13 | 0.12 | 0.10 | 0.12 | 0.12 | 0.10 | .. |
| Belgium | 0.10 | 0.08 | 0.09 | 0.04 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | 0.04 | 0.01 |
| Denmark | 0.20 | 0.23 | 0.25 | 0.23 | 0.23 | 0.23 | 0.11 | 0.11 | 0.14 |
| Finland | 0.49 | 0.67 | 0.64 | 0.57 | 0.45 | 0.41 | 0.45 | 0.34 | .. |
| France | 0.04 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.06 | .. | .. |
| Germany | 0.07 | 0.06 | 0.06 | 0.05 | 0.06 | 0.08 | 0.07 | 0.11 | 0.11 |
| Greece | 0.08 | 0.14 | .. | .. | 0.04 | 0.05 | 0.05 | .. | .. |
| Hungary | .. | .. | .. | .. | 0.03 | 0.02 | 0.03 | 0.02 | 0.03 |
| Ireland | .. | .. | .. | .. | .. | .. | 0.03 | 0.05 | 0.06 |
| Italy | 0.14 | 0.12 | 0.12 | .. | 0.13 | 0.14 | 0.16 | 0.15 | 0.15 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 0.36 | 0.38 | 0.36 | 0.34 | 0.26 | 0.32 | 0.27 | 0.24 | 0.24 |
| Norway | 0.23 | 0.21 | 0.19 | 0.25 | 0.21 | 0.21 | 0.22 | 0.21 | 0.24 |
| Portugal | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.00 | 0.02 |
| Spain | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.04 | 0.05 |
| Sweden | 0.20 | 0.22 | 0.20 | 0.26 | 0.27 | 0.32 | 0.34 | 0.34 | 0.36 |
| Switzerland | 0.39 | 0.36 | 0.33 | 0.34 | 0.27 | 0.29 | 0.29 | 0.30 | 0.30 |
| Turkey | 0.01 | 0.05 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 |
| United Kingdom | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B5

## IEA Government R&D Budgets for Conservation

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 32.8 | 48.7 | 47.6 | 48.8 | 47.0 | 48.0 | 50.9 | 39.7 | 50.4 | 76.5 | 77.2 | 77.1 |
| United States | 376.4 | 512.7 | 594.7 | 476.0 | 439.8 | 472.4 | 530.9 | 583.0 | 614.5 | 600.8 | 399.9 | 392.0 |
| Australia | 6.2 | .. | 12.7 | .. | 8.9 | .. | 8.2 | .. | 11.1 | .. | 10.3 | .. |
| Japan[2] | 28.4 | 238.6 | 254.5 | 290.6 | 282.8 | 456.7 | 555.8 | 602.1 | 640.1 | 662.1 | 495.5 | 455.8 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 19.1 | .. | .. |
| New Zealand | 0.6 | 0.5 | 0.8 | 0.7 | 0.6 | 0.3 | 0.7 | 0.7 | 0.5 | 0.6 | 1.1 | 1.2 |
| Austria | 10.7 | 13.2 | 12.0 | 12.2 | 11.6 | 9.3 | 10.3 | 9.5 | 11.9 | 10.2 | 6.4 | .. |
| Belgium | 9.0 | 12.2 | 11.1 | 14.2 | 12.5 | 18.3 | 5.5 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – |
| Denmark | 8.9 | 7.3 | 6.2 | 6.5 | 9.9 | 11.4 | 12.7 | 17.3 | 13.5 | 0.5 | 1.4 | 1.1 |
| Finland | 19.3 | 21.2 | 29.3 | 28.4 | 47.2 | 57.0 | 47.3 | 35.6 | 31.6 | 33.5 | 17.0 | .. |
| France | 15.2 | 10.2 | 9.9 | 9.0 | 5.8 | 8.2 | 15.6 | 15.9 | 15.5 | 24.3 | .. | .. |
| Germany | 14.6 | 16.7 | 19.1 | 27.8 | 18.1 | 16.3 | 15.0 | 11.7 | 30.3 | 19.6 | 21.5 | 16.9 |
| Greece | 0.3 | 1.8 | 2.1 | 2.8 | 6.9 | .. | .. | 0.7 | 0.7 | 1.9 | .. | .. |
| Hungary | .. | .. | – | – | .. | – | .. | 1.3 | 0.2 | 0.3 | – | – |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3.4 | 6.1 | 4.8 |
| Italy | 72.3 | 68.2 | 72.0 | 73.0 | 67.6 | 67.3 | .. | 32.1 | 33.8 | 32.8 | 30.0 | 27.3 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 85.3 | 65.6 | 69.5 | 79.9 | 83.2 | 83.2 | 84.1 | 54.3 | 75.5 | 55.0 | 37.4 | 47.8 |
| Norway | 19.3 | 11.1 | 2.6 | 2.4 | 2.2 | 2.1 | 2.0 | 2.1 | 1.9 | 2.4 | 2.6 | 2.2 |
| Portugal | 1.3 | 0.5 | 1.1 | 0.9 | 0.9 | 0.1 | 0.3 | 0.3 | 0.4 | 0.1 | 0.1 | - |
| Spain | 6.8 | 11.0 | 8.5 | 5.2 | 5.2 | 9.7 | 4.6 | 5.9 | 3.3 | 2.6 | 5.3 | 6.3 |
| Sweden | 29.5 | 28.0 | 25.4 | 29.6 | 22.0 | 18.4 | 27.6 | 34.1 | 44.1 | 55.0 | 56.5 | 50.8 |
| Switzerland | 31.5 | 35.9 | 34.3 | 32.1 | 25.4 | 24.2 | 26.8 | 20.9 | 21.7 | 19.6 | 20.5 | 21.7 |
| Turkey | 1.5 | 0.1 | 0.2 | 0.3 | 0.1 | 0.3 | 0.2 | 0.6 | 1.9 | 0.4 | 0.4 | 0.1 |
| United Kingdom | 48.6 | 5.5 | 3.4 | 2.9 | 2.2 | 1.1 | 1.5 | 2.9 | – | – | – | – |
| **Estimated IEA Total[3]** | **818.1** | **1 116.1** | **1 215.1** | **1 151.1** | **1 093.0** | **1 313.0** | **1 446.7** | **1 483.8** | **1 608.1** | **1 612.7** | **1 203.1** | **1 151.8** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. The items included in Conservation were expanded in 1994. Earlier budgetary data are not comparable.
3. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B6

# IEA Government R&D Budgets for Oil & Gas

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 63.1 | 50.7 | 46.9 | 55.2 | 46.2 | 47.3 | 47.7 | 43.8 | 53.4 | 48.4 | 54.2 | 50.5 |
| United States | 194.0 | 117.6 | 130.1 | 89.3 | 77.4 | 82.0 | 80.8 | 93.7 | 118.2 | 106.5 | 88.6 | 78.1 |
| Australia | 44.5 | .. | 37.0 | .. | 77.2 | .. | 54.2 | .. | 46.3 | .. | 33.5 | .. |
| Japan | 116.8 | 123.7 | 141.1 | 139.5 | 135.3 | 101.9 | 34.5 | 27.3 | 35.1 | 293.8 | 244.8 | 225.7 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1.0 | 1.1 | .. |
| New Zealand | 1.8 | 0.7 | 0.6 | 0.7 | 0.7 | 0.9 | 0.8 | 0.8 | 2.2 | 3.3 | 2.9 | 2.8 |
| Austria | 0.4 | 0.3 | 0.4 | 0.8 | 0.3 | 0.3 | 0.2 | – | 0.4 | 0.2 | 0.1 | .. |
| Belgium | – | – | – | 0.1 | 0.1 | – | 0.3 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.4 | 0.2 |
| Denmark | 3.9 | 4.3 | 4.5 | 3.7 | 3.2 | 2.6 | 3.3 | 2.4 | 2.4 | – | – | – |
| Finland | – | – | – | – | 2.8 | 3.1 | 3.4 | 1.7 | 3.3 | 3.4 | 0.5 | .. |
| France | 42.2 | 42.1 | 40.3 | 39.8 | 39.3 | 38.9 | 38.8 | 40.7 | 44.4 | 36.4 | .. | .. |
| Germany | 5.0 | 3.5 | 0.9 | – | – | – | – | – | – | – | – | – |
| Greece | 0.1 | 0.8 | 1.5 | 1.6 | 2.4 | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | – | 0.1 | 0.7 | 0.2 | 0.2 | 0.3 | 0.2 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.2 | 0.4 | 0.2 |
| Italy | – | – | – | – | – | – | .. | – | – | 2.6 | 2.6 | 2.5 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 13.4 | 17.0 | 12.1 | 12.1 | 13.5 | 11.2 | 10.7 | 11.8 | 10.3 | 20.6 | 13.7 | 13.0 |
| Norway | 21.5 | 33.9 | 31.6 | 27.8 | 26.4 | 25.3 | 41.0 | 31.7 | 29.6 | 23.7 | 28.6 | 35.3 |
| Portugal | – | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | – | – | 0.2 | 2.8 |
| Spain | – | – | – | – | – | – | 0.1 | 2.1 | – | – | – | – |
| Sweden | – | – | – | – | – | – | – | – | – | – | – | – |
| Switzerland | 15.2 | 14.4 | 13.7 | 10.7 | 11.8 | 10.2 | 9.7 | 8.9 | 9.2 | 12.5 | 11.9 | 11.7 |
| Turkey | 0.1 | 0.1 | 3.6 | 2.5 | 5.2 | 1.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 |
| United Kingdom | 8.2 | 6.4 | 13.8 | 6.5 | 9.6 | 7.6 | 5.1 | 5.7 | 4.3 | 1.7 | 1.7 | 1.8 |
| **Estimated IEA Total[2]** | **530.2** | **456.6** | **476.8** | **438.7** | **449.2** | **400.7** | **331.0** | **324.9** | **359.6** | **595.9** | **517.1** | **497.2** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B7

# IEA Government R&D Budgets for Coal

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 14.0 | 10.1 | 12.6 | 9.2 | 3.1 | 5.1 | 6.6 | 3.8 | 4.0 | 4.4 | 6.7 | 4.4 |
| United States | 289.7 | 464.2 | 224.6 | 306.9 | 109.4 | 117.1 | 139.9 | 130.8 | 254.5 | 334.6 | 335.9 | 373.0 |
| Australia | 18.8 | .. | 18.1 | .. | 23.0 | .. | 23.6 | .. | 30.2 | .. | 29.6 | .. |
| Japan | 264.1 | 261.9 | 242.0 | 216.0 | 191.5 | 173.9 | 133.9 | 84.5 | 44.6 | 65.2 | 61.3 | 117.0 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 11.9 | 12.3 | .. |
| New Zealand | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | – | – |
| Austria | 1.4 | 0.9 | 0.7 | 1.5 | 2.0 | 0.5 | 0.7 | 0.5 | 0.5 | 0.4 | 0.5 | .. |
| Belgium | 1.5 | 2.2 | 1.8 | 2.0 | 2.8 | 0.6 | 0.8 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2.8 | 0.7 |
| Denmark | 6.8 | 6.1 | 3.6 | 1.0 | – | 0.1 | 0.1 | – | – | – | – | – |
| Finland | 3.7 | 4.8 | 4.1 | 4.5 | 4.5 | 3.7 | 3.9 | 3.4 | 2.8 | 3.2 | 0.3 | .. |
| France | 7.1 | 6.9 | 7.0 | 6.5 | 6.4 | 0.1 | – | – | – | – | .. | .. |
| Germany | 31.0 | 22.6 | 16.3 | 4.4 | 1.8 | 1.6 | 12.9 | 11.9 | 22.5 | 17.1 | 10.0 | 12.3 |
| Greece | 0.5 | 0.5 | 1.0 | 0.9 | 2.9 | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | – | .. | .. | 0.3 | 0.3 | – | – |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| Italy | – | – | – | – | – | – | .. | – | – | 15.1 | 14.7 | 14.3 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 10.2 | 17.5 | 4.7 | 4.6 | 3.8 | 2.7 | 1.1 | 0.2 | 0.1 | 3.0 | 2.8 | 2.5 |
| Norway | 0.1 | – | – | – | – | – | – | – | – | – | – | – |
| Portugal | 0.8 | – | – | – | – | 0.2 | 0.3 | 0.4 | 0.2 | 0.8 | 0.2 | 0.2 |
| Spain | 2.2 | 6.1 | 6.8 | 5.9 | 5.5 | 3.7 | 7.3 | 2.5 | 6.1 | 3.4 | 3.8 | 5.5 |
| Sweden | 1.0 | 0.9 | 0.6 | 0.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | – |
| Switzerland | 0.2 | 0.4 | 0.5 | – | – | – | – | – | – | – | – | – |
| Turkey | 0.4 | 0.2 | 0.3 | 0.1 | 4.1 | 2.1 | 1.7 | 0.5 | 0.8 | 0.3 | 0.7 | 0.7 |
| United Kingdom | 17.6 | 7.6 | 11.3 | 10.7 | 5.3 | 2.8 | 1.3 | 3.3 | 7.3 | 5.8 | 3.9 | 5.1 |
| **Estimated IEA Total[2]** | **671.0** | **830.3** | **555.3** | **598.6** | **363.8** | **334.9** | **334.4** | **266.7** | **374.8** | **482.0** | **471.6** | **568.7** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B8

# IEA Government R&D Budgets for Conventional Nuclear[1]

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[2] | 146.7 | 146.8 | 143.7 | 109.2 | 105.6 | 88.2 | 67.2 | 59.1 | 49.5 | 50.7 | 43.1 | 41.5 |
| United States | 143.2 | 114.1 | 99.0 | 45.1 | 64.0 | 22.4 | 24.9 | 37.6 | 50.0 | 51.2 | 132.7 | 130.0 |
| Australia | 1.1 | .. | 7.2 | .. | 1.0 | .. | .. | .. | .. | .. | .. | .. |
| Japan | 1 929.7 | 1 984.8 | 2 175.5 | 2 298.0 | 2 204.9 | 2 166.3 | 2 198.5 | 2 084.4 | 2 183.2 | 2 733.9 | 2 671.9 | 2 296.1 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 28.2 | 32.6 | 33.1 |
| New Zealand | – | – | – | – | – | – | – | – | – | – | – | – |
| Austria | 0.7 | 0.8 | 0.7 | 1.1 | 0.8 | – | 0.5 | – | 0.3 | 0.2 | – | .. |
| Belgium | .. | 23.2 | 30.6 | 45.0 | 45.9 | 62.0 | 47.6 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3.3 | 3.7 |
| Denmark | 1.0 | 1.0 | 0.7 | 0.7 | 0.6 | 3.8 | 3.7 | 3.5 | 3.2 | 2.5 | 2.2 | 1.9 |
| Finland | 10.4 | 9.0 | 7.7 | 9.8 | 8.9 | 9.3 | 10.3 | 7.9 | 7.3 | 4.9 | 5.6 | .. |
| France | 474.8 | 446.0 | 572.0 | 539.7 | 548.8 | 591.5 | 693.4 | 645.2 | 440.4 | 347.8 | .. | .. |
| Germany | 109.1 | 89.7 | 88.0 | 68.9 | 48.9 | 46.7 | 26.2 | 30.1 | 21.1 | 37.2 | 30.3 | 30.1 |
| Greece | – | 0.2 | 0.3 | 0.4 | 0.3 | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | 0.3 | 0.5 | 1.3 | 1.3 | 1.3 | 1.4 | 1.5 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| Italy | 69.8 | 70.0 | 55.8 | 50.3 | 49.7 | 44.6 | .. | 64.4 | 62.7 | 61.0 | 58.0 | 56.5 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 34.5 | 17.1 | 16.3 | 14.4 | 15.8 | 9.7 | 10.5 | 19.3 | 18.9 | 11.6 | 9.7 | 9.7 |
| Norway | 11.4 | 10.8 | 11.0 | 10.4 | 10.1 | 11.4 | 10.7 | 9.7 | 9.4 | 9.6 | 9.3 | 10.1 |
| Portugal | 0.5 | 3.1 | 0.1 | 0.2 | 0.1 | – | – | – | – | – | – | – |
| Spain | 27.3 | 25.8 | 24.2 | 24.2 | 23.8 | 11.2 | 7.2 | 19.6 | 20.0 | 18.5 | 18.8 | 21.7 |
| Sweden | 1.9 | 1.8 | 1.7 | 1.4 | 5.2 | 5.2 | 5.2 | 5.1 | 5.0 | 5.4 | 5.3 | 5.2 |
| Switzerland | 29.4 | 29.6 | 28.6 | 25.0 | 25.5 | 23.9 | 17.4 | 23.8 | 22.2 | 24.6 | 25.3 | 24.1 |
| Turkey | 1.6 | 1.2 | 0.8 | 1.0 | 1.5 | 1.1 | 0.2 | 0.2 | 0.2 | – | 0.3 | 1.1 |
| United Kingdom | 26.4 | 18.9 | 16.9 | 8.9 | 2.2 | 4.2 | – | – | – | – | 0.4 | 0.1 |
| **Estimated IEA Total[3]** | **3 058.1** | **2 990.9** | **3 280.3** | **3 255.9** | **3 159.6** | **3 099.5** | **3 176.4** | **3 057.4** | **2 938.1** | **3 405.8** | **3 411.2** | **2 974.8** |

1. Conventional Nuclear refers to Total Nuclear Fission minus Nuclear Breeder.
2. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
3. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B9

## IEA Government R&D Budgets for Nuclear Breeders

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | – | – | – | – | – | 0.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| United States | – | – | – | – | – | – | – | – | – | – | – | – |
| Australia | – | .. | – | .. | – | .. | .. | .. | .. | .. | .. | .. |
| Japan | 495.5 | 446.7 | 348.9 | 322.9 | 277.6 | 239.8 | 221.6 | 376.3 | 310.1 | 139.8 | 143.5 | 131.5 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| New Zealand | – | – | – | – | – | – | – | – | – | – | – | – |
| Austria | – | – | – | – | – | – | – | – | – | – | – | .. |
| Belgium | .. | .. | – | – | – | – | – | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – |
| Denmark | – | – | – | – | – | – | – | – | – | – | – | – |
| Finland | 0.1 | – | 1.1 | – | – | – | – | – | – | – | – | .. |
| France | 57.7 | 46.2 | 19.6 | 18.9 | 15.2 | 27.8 | 25.7 | 14.7 | – | 5.1 | .. | .. |
| Germany | – | – | – | – | – | – | – | – | – | – | – | – |
| Greece | – | – | – | – | – | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | – | – | .. | – | – | – | – |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| Italy | – | – | – | – | – | – | .. | – | – | – | – | – |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 0.7 | 30.2 | – | – | – | – | – | – | – | 4.8 | 4.5 | 3.7 |
| Norway | – | – | – | – | – | – | – | – | – | – | – | – |
| Portugal | – | – | – | – | – | – | – | – | – | – | – | – |
| Spain | – | – | – | – | – | – | – | 1.2 | – | – | – | – |
| Sweden | 5.6 | 5.4 | 5.0 | 4.3 | .. | .. | .. | .. | .. | .. | – | – |
| Switzerland | 1.5 | 0.6 | 1.1 | 1.2 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | – | – | – |
| Turkey | – | – | – | – | – | – | – | – | – | – | – | – |
| United Kingdom | 60.1 | 2.4 | 0.3 | – | – | – | – | – | – | – | – | – |
| **Estimated IEA Total[2]** | **633.7** | **537.3** | **375.9** | **347.4** | **297.1** | **271.8** | **251.7** | **396.6** | **314.5** | **154.4** | **153.7** | **140.2** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.
Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B10

# IEA Government R&D Budgets for Nuclear Fusion

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 7.9 | 7.8 | 7.6 | 8.5 | – | 3.1 | 0.2 | 1.0 | 1.0 | 1.0 | 0.4 | 0.5 |
| United States | 410.2 | 393.8 | 432.8 | 275.3 | 248.9 | 243.6 | 243.8 | 257.8 | 262.6 | 250.6 | 245.7 | 262.6 |
| Australia | – | .. | – | .. | – | .. | .. | .. | .. | .. | .. | .. |
| Japan | 296.9 | 300.2 | 308.9 | 343.0 | 319.9 | 259.2 | 255.1 | 245.2 | 211.4 | 132.0 | 126.6 | 115.0 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| New Zealand | – | – | – | – | – | – | – | – | – | – | – | – |
| Austria | 2.3 | 1.4 | 1.5 | 0.8 | 1.5 | 3.2 | 3.5 | 3.6 | 4.0 | 4.2 | 3.7 | .. |
| Belgium | .. | 11.7 | 4.5 | 6.3 | 6.6 | 6.8 | 7.5 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – |
| Denmark | 1.7 | – | – | – | – | 2.4 | 2.4 | 2.4 | 1.6 | 1.6 | 1.3 | 1.3 |
| Finland | – | – | – | 1.2 | 2.0 | 1.3 | 3.2 | 1.8 | 1.5 | 4.2 | – | .. |
| France | 46.6 | 46.0 | 47.2 | 46.9 | 46.1 | 40.6 | 40.4 | 38.7 | 42.1 | 48.8 | .. | .. |
| Germany | 165.6 | 142.9 | 122.4 | 130.9 | 143.1 | 159.5 | 80.3 | 159.1 | 141.6 | 111.4 | 144.3 | 142.9 |
| Greece | – | – | – | – | – | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | – | – | .. | – | – | – | – |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – | – |
| Italy | 113.8 | 92.1 | 93.0 | 101.3 | 99.3 | 95.2 | .. | 84.1 | 81.9 | 65.5 | 57.4 | 49.7 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 19.4 | 21.9 | 9.5 | 8.1 | 10.9 | 10.1 | 11.1 | 12.4 | 9.9 | 7.0 | 9.1 | 8.9 |
| Norway | – | – | – | – | – | – | – | – | – | – | – | – |
| Portugal | 1.3 | – | – | – | – | – | – | – | – | – | 2.5 | 2.7 |
| Spain | 14.7 | 23.6 | 22.4 | 22.4 | 22.3 | 20.6 | 23.2 | 14.5 | 14.5 | 14.2 | 13.6 | 15.1 |
| Sweden | 11.7 | 12.2 | 2.2 | 2.0 | 1.6 | 1.7 | 1.5 | 1.5 | 1.4 | 1.5 | 1.5 | 1.5 |
| Switzerland | 27.9 | 24.0 | 21.3 | 25.0 | 25.9 | 21.0 | 21.3 | 20.3 | 20.1 | 19.2 | 18.4 | 18.5 |
| Turkey | – | – | – | – | – | – | – | – | – | – | – | – |
| United Kingdom | 38.5 | 37.9 | 36.6 | 26.8 | 36.9 | 27.4 | 29.8 | 34.7 | 29.2 | 30.1 | 29.9 | 29.3 |
| **Estimated IEA Total[2]** | **1 165.6** | **1 115.5** | **1 110.1** | **998.6** | **965.1** | **895.8** | **812.9** | **885.4** | **830.4** | **697.5** | **710.5** | **707.3** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B11

## IEA Government R&D Budgets for Renewables

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 12.2 | 14.1 | 13.8 | 13.7 | 10.6 | 10.9 | 13.2 | 24.6 | 21.7 | 24.1 | 37.0 | 31.6 |
| United States | 146.4 | 264.9 | 320.8 | 236.5 | 223.4 | 274.4 | 286.0 | 228.0 | 264.6 | 257.1 | 247.7 | 241.6 |
| Australia | 10.2 | .. | 4.9 | .. | 7.2 | .. | 11.7 | .. | 12.5 | .. | 12.3 | .. |
| Japan[2] | 119.4 | 110.4 | 111.2 | 113.2 | 112.3 | 124.4 | 132.5 | 158.4 | 144.0 | 181.9 | 148.7 | 320.5 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 11.2 | 13.5 | .. |
| New Zealand | 1.1 | 1.2 | 1.3 | 1.7 | 1.7 | 2.0 | 1.4 | 1.5 | 2.6 | 1.9 | 2.6 | 3.1 |
| Austria | 7.0 | 9.1 | 10.7 | 8.3 | 10.1 | 13.3 | 12.5 | 8.7 | 10.3 | 12.4 | 12.5 | .. |
| Belgium | 3.0 | 3.2 | 5.1 | 3.8 | 4.2 | 1.7 | 1.4 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.7 | 0.4 |
| Denmark | 26.9 | 23.3 | 21.8 | 17.6 | 22.7 | 24.9 | 21.6 | 21.7 | 24.4 | 12.5 | 12.3 | 17.0 |
| Finland | 6.6 | 7.3 | 7.4 | 9.3 | 15.1 | 11.0 | 12.4 | 11.3 | 10.5 | 12.3 | 21.5 | .. |
| France | 7.1 | 6.7 | 6.6 | 6.2 | 3.8 | 5.2 | 16.8 | 17.5 | 23.7 | 30.4 | .. | .. |
| Germany | 162.2 | 107.2 | 94.6 | 117.4 | 91.9 | 103.0 | 90.7 | 95.1 | 90.6 | 95.6 | 86.7 | 74.3 |
| Greece | 4.6 | 2.5 | 4.4 | 4.1 | 8.6 | .. | .. | 2.5 | 3.7 | 4.3 | .. | .. |
| Hungary | .. | .. | 0.6 | 0.1 | .. | – | – | 0.6 | 1.4 | 2.4 | 1.7 | 2.6 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.8 | 2.0 | 3.4 |
| Italy | 36.5 | 41.4 | 56.4 | 52.7 | 48.5 | 45.2 | .. | 31.0 | 51.1 | 68.2 | 64.5 | 63.1 |
| Luxembourg | 0.1 | 0.1 | – | 0.1 | 0.5 | 0.2 | 0.7 | 0.5 | .. | .. | .. | .. |
| Netherlands | 28.0 | 34.9 | 31.2 | 37.6 | 49.9 | 54.8 | 57.1 | 42.8 | 54.7 | 56.9 | 61.0 | 51.6 |
| Norway | 12.1 | 9.9 | 6.5 | 6.0 | 5.9 | 7.0 | 6.9 | 6.9 | 5.4 | 5.1 | 4.6 | 5.0 |
| Portugal | 2.1 | 0.8 | 0.8 | 1.6 | 0.8 | 1.7 | 1.9 | 1.1 | 0.5 | 1.6 | 0.3 | 0.4 |
| Spain | 28.7 | 21.0 | 20.4 | 20.4 | 20.3 | 25.4 | 21.7 | 23.5 | 22.0 | 21.6 | 26.5 | 35.4 |
| Sweden | 16.8 | 20.4 | 15.8 | 10.1 | 10.4 | 16.8 | 16.4 | 31.8 | 34.3 | 32.1 | 26.3 | 28.9 |
| Switzerland | 48.7 | 46.0 | 45.0 | 43.1 | 45.5 | 44.4 | 45.5 | 33.1 | 32.2 | 34.1 | 35.8 | 38.2 |
| Turkey | 0.3 | 0.5 | 0.1 | 0.2 | 2.6 | 2.1 | 1.4 | 1.6 | 0.6 | 1.2 | 0.7 | 2.0 |
| United Kingdom | 36.5 | 21.5 | 21.0 | 13.8 | 9.3 | 6.9 | 9.5 | 9.0 | 12.2 | 20.3 | 21.7 | 21.4 |
| **Estimated IEA Total[3]** | **711.9** | **750.7** | **795.2** | **719.0** | **696.4** | **784.2** | **798.0** | **760.9** | **819.2** | **883.1** | **853.6** | **1 024.1** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. For 2004, Total Renewable Energy includes Other Renewables.
3. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B12

# IEA Government R&D Budgets for Power and Storage

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 11.6 | 10.9 | 10.5 | 9.0 | 5.0 | 5.4 | 5.6 | 18.9 | 24.1 | 28.5 | 41.5 | 30.8 |
| United States | 51.8 | 139.0 | 154.6 | 139.4 | 142.5 | 141.6 | 140.7 | 133.9 | 142.9 | 150.6 | 167.2 | 160.3 |
| Australia | 7.7 | .. | 6.2 | .. | 5.7 | .. | 10.3 | .. | 6.7 | .. | 4.8 | .. |
| Japan | 62.7 | 71.7 | 71.8 | 74.8 | 77.0 | 132.6 | 138.1 | 170.6 | 195.9 | 79.2 | 41.0 | 58.4 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 17.9 | 26.1 | .. |
| New Zealand | – | – | 0.1 | 0.3 | 0.3 | 0.3 | 0.8 | 0.8 | 0.6 | 0.7 | – | – |
| Austria | 4.5 | 5.8 | 4.9 | 5.7 | 5.0 | 5.6 | 4.1 | 4.3 | 6.0 | 4.9 | 5.0 | .. |
| Belgium | 9.5 | 5.3 | 7.3 | 7.3 | 2.4 | 6.2 | 3.7 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – |
| Denmark | 7.2 | 5.3 | 5.0 | 5.5 | 5.5 | 5.6 | 5.1 | 4.7 | 5.1 | 4.5 | 4.8 | 5.8 |
| Finland | 16.2 | 20.8 | 20.5 | 15.8 | 21.3 | 19.2 | 19.3 | 16.5 | 17.1 | 17.9 | 15.6 | .. |
| France | – | – | – | – | – | – | – | 0.9 | 2.6 | 5.8 | .. | .. |
| Germany | 3.2 | 3.9 | 2.6 | 15.2 | 26.4 | 28.0 | 10.0 | 27.3 | 53.6 | 43.9 | 41.4 | 38.4 |
| Greece | – | 0.1 | 0.1 | 0.1 | 0.3 | .. | .. | 3.0 | 3.2 | 3.4 | .. | .. |
| Hungary | .. | .. | – | – | .. | 0.2 | – | .. | – | – | 0.1 | 0.5 |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.6 | 0.2 | 0.8 |
| Italy | 15.2 | 26.6 | 21.1 | 21.7 | 19.9 | 20.8 | .. | 108.6 | 105.7 | 102.6 | 99.7 | 97.1 |
| Luxembourg | – | – | – | – | 0.7 | – | – | – | .. | .. | .. | .. |
| Netherlands | 45.2 | 48.8 | 20.8 | 23.6 | 24.1 | 16.5 | 13.7 | 13.0 | 11.6 | 12.5 | 13.3 | 11.7 |
| Norway | 4.0 | 4.0 | 5.0 | 3.7 | 3.3 | 3.0 | 2.5 | 7.1 | 3.5 | 4.9 | 4.7 | 3.3 |
| Portugal | – | – | – | – | – | 0.1 | – | – | 0.1 | – | – | – |
| Spain | – | – | 0.4 | 0.5 | 0.5 | 0.5 | 1.7 | 2.3 | 1.2 | – | 0.6 | 0.7 |
| Sweden | 4.6 | 11.3 | 5.3 | 1.3 | 13.1 | 9.3 | 19.2 | 9.8 | 11.9 | 12.4 | 15.0 | 19.1 |
| Switzerland | 26.0 | 22.6 | 22.8 | 24.4 | 19.2 | 21.1 | 20.5 | 22.4 | 26.0 | 24.3 | 22.3 | 21.7 |
| Turkey | 0.1 | 0.1 | – | – | 0.2 | 0.2 | 0.6 | 1.5 | 1.0 | 1.2 | 0.8 | 0.5 |
| United Kingdom | – | 8.9 | 7.1 | 2.5 | 2.4 | 2.5 | 2.9 | 3.5 | 3.2 | 8.3 | 5.6 | 7.7 |
| **Estimated IEA Total[2]** | **269.6** | **391.7** | **366.2** | **356.4** | **373.7** | **426.1** | **446.5** | **559.0** | **623.8** | **511.8** | **492.8** | **490.2** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B12a

## IEA Government R&D Budgets for Energy Systems Analysis & Others

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canada[1] | 8.1 | 9.7 | 9.6 | 14.9 | 17.1 | 13.0 | 24.7 | 31.5 | 37.8 | 28.9 | 28.3 | 26.0 |
| United States | 1 047.6 | 919.5 | 873.5 | 908.8 | 924.1 | 916.6 | 1 088.3 | 987.8 | 1 266.5 | 1 207.9 | 1 189.3 | 1 212.9 |
| Australia | 14.8 | .. | 20.3 | .. | 15.9 | .. | 7.9 | .. | 15.6 | .. | 24.4 | .. |
| Japan | 99.1 | 117.5 | 122.3 | 122.2 | 125.2 | 110.9 | 72.5 | 77.7 | 87.4 | 364.2 | 316.8 | 243.1 |
| Korea | .. | .. | .. | .. | .. | .. | .. | .. | .. | 12.3 | 20.1 | .. |
| New Zealand | – | 0.3 | 0.2 | 0.1 | – | 0.8 | 0.4 | 0.4 | 0.2 | 0.4 | 1.4 | 1.8 |
| Austria | 2.8 | 1.5 | 2.2 | 2.7 | 3.7 | 4.9 | 4.0 | 4.3 | 5.5 | 5.0 | 3.4 | .. |
| Belgium | 1.7 | 2.4 | 2.5 | 1.6 | 1.9 | 1.4 | 0.8 | .. | .. | .. | .. | .. |
| Czech Republic | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | – | – |
| Denmark | 6.0 | 5.3 | 7.1 | 7.4 | 7.3 | 8.9 | 9.1 | 6.8 | 7.6 | 7.5 | 8.0 | 8.7 |
| Finland | 3.5 | 8.1 | 12.2 | 10.6 | 8.5 | 5.1 | 4.9 | 7.1 | 5.1 | 8.7 | 6.6 | .. |
| France | – | – | – | – | – | – | – | 10.0 | 11.8 | 19.2 | .. | .. |
| Germany[2] | 23.0 | 24.2 | 7.8 | 14.0 | 11.7 | 10.4 | 8.6 | 14.2 | 16.2 | 10.0 | 138.3 | 146.3 |
| Greece | 1.8 | 0.7 | 1.8 | 3.0 | 1.5 | .. | .. | .. | .. | .. | .. | .. |
| Hungary | .. | .. | – | – | .. | 0.4 | – | .. | – | – | 0.1 | – |
| Ireland | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0.1 | 0.4 | 1.8 |
| Italy | 90.6 | 79.4 | 90.7 | 61.4 | 43.3 | 46.7 | .. | 44.6 | 47.3 | 45.9 | 44.6 | 43.5 |
| Luxembourg | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Netherlands | 12.8 | 10.2 | 24.3 | 15.1 | 19.0 | 19.2 | 17.0 | 23.6 | 31.5 | 10.2 | 9.9 | 14.3 |
| Norway | 10.2 | 6.6 | 6.8 | 7.4 | 6.8 | 5.6 | 5.2 | 1.2 | 10.6 | 16.9 | 10.0 | 13.9 |
| Portugal | – | – | – | – | – | 0.2 | 0.3 | 0.2 | – | – | – | – |
| Spain | 27.5 | 26.3 | 18.9 | 18.4 | 18.9 | 2.8 | 10.3 | 0.8 | 2.9 | 1.4 | 3.3 | 3.6 |
| Sweden | 19.0 | 15.3 | 13.9 | 13.9 | 17.8 | 14.2 | 17.3 | 11.9 | 12.1 | 13.3 | 15.2 | 24.7 |
| Switzerland | 13.0 | 14.8 | 14.6 | 13.3 | 13.1 | 10.1 | 10.4 | 10.2 | 12.2 | 12.5 | 14.8 | 14.9 |
| Turkey | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.4 | 0.5 | 0.5 | 1.1 |
| United Kingdom | 1.4 | 11.4 | 11.8 | 9.1 | 39.2 | 39.9 | 38.3 | 38.5 | 4.4 | 1.9 | 0.7 | 0.7 |
| **Estimated IEA Total[3]** | **1 381.3** | **1 270.2** | **1 239.0** | **1 238.9** | **1 273.7** | **1 222.0** | **1 366.0** | **1 282.8** | **1 575.8** | **1 774.9** | **1 836.5** | **1 810.1** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
2. For 2003 and 2004, data include the institutionally financed R&D activities of the Helmholtz centers, which were not considered in the last years and can not be allocated to a specific technology area.
3. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been included in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.

Note: Budgets provided for recent years by some countries may have been estimated.

Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B13

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | Australia 2003 USD | % | 2004e USD | % | Austria 2003 USD | % | 2004e USD | % |
|---|---|---|---|---|---|---|---|---|
| 1.1 Industry | 3.76 | 3.24 | .. | .. | 0.95 | 3.01 | .. | .. |
| 1.2 Residential, Commercial | 3.84 | 3.32 | .. | .. | 3.02 | 9.54 | .. | .. |
| 1.3 Transportation | 1.40 | 1.21 | .. | .. | 2.07 | 6.53 | .. | .. |
| 1.4 Other Conservation | 1.29 | 1.11 | .. | .. | 0.38 | 1.20 | .. | .. |
| **TOTAL CONSERVATION** | **10.28** | **8.88** | **..** | **..** | **6.41** | **20.28** | **..** | **..** |
| 2.1 Enhanced Oil & Gas | 0.19 | 0.16 | .. | .. | – | – | .. | .. |
| 2.2 Refining, Transp. & Stor. | 2.52 | 2.17 | .. | .. | 0.02 | 0.06 | .. | .. |
| 2.3 Oil Shale & Tar Sands | 0.62 | 0.53 | .. | .. | – | – | .. | .. |
| 2.4 Other Oil & Gas | 30.14 | 26.02 | .. | .. | 0.04 | 0.12 | .. | .. |
| Total Oil & Gas | 33.47 | 28.89 | .. | .. | 0.05 | 0.17 | .. | .. |
| 3.1 Coal Prod., Prep., & Trans. | 12.97 | 11.20 | .. | .. | – | – | .. | .. |
| 3.2 Coal Combustion | 4.55 | 3.93 | .. | .. | 0.30 | 0.96 | .. | .. |
| 3.3 Coal Conversion | – | – | .. | .. | – | – | .. | .. |
| 3.4 Other Coal | 12.12 | 10.47 | .. | .. | 0.23 | 0.72 | .. | .. |
| Total Coal | 29.64 | 25.59 | .. | .. | 0.53 | 1.67 | .. | .. |
| **TOTAL FOSSIL FUELS** | **63.11** | **54.48** | **..** | **..** | **0.58** | **1.85** | **..** | **..** |
| 4.1 Solar Heating & Cooling | 1.31 | 1.13 | .. | .. | 2.69 | 8.51 | .. | .. |
| 4.2 Solar Photo-Electric | 4.43 | 3.82 | .. | .. | 1.66 | 5.24 | .. | .. |
| 4.3 Solar Thermal-Electric | 0.19 | 0.16 | .. | .. | – | – | .. | .. |
| Total Solar | 5.93 | 5.12 | .. | .. | 4.35 | 13.76 | .. | .. |
| 5. Wind | 1.75 | 1.51 | .. | .. | 1.07 | 3.38 | .. | .. |
| 6. Ocean | – | – | .. | .. | – | – | .. | .. |
| 7. Biomass | – | – | .. | .. | 6.70 | 21.18 | .. | .. |
| 8. Geothermal | 4.33 | 3.74 | .. | .. | 0.01 | 0.03 | .. | .. |
| 9.1 Large Hydro (>10 MW) | .. | .. | .. | .. | 0.13 | 0.40 | .. | .. |
| 9.2 Small Hydro (<10 MW) | .. | .. | .. | .. | 0.29 | 0.93 | .. | .. |
| Total Hydro | 0.27 | 0.24 | .. | .. | 0.42 | 1.34 | .. | .. |
| **TOTAL RENEWABLE ENERGY** | **12.28** | **10.60** | **..** | **..** | **12.55** | **39.68** | **..** | **..** |
| 10.1 Nuclear LWR | .. | .. | .. | .. | – | – | .. | .. |
| 10.2 Other Converter Reactors | .. | .. | .. | .. | – | – | .. | .. |
| 10.3 Nuclear Fuel Cycle | .. | .. | .. | .. | – | – | .. | .. |
| 10.4 Nuclear Supporting Tech. | .. | .. | .. | .. | – | – | .. | .. |
| 10.5 Nuclear Breeder | .. | .. | .. | .. | – | – | .. | .. |
| Total Nuclear Fission | .. | .. | .. | .. | – | – | .. | .. |
| 11. Nuclear Fusion | .. | .. | .. | .. | 3.68 | 11.64 | .. | .. |
| **TOTAL NUCLEAR** | **1.02** | **0.88** | **..** | **..** | **3.68** | **11.64** | **..** | **..** |
| 12.1 Electric Power Conversion | – | – | .. | .. | 2.76 | 8.74 | .. | .. |
| 12.2 Electricity Transm., & Distr. | 2.90 | 2.50 | .. | .. | 2.11 | 6.66 | .. | .. |
| 12.3 Energy Storage | 1.86 | 1.61 | .. | .. | 0.13 | 0.41 | .. | .. |
| **TOTAL POWER & STORAGE** | **4.76** | **4.11** | **..** | **..** | **5.00** | **15.80** | **..** | **..** |
| 13.1 Energy Systems Analysis | 1.38 | 1.19 | .. | .. | 1.12 | 3.53 | .. | .. |
| 13.2 Other Tech. or Research | 22.99 | 19.84 | .. | .. | 2.29 | 7.23 | .. | .. |
| **TOTAL OTHER TECH./RESEARCH** | **24.37** | **21.04** | **..** | **..** | **3.40** | **10.76** | **..** | **..** |
| **TOTAL ENERGY R&D** | **115.83** | **100.00** | **..** | **..** | **31.63** | **100.00** | **..** | **..** |

1. All data refer to the fiscal year, April 2004 to March 2005 for 2004.
Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

| Belgium | | | | Canada[1] | | | | Czech Republic | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| .. | .. | .. | .. | 19.53 | 6.76 | 19.71 | 7.49 | – | – | – | – |
| .. | .. | .. | .. | 18.19 | 6.30 | 22.94 | 8.72 | – | – | – | – |
| .. | .. | .. | .. | 32.14 | 11.13 | 29.44 | 11.19 | – | – | – | – |
| .. | .. | .. | .. | 7.33 | 2.54 | 5.01 | 1.90 | – | – | – | |
| **..** | **..** | **..** | **..** | **77.19** | **26.72** | **77.10** | **29.31** | **–** | **–** | **–** | **–** |
| .. | .. | .. | .. | 3.12 | 1.08 | 4.00 | 1.52 | 0.40 | 5.60 | 0.19 | 3.85 |
| .. | .. | .. | .. | 8.56 | 2.96 | 6.46 | 2.45 | – | – | – | – |
| .. | .. | .. | .. | 21.14 | 7.32 | 17.51 | 6.66 | – | – | – | – |
| .. | .. | .. | .. | 21.35 | 7.39 | 22.55 | 8.57 | – | – | – | – |
| .. | .. | .. | .. | 54.17 | 18.75 | 50.51 | 19.20 | 0.40 | 5.60 | 0.19 | 3.85 |
| .. | .. | .. | .. | 0.31 | 0.11 | 1.19 | 0.45 | 0.79 | 10.99 | 0.12 | 2.31 |
| .. | .. | .. | .. | 3.47 | 1.20 | 0.45 | 0.17 | 1.61 | 22.42 | 0.39 | 7.69 |
| .. | .. | .. | .. | 1.70 | 0.59 | 1.85 | 0.70 | 0.40 | 5.60 | 0.19 | 3.85 |
| .. | .. | .. | .. | 1.25 | 0.43 | 0.95 | 0.36 | – | – | – | – |
| .. | .. | .. | .. | 6.72 | 2.33 | 4.44 | 1.69 | 2.81 | 39.01 | 0.70 | 13.85 |
| **..** | **..** | **..** | **..** | **60.90** | **21.08** | **54.95** | **20.89** | **3.21** | **44.62** | **0.90** | **17.69** |
| .. | .. | .. | .. | 2.77 | 0.96 | 3.81 | 1.45 | 0.30 | 4.17 | 0.19 | 3.85 |
| .. | .. | .. | .. | 9.79 | 3.39 | 6.20 | 2.36 | – | – | – | – |
| .. | .. | .. | .. | 0.69 | 0.24 | 0.69 | 0.26 | – | – | – | – |
| .. | .. | .. | .. | 13.25 | 4.59 | 10.70 | 4.07 | 0.30 | 4.17 | 0.19 | 3.85 |
| .. | .. | .. | .. | 2.91 | 1.01 | 2.42 | 0.92 | 0.40 | 5.60 | 0.25 | 4.97 |
| .. | .. | .. | .. | 0.09 | 0.03 | – | – | – | – | – | – |
| .. | .. | .. | .. | 16.38 | 5.67 | 14.28 | 5.43 | – | – | – | – |
| .. | .. | .. | .. | 1.11 | 0.38 | 0.75 | 0.29 | – | – | – | – |
| .. | .. | .. | .. | 1.56 | 0.54 | 1.76 | 0.67 | – | – | – | – |
| .. | .. | .. | .. | 1.69 | 0.59 | 1.65 | 0.63 | – | – | – | – |
| .. | .. | .. | .. | 3.26 | 1.13 | 3.40 | 1.29 | – | – | – | – |
| **..** | **..** | **..** | **..** | **36.99** | **12.81** | **31.56** | **12.00** | **0.70** | **9.77** | **0.45** | **8.81** |
| .. | .. | .. | .. | 0.49 | 0.17 | 0.55 | 0.21 | 0.40 | 5.60 | 0.39 | 7.69 |
| .. | .. | .. | .. | 41.53 | 14.38 | 39.73 | 15.10 | 0.40 | 5.60 | 0.39 | 7.69 |
| .. | .. | .. | .. | 0.49 | 0.17 | 0.58 | 0.22 | 1.65 | 22.98 | 1.95 | 38.46 |
| .. | .. | .. | .. | 0.63 | 0.22 | 0.68 | 0.26 | 0.82 | 11.42 | 0.99 | 19.65 |
| .. | .. | .. | .. | 0.49 | 0.17 | 0.55 | 0.21 | – | – | – | – |
| .. | .. | .. | .. | 43.62 | 15.10 | 42.08 | 16.00 | 3.28 | 45.61 | 3.72 | 73.49 |
| .. | .. | .. | .. | 0.42 | 0.15 | 0.48 | 0.18 | – | – | – | – |
| **..** | **..** | **..** | **..** | **44.05** | **15.25** | **42.56** | **16.18** | **3.28** | **45.61** | **3.72** | **73.49** |
| .. | .. | .. | .. | 23.60 | 8.17 | 16.74 | 6.36 | – | – | – | – |
| .. | .. | .. | .. | 3.20 | 1.11 | 3.38 | 1.29 | – | – | – | – |
| .. | .. | .. | .. | 14.67 | 5.08 | 10.73 | 4.08 | – | – | – | – |
| **..** | **..** | **..** | **..** | **41.48** | **14.36** | **30.85** | **11.73** | **–** | **–** | **–** | **–** |
| .. | .. | .. | .. | 2.38 | 0.83 | 2.12 | 0.80 | – | – | – | – |
| .. | .. | .. | .. | 25.89 | 8.96 | 23.90 | 9.09 | – | – | – | – |
| **..** | **..** | **..** | **..** | **28.27** | **9.79** | **26.01** | **9.89** | **–** | **–** | **–** | **–** |
| **..** | **..** | **..** | **..** | **288.88** | **100.00** | **263.04** | **100.00** | **7.20** | **100.00** | **5.06** | **100.00** |

Table B13 *(continued)*

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | Denmark | | | | Finland[1] | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| 1.1 Industry | 0.08 | 0.28 | 0.25 | 0.70 | 6.95 | 10.36 | .. | .. |
| 1.2 Residential, Commercial | 0.98 | 3.27 | 0.89 | 2.47 | 4.90 | 7.31 | .. | .. |
| 1.3 Transportation | – | – | – | – | 2.01 | 2.99 | .. | .. |
| 1.4 Other Conservation | 0.34 | 1.13 | – | – | 3.15 | 4.70 | .. | .. |
| **TOTAL CONSERVATION** | **1.41** | **4.68** | **1.14** | **3.17** | **17.01** | **25.37** | **..** | **..** |
| 2.1 Enhanced Oil & Gas | – | – | – | – | – | – | .. | .. |
| 2.2 Refining, Transp. & Stor. | – | – | – | – | 0.50 | 0.74 | .. | .. |
| 2.3 Oil Shale & Tar Sands | – | – | – | – | – | – | .. | .. |
| 2.4 Other Oil & Gas | – | – | – | – | – | – | .. | .. |
| Total Oil & Gas | – | – | – | – | 0.50 | 0.74 | .. | .. |
| 3.1 Coal Prod., Prep., & Trans. | – | – | – | – | 0.03 | 0.04 | .. | .. |
| 3.2 Coal Combustion | – | – | – | – | 0.25 | 0.37 | .. | .. |
| 3.3 Coal Conversion | – | – | – | – | – | – | .. | .. |
| 3.4 Other Coal | – | – | – | – | 0.03 | 0.04 | .. | .. |
| Total Coal | – | – | – | – | 0.30 | 0.45 | .. | .. |
| **TOTAL FOSSIL FUELS** | **–** | **–** | **–** | **–** | **0.80** | **1.19** | **..** | **..** |
| 4.1 Solar Heating & Cooling | 0.03 | 0.11 | 0.40 | 1.12 | 0.05 | 0.07 | .. | .. |
| 4.2 Solar Photo-Electric | 1.39 | 4.63 | 1.30 | 3.63 | – | – | .. | .. |
| 4.3 Solar Thermal-Electric | – | – | 0.65 | 1.82 | 0.07 | 0.10 | .. | .. |
| Total Solar | 1.43 | 4.74 | 2.35 | 6.57 | 0.11 | 0.17 | .. | .. |
| 5. Wind | 9.11 | 30.30 | 10.27 | 28.64 | 2.71 | 4.04 | .. | .. |
| 6. Ocean | 0.10 | 0.34 | – | – | – | – | .. | .. |
| 7. Biomass | 1.60 | 5.30 | 4.34 | 12.11 | 8.27 | 12.33 | .. | .. |
| 8. Geothermal | – | – | – | – | – | – | .. | .. |
| 9.1 Large Hydro (>10 MW) | – | – | – | – | – | – | .. | .. |
| 9.2 Small Hydro (<10 MW) | 0.10 | 0.34 | – | – | 10.40 | 15.51 | .. | .. |
| Total Hydro | 0.10 | 0.34 | – | – | 10.40 | 15.51 | .. | .. |
| **TOTAL RENEWABLE ENERGY** | **12.34** | **41.03** | **16.97** | **47.32** | **21.49** | **32.05** | **..** | **..** |
| 10.1 Nuclear LWR | – | – | – | – | 3.83 | 5.70 | .. | .. |
| 10.2 Other Converter Reactors | – | – | – | – | – | – | .. | .. |
| 10.3 Nuclear Fuel Cycle | – | – | – | – | 1.07 | 1.59 | .. | .. |
| 10.4 Nuclear Supporting Tech. | 2.21 | 7.34 | 1.94 | 5.40 | 0.67 | 1.00 | .. | .. |
| 10.5 Nuclear Breeder | – | – | – | – | – | – | .. | .. |
| Total Nuclear Fission | 2.21 | 7.34 | 1.94 | 5.40 | 5.56 | 8.29 | .. | .. |
| 11. Nuclear Fusion | 1.31 | 4.35 | 1.25 | 3.49 | – | – | .. | .. |
| **TOTAL NUCLEAR** | **3.51** | **11.68** | **3.19** | **8.90** | **5.56** | **8.29** | **..** | **..** |
| 12.1 Electric Power Conversion | 1.41 | 4.68 | 3.61 | 10.06 | 9.78 | 14.58 | .. | .. |
| 12.2 Electricity Transm., & Distr. | – | – | – | – | 5.72 | 8.52 | .. | .. |
| 12.3 Energy Storage | 3.38 | 11.23 | 2.24 | 6.24 | 0.14 | 0.20 | .. | .. |
| **TOTAL POWER & STORAGE** | **4.79** | **15.91** | **5.85** | **16.30** | **15.63** | **23.31** | **..** | **..** |
| 13.1 Energy Systems Analysis | 1.51 | 5.02 | 3.31 | 9.22 | 6.34 | 9.45 | .. | .. |
| 13.2 Other Tech. or Research | 6.52 | 21.67 | 5.41 | 15.09 | 0.23 | 0.34 | .. | .. |
| **TOTAL OTHER TECH./RESEARCH** | **8.03** | **26.69** | **8.72** | **24.31** | **6.56** | **9.79** | **..** | **..** |
| **TOTAL ENERGY R&D** | **30.07** | **100.00** | **35.86** | **100.00** | **67.06** | **100.00** | **..** | **..** |

1. Other coal refers to peat. Coal Combustion includes Coal Conversion, Solar Thermal-Electric includes Solar Photo-Electric and Small Hydro includes Large Hydro.
2. Other Technologies or Research includes the institutionally financed R&D activities of the Helmholtz centers, which were not considered in the last years and can not be allocated to a specific technology area.

| France | | | | Germany[2] | | | | Greece | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| .. | .. | .. | .. | 6.88 | 1.46 | 5.47 | 1.19 | .. | .. | .. | .. |
| .. | .. | .. | .. | 11.01 | 2.33 | 8.20 | 1.78 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 3.63 | 0.77 | 3.23 | 0.70 | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **21.53** | **4.56** | **16.89** | **3.66** | **..** | **..** | **..** | **..** |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 8.01 | 1.69 | 10.93 | 2.37 | .. | .. | .. | .. |
| .. | .. | .. | .. | 2.00 | 0.42 | 1.37 | 0.30 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 10.01 | 2.12 | 12.30 | 2.67 | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **10.01** | **2.12** | **12.30** | **2.67** | **..** | **..** | **..** | **..** |
| .. | .. | .. | .. | 10.26 | 2.17 | 13.91 | 3.02 | .. | .. | .. | .. |
| .. | .. | .. | .. | 37.17 | 7.87 | 30.31 | 6.57 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | 4.72 | 1.02 | .. | .. | .. | .. |
| .. | .. | .. | .. | 47.43 | 10.04 | 48.94 | 10.61 | .. | .. | .. | .. |
| .. | .. | .. | .. | 15.27 | 3.23 | 11.68 | 2.53 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 9.39 | 1.99 | 6.34 | 1.37 | .. | .. | .. | .. |
| .. | .. | .. | .. | 14.27 | 3.02 | 7.33 | 1.59 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 0.38 | 0.08 | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 0.38 | 0.08 | – | – | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **86.73** | **18.35** | **74.29** | **16.11** | **..** | **..** | **..** | **..** |
| .. | .. | .. | .. | 20.90 | 4.42 | 21.61 | 4.69 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 9.39 | 1.99 | 8.45 | 1.83 | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | – | – | – | – | .. | .. | .. | .. |
| .. | .. | .. | .. | 30.29 | 6.41 | 30.06 | 6.52 | .. | .. | .. | .. |
| .. | .. | .. | .. | 144.30 | 30.53 | 142.86 | 30.98 | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **174.59** | **36.94** | **172.92** | **37.50** | **..** | **..** | **..** | **..** |
| .. | .. | .. | .. | 34.42 | 7.28 | 33.04 | 7.17 | .. | .. | .. | .. |
| .. | .. | .. | .. | 5.76 | 1.22 | 4.97 | 1.08 | .. | .. | .. | .. |
| .. | .. | .. | .. | 1.25 | 0.26 | 0.37 | 0.08 | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **41.42** | **8.77** | **38.39** | **8.32** | **..** | **..** | **..** | **..** |
| .. | .. | .. | .. | 0.50 | 0.11 | 0.37 | 0.08 | .. | .. | .. | .. |
| .. | .. | .. | .. | 137.79 | 29.16 | 145.96 | 31.65 | .. | .. | .. | .. |
| **..** | **..** | **..** | **..** | **138.29** | **29.26** | **146.34** | **31.73** | **..** | **..** | **..** | **..** |
| **..** | **..** | **..** | **..** | **472.57** | **100.00** | **461.12** | **100.00** | **..** | **..** | **..** | **..** |

Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

Table B13 *(continued)*

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | Hungary | | | | Ireland | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| 1.1 Industry | – | – | – | – | 0.75 | 8.29 | 0.62 | 5.67 |
| 1.2 Residential, Commercial | – | – | – | – | 5.37 | 59.24 | 4.02 | 36.57 |
| 1.3 Transportation | – | – | – | – | 0.01 | 0.10 | 0.19 | 1.69 |
| 1.4 Other Conservation | – | – | – | – | – | – | – | – |
| **TOTAL CONSERVATION** | **–** | **–** | **–** | **–** | **6.13** | **67.63** | **4.83** | **43.93** |
| 2.1 Enhanced Oil & Gas | 0.26 | 7.26 | 0.25 | 5.12 | 0.25 | 2.81 | – | – |
| 2.2 Refining, Transp. & Stor. | – | – | – | – | – | – | – | – |
| 2.3 Oil Shale & Tar Sands | – | – | – | – | – | – | – | – |
| 2.4 Other Oil & Gas | – | – | – | – | 0.12 | 1.28 | 0.25 | 2.26 |
| Total Oil & Gas | 0.26 | 7.26 | 0.25 | 5.12 | 0.37 | 4.09 | 0.25 | 2.26 |
| 3.1 Coal Prod., Prep., & Trans. | – | – | – | – | – | – | – | – |
| 3.2 Coal Combustion | – | – | – | – | – | – | – | – |
| 3.3 Coal Conversion | – | – | – | – | – | – | – | – |
| 3.4 Other Coal | – | – | – | – | – | – | – | – |
| Total Coal | – | – | – | – | – | – | – | – |
| **TOTAL FOSSIL FUELS** | **0.26** | **7.26** | **0.25** | **5.12** | **0.37** | **4.09** | **0.25** | **2.26** |
| 4.1 Solar Heating & Cooling | – | – | – | – | 0.10 | 1.06 | 0.12 | 1.12 |
| 4.2 Solar Photo-Electric | – | – | – | – | 0.05 | 0.58 | 0.05 | 0.46 |
| 4.3 Solar Thermal-Electric | – | – | – | – | 0.69 | 7.66 | 0.49 | 4.48 |
| Total Solar | – | – | – | – | 0.84 | 9.31 | 0.67 | 6.06 |
| 5. Wind | 0.09 | 2.61 | 0.09 | 1.84 | 0.58 | 6.44 | 0.99 | 8.96 |
| 6. Ocean | – | – | – | – | 0.12 | 1.32 | 0.32 | 2.91 |
| 7. Biomass | 1.60 | 45.04 | 2.52 | 52.23 | 0.40 | 4.46 | 1.41 | 12.86 |
| 8. Geothermal | – | – | – | – | – | – | – | – |
| 9.1 Large Hydro (>10 MW) | – | – | – | – | – | – | – | – |
| 9.2 Small Hydro (<10 MW) | – | – | – | – | – | – | – | – |
| Total Hydro | – | – | – | – | – | – | – | – |
| **TOTAL RENEWABLE ENERGY** | **1.70** | **47.66** | **2.61** | **54.08** | **1.95** | **21.53** | **3.39** | **30.79** |
| 10.1 Nuclear LWR | 1.17 | 32.82 | 1.19 | 24.68 | – | – | – | – |
| 10.2 Other Converter Reactors | – | – | – | – | – | – | – | – |
| 10.3 Nuclear Fuel Cycle | 0.05 | 1.45 | 0.06 | 1.33 | – | – | – | – |
| 10.4 Nuclear Supporting Tech. | 0.18 | 5.08 | 0.21 | 4.30 | – | – | – | – |
| 10.5 Nuclear Breeder | – | – | – | – | – | – | – | – |
| Total Nuclear Fission | 1.40 | 39.35 | 1.46 | 30.32 | – | – | – | – |
| 11. Nuclear Fusion | – | – | – | – | – | – | – | – |
| **TOTAL NUCLEAR** | **1.40** | **39.35** | **1.46** | **30.32** | **–** | **–** | **–** | **–** |
| 12.1 Electric Power Conversion | – | – | 0.51 | 10.49 | 0.14 | 1.49 | 0.18 | 1.66 |
| 12.2 Electricity Transm., & Distr. | 0.11 | 3.22 | – | – | 0.04 | 0.40 | 0.59 | 5.38 |
| 12.3 Energy Storage | – | – | – | – | – | – | – | – |
| **TOTAL POWER & STORAGE** | **0.11** | **3.22** | **0.51** | **10.49** | **0.17** | **1.89** | **0.78** | **7.04** |
| 13.1 Energy Systems Analysis | 0.09 | 2.51 | – | – | 0.04 | 0.41 | – | – |
| 13.2 Other Tech. or Research | – | – | – | – | 0.40 | 4.46 | 1.76 | 15.98 |
| **TOTAL OTHER TECH./RESEARCH** | **0.09** | **2.51** | **–** | **–** | **0.44** | **4.87** | **1.76** | **15.98** |
| **TOTAL ENERGY R&D** | **3.56** | **100.00** | **4.82** | **100.00** | **9.06** | **100.00** | **11.01** | **100.00** |

1. Nuclear Energy figures are provisional. For 2004, Total Renewable Energy includes Other Renewables.
Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

| Italy | | | | Japan[1] | | | | Korea | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| 10.84 | 2.92 | 8.70 | 2.46 | 346.83 | 8.16 | .. | .. | .. | .. | .. | .. |
| 17.85 | 4.81 | 17.39 | 4.91 | 13.40 | 0.32 | .. | .. | .. | .. | .. | .. |
| 1.28 | 0.34 | 1.24 | 0.35 | 30.57 | 0.72 | .. | .. | .. | .. | .. | .. |
| – | – | – | – | 104.69 | 2.46 | .. | .. | 1.75 | .. | .. | .. |
| **29.96** | **8.07** | **27.33** | **7.72** | **495.48** | **11.66** | **455.78** | **11.50** | **..** | **..** | **..** | **..** |
| – | – | – | – | – | – | – | – | – | .. | – | .. |
| – | – | – | – | 59.19 | 1.39 | 163.68 | 4.13 | 0.69 | .. | .. | .. |
| – | – | – | – | – | – | – | – | – | .. | – | .. |
| 2.55 | 0.69 | 2.48 | 0.70 | 185.64 | 4.37 | 61.99 | 1.56 | 0.46 | .. | 0.87 | .. |
| 2.55 | 0.69 | 2.48 | 0.70 | 244.84 | 5.76 | 225.68 | 5.69 | 1.15 | .. | .. | .. |
| – | – | – | – | – | – | 2.76 | 0.07 | – | .. | – | .. |
| 4.46 | 1.20 | 4.35 | 1.23 | 15.00 | 0.35 | 43.97 | 1.11 | 11.42 | .. | 13.06 | .. |
| 5.10 | 1.37 | 4.97 | 1.40 | 40.87 | 0.96 | 70.25 | 1.77 | 0.54 | .. | .. | .. |
| 5.10 | 1.37 | 4.97 | 1.40 | 5.48 | 0.13 | – | – | 0.33 | .. | .. | .. |
| 14.66 | 3.95 | 14.29 | 4.04 | 61.33 | 1.44 | 116.98 | 2.95 | 12.28 | .. | .. | .. |
| **17.21** | **4.63** | **16.77** | **4.74** | **306.17** | **7.20** | **342.66** | **8.65** | **13.43** | **..** | **..** | **..** |
| 5.23 | 1.41 | 5.09 | 1.44 | – | – | – | – | 0.64 | .. | .. | .. |
| 13.13 | 3.54 | 12.80 | 3.61 | 101.40 | 2.39 | 182.69 | 4.61 | 3.47 | .. | 2.79 | .. |
| 43.10 | 11.60 | 41.99 | 11.86 | – | – | – | – | – | .. | – | .. |
| 61.46 | 16.55 | 59.88 | 16.91 | 101.40 | 2.39 | 182.69 | 4.61 | 4.11 | .. | .. | .. |
| 0.13 | 0.03 | 0.12 | 0.04 | 13.72 | 0.32 | 12.44 | 0.31 | 3.08 | .. | 2.33 | .. |
| – | – | – | – | – | – | – | – | 0.27 | .. | 0.26 | .. |
| 2.93 | 0.79 | 3.11 | 0.88 | 32.81 | 0.77 | 66.51 | 1.68 | 2.30 | .. | .. | .. |
| – | – | – | – | – | – | – | – | 0.69 | .. | .. | .. |
| – | – | – | – | – | – | – | – | 2.69 | .. | 7.20 | .. |
| – | – | – | – | 0.82 | 0.02 | – | – | 0.38 | .. | .. | .. |
| – | – | – | – | 0.82 | 0.02 | – | – | 3.07 | .. | .. | .. |
| **64.52** | **17.37** | **63.11** | **17.82** | **148.74** | **3.50** | **320.47** | **8.09** | **13.52** | **..** | **..** | **..** |
| – | – | – | – | 40.50 | 0.95 | 34.41 | 0.87 | – | .. | – | .. |
| – | – | – | – | 47.26 | 1.11 | 63.20 | 1.59 | – | .. | – | .. |
| 58.01 | 15.62 | 56.52 | 15.96 | 908.19 | 21.37 | 835.06 | 21.07 | 23.00 | .. | 24.03 | .. |
| – | – | – | – | 1 675.95 | 39.43 | 1 363.46 | 34.40 | 9.60 | .. | 9.09 | .. |
| – | – | – | – | 143.50 | 3.38 | 131.47 | 3.32 | – | .. | – | .. |
| 58.01 | 15.62 | 56.52 | 15.96 | 2 815.40 | 66.24 | 2 427.60 | 61.26 | 32.60 | .. | 33.12 | .. |
| 57.38 | 15.45 | 49.69 | 14.04 | 126.64 | 2.98 | 115.02 | 2.90 | – | .. | – | .. |
| **115.39** | **31.07** | **106.21** | **30.00** | **2 942.04** | **69.22** | **2 542.63** | **64.16** | **32.60** | **..** | **33.12** | **..** |
| 38.25 | 10.30 | 37.27 | 10.53 | 3.29 | 0.08 | – | – | 2.63 | .. | .. | .. |
| 45.90 | 12.36 | 44.72 | 12.63 | 23.14 | 0.54 | 58.39 | 1.47 | 21.00 | .. | 23.35 | .. |
| 15.56 | 4.19 | 15.16 | 4.28 | 14.59 | 0.34 | – | – | 2.46 | .. | 4.02 | .. |
| **99.71** | **26.85** | **97.14** | **27.44** | **41.01** | **0.96** | **58.39** | **1.47** | **26.09** | **..** | **..** | **..** |
| 12.75 | 3.43 | 12.42 | 3.51 | – | – | – | – | 2.45 | .. | .. | .. |
| 31.88 | 8.58 | 31.06 | 8.77 | 316.83 | 7.45 | 243.13 | 6.13 | 17.66 | .. | 15.28 | .. |
| **44.63** | **12.02** | **43.48** | **12.28** | **316.83** | **7.45** | **243.13** | **6.13** | **20.10** | **..** | **..** | **..** |
| **371.41** | **100.00** | **354.04** | **100.00** | **4 250.27** | **100.00** | **3 963.06** | **100.00** | **..** | **..** | **..** | **..** |

Table B13 *(continued)*

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | Luxembourg | | | | Netherlands | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| 1.1 Industry | .. | .. | .. | .. | 19.83 | 12.30 | 22.36 | 13.70 |
| 1.2 Residential, Commercial | .. | .. | .. | .. | 7.98 | 4.95 | 12.42 | 7.61 |
| 1.3 Transportation | .. | .. | .. | .. | 9.33 | 5.79 | 11.18 | 6.85 |
| 1.4 Other Conservation | .. | .. | .. | .. | 0.23 | 0.15 | 1.86 | 1.14 |
| **TOTAL CONSERVATION** | .. | .. | .. | .. | **37.37** | **23.18** | **47.83** | **29.30** |
| 2.1 Enhanced Oil & Gas | .. | .. | .. | .. | 9.40 | 5.83 | 9.32 | 5.71 |
| 2.2 Refining, Transp. & Stor. | .. | .. | .. | .. | 3.78 | 2.35 | 1.86 | 1.14 |
| 2.3 Oil Shale & Tar Sands | .. | .. | .. | .. | 0.47 | 0.29 | – | – |
| 2.4 Other Oil & Gas | .. | .. | .. | .. | – | – | 1.86 | 1.14 |
| Total Oil & Gas | .. | .. | .. | .. | 13.65 | 8.47 | 13.04 | 7.99 |
| 3.1 Coal Prod., Prep., & Trans. | .. | .. | .. | .. | 0.09 | 0.05 | – | – |
| 3.2 Coal Combustion | .. | .. | .. | .. | – | – | – | – |
| 3.3 Coal Conversion | .. | .. | .. | .. | 0.03 | 0.02 | – | – |
| 3.4 Other Coal | .. | .. | .. | .. | 2.69 | 1.67 | 2.48 | 1.52 |
| Total Coal | .. | .. | .. | .. | 2.81 | 1.74 | 2.48 | 1.52 |
| **TOTAL FOSSIL FUELS** | .. | .. | .. | .. | **16.46** | **10.21** | **15.53** | **9.51** |
| 4.1 Solar Heating & Cooling | .. | .. | .. | .. | 1.42 | 0.88 | 1.24 | 0.76 |
| 4.2 Solar Photo-Electric | .. | .. | .. | .. | 17.45 | 10.82 | 17.39 | 10.65 |
| 4.3 Solar Thermal-Electric | .. | .. | .. | .. | – | – | – | – |
| Total Solar | .. | .. | .. | .. | 18.87 | 11.71 | 18.63 | 11.42 |
| 5. Wind | .. | .. | .. | .. | 12.53 | 7.77 | 13.04 | 7.99 |
| 6. Ocean | .. | .. | .. | .. | 0.01 | 0.00 | – | – |
| 7. Biomass | .. | .. | .. | .. | 29.55 | 18.33 | 19.88 | 12.18 |
| 8. Geothermal | .. | .. | .. | .. | – | – | – | – |
| 9.1 Large Hydro (>10 MW) | .. | .. | .. | .. | – | – | – | – |
| 9.2 Small Hydro (<10 MW) | .. | .. | .. | .. | – | – | – | – |
| Total Hydro | .. | .. | .. | .. | – | – | – | – |
| **TOTAL RENEWABLE ENERGY** | .. | .. | .. | .. | **60.95** | **37.81** | **51.55** | **31.58** |
| 10.1 Nuclear LWR | .. | .. | .. | .. | 1.65 | 1.02 | 1.61 | 0.99 |
| 10.2 Other Converter Reactors | .. | .. | .. | .. | 1.93 | 1.19 | 1.86 | 1.14 |
| 10.3 Nuclear Fuel Cycle | .. | .. | .. | .. | 2.88 | 1.79 | 2.48 | 1.52 |
| 10.4 Nuclear Supporting Tech. | .. | .. | .. | .. | 3.23 | 2.00 | 3.73 | 2.28 |
| 10.5 Nuclear Breeder | .. | .. | .. | .. | 4.53 | 2.81 | 3.73 | 2.28 |
| Total Nuclear Fission | .. | .. | .. | .. | 14.21 | 8.82 | 13.42 | 8.22 |
| 11. Nuclear Fusion | .. | .. | .. | .. | 9.05 | 5.61 | 8.94 | 5.48 |
| **TOTAL NUCLEAR** | .. | .. | .. | .. | **23.27** | **14.43** | **22.36** | **13.70** |
| 12.1 Electric Power Conversion | .. | .. | .. | .. | 7.60 | 4.71 | 8.07 | 4.95 |
| 12.2 Electricity Transm., & Distr. | .. | .. | .. | .. | 5.73 | 3.55 | 3.11 | 1.90 |
| 12.3 Energy Storage | .. | .. | .. | .. | – | – | 0.50 | 0.30 |
| **TOTAL POWER & STORAGE** | .. | .. | .. | .. | **13.32** | **8.26** | **11.68** | **7.15** |
| 13.1 Energy Systems Analysis | .. | .. | .. | .. | 0.46 | 0.28 | 1.86 | 1.14 |
| 13.2 Other Tech. or Research | .. | .. | .. | .. | 9.40 | 5.83 | 12.42 | 7.61 |
| **TOTAL OTHER TECH./RESEARCH** | .. | .. | .. | .. | **9.86** | **6.11** | **14.29** | **8.75** |
| **TOTAL ENERGY R&D** | .. | .. | .. | .. | **161.23** | **100.00** | **163.23** | **100.00** |

Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

| New Zealand | | | | Norway | | | | Portugal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| – | – | 0.18 | 2.04 | 0.16 | 0.26 | 0.27 | 0.38 | 0.12 | 3.47 | 0.03 | 0.48 |
| 0.54 | 6.86 | 0.53 | 5.92 | 2.41 | 4.03 | 1.93 | 2.76 | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – |
| 0.54 | 6.82 | 0.52 | 5.84 | – | – | – | – | – | – | – | – |
| **1.09** | **13.68** | **1.23** | **13.80** | **2.57** | **4.29** | **2.20** | **3.14** | **0.12** | **3.47** | **0.03** | **0.48** |
| 2.64 | 33.26 | 2.79 | 31.26 | 5.96 | 9.97 | 7.86 | 11.26 | – | – | – | – |
| – | – | – | – | 2.38 | 3.98 | 2.95 | 4.23 | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – |
| 0.22 | 2.72 | 0.03 | 0.28 | 20.25 | 33.86 | 24.44 | 34.98 | 0.16 | 4.88 | 2.83 | 45.49 |
| 2.86 | 35.98 | 2.82 | 31.54 | 28.59 | 47.81 | 35.26 | 50.47 | 0.16 | 4.88 | 2.83 | 45.49 |
| – | – | – | – | – | – | – | – | 0.02 | 0.46 | 0.07 | 1.20 |
| – | – | – | – | – | – | – | – | 0.14 | 4.19 | 0.14 | 2.26 |
| – | – | – | – | – | – | – | – | 0.00 | 0.08 | – | – |
| – | – | – | – | – | – | – | – | 0.01 | 0.27 | 0.01 | 0.18 |
| – | – | – | – | – | – | – | – | 0.17 | 4.99 | 0.23 | 3.64 |
| **2.86** | **35.98** | **2.82** | **31.54** | **28.59** | **47.81** | **35.26** | **50.47** | **0.33** | **9.87** | **3.05** | **49.13** |
| – | – | – | – | 0.08 | 0.13 | 0.18 | 0.25 | 0.06 | 1.71 | 0.06 | 0.96 |
| 1.26 | 15.79 | 1.21 | 13.52 | 1.56 | 2.60 | 1.19 | 1.70 | 0.01 | 0.38 | 0.01 | 0.16 |
| 0.24 | 2.99 | 0.23 | 2.56 | – | – | – | – | – | – | – | – |
| 1.49 | 18.78 | 1.44 | 16.08 | 1.63 | 2.73 | 1.37 | 1.95 | 0.07 | 2.10 | 0.07 | 1.12 |
| – | – | – | – | 1.18 | 1.98 | 1.41 | 2.02 | – | – | 0.27 | 4.28 |
| – | – | – | – | 0.09 | 0.16 | 0.10 | 0.15 | 0.05 | 1.37 | 0.06 | 0.98 |
| 0.36 | 4.55 | 0.05 | 0.58 | 0.56 | 0.94 | 0.88 | 1.25 | 0.18 | 5.37 | 0.00 | 0.06 |
| 0.76 | 9.53 | 0.73 | 8.16 | 0.16 | 0.26 | – | – | 0.03 | 0.84 | – | – |
| – | – | 0.86 | 9.63 | 0.93 | 1.56 | 1.29 | 1.85 | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | 0.86 | 9.63 | 0.93 | 1.56 | 1.29 | 1.85 | – | – | – | – |
| **2.61** | **32.86** | **3.08** | **34.46** | **4.56** | **7.63** | **5.05** | **7.22** | **0.32** | **9.68** | **0.40** | **6.43** |
| – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | 3.89 | 6.51 | 4.82 | 6.90 | – | – | – | – |
| – | – | – | – | 5.45 | 9.11 | 5.27 | 7.54 | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | 9.34 | 15.61 | 10.09 | 14.44 | – | – | – | – |
| – | – | – | – | – | – | – | – | 2.54 | 76.22 | 2.73 | 43.96 |
| **–** | **–** | **–** | **–** | **9.34** | **15.61** | **10.09** | **14.44** | **2.54** | **76.22** | **2.73** | **43.96** |
| – | – | – | – | 1.34 | 2.24 | 0.45 | 0.64 | – | – | – | – |
| – | – | – | – | 2.49 | 4.16 | 2.57 | 3.67 | – | – | – | – |
| – | – | – | – | 0.87 | 1.46 | 0.31 | 0.45 | – | – | – | – |
| **–** | **–** | **–** | **–** | **4.70** | **7.86** | **3.32** | **4.76** | **–** | **–** | **–** | **–** |
| 0.56 | 6.99 | 0.70 | 7.84 | 2.42 | 4.05 | 2.34 | 3.36 | – | – | – | – |
| 0.83 | 10.49 | 1.10 | 12.36 | 7.63 | 12.75 | 11.60 | 16.61 | 0.03 | 0.76 | – | – |
| **1.39** | **17.48** | **1.80** | **20.20** | **10.05** | **16.80** | **13.95** | **19.97** | **0.03** | **0.76** | **–** | **–** |
| **7.95** | **100.00** | **8.93** | **100.00** | **59.80** | **100.00** | **69.86** | **100.00** | **3.34** | **100.00** | **6.22** | **100.00** |

Table B13 *(continued)*

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | Spain | | | | Sweden | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 USD | % | 2004e USD | % | 2003 USD | % | 2004e USD | % |
| 1.1 Industry | 1.31 | 1.83 | 1.59 | 1.79 | 16.66 | 13.89 | 17.28 | 13.27 |
| 1.2 Residential, Commercial | 2.20 | 3.05 | 2.65 | 3.00 | 6.19 | 5.16 | 3.43 | 2.64 |
| 1.3 Transportation | 1.75 | 2.43 | 2.11 | 2.39 | 29.99 | 25.00 | 26.26 | 20.16 |
| 1.4 Other Conservation | – | – | – | – | 3.67 | 3.06 | 3.81 | 2.93 |
| **TOTAL CONSERVATION** | **5.26** | **7.31** | **6.34** | **7.18** | **56.51** | **47.10** | **50.79** | **39.00** |
| 2.1 Enhanced Oil & Gas | – | – | – | – | – | – | – | – |
| 2.2 Refining, Transp. & Stor. | – | – | – | – | – | – | – | – |
| 2.3 Oil Shale & Tar Sands | – | – | – | – | – | – | – | – |
| 2.4 Other Oil & Gas | – | – | – | – | – | – | – | – |
| Total Oil & Gas | – | – | – | – | – | – | – | – |
| 3.1 Coal Prod., Prep., & Trans. | – | – | – | – | – | – | – | – |
| 3.2 Coal Combustion | 3.78 | 5.25 | 5.48 | 6.20 | – | – | – | – |
| 3.3 Coal Conversion | – | – | – | – | – | – | – | – |
| 3.4 Other Coal | – | – | – | – | 0.16 | 0.13 | 0.03 | 0.02 |
| Total Coal | 3.78 | 5.25 | 5.48 | 6.20 | 0.16 | 0.13 | 0.03 | 0.02 |
| **TOTAL FOSSIL FUELS** | **3.78** | **5.25** | **5.48** | **6.20** | **0.16** | **0.13** | **0.03** | **0.02** |
| 4.1 Solar Heating & Cooling | 0.30 | 0.42 | 0.37 | 0.42 | 2.09 | 1.74 | 0.99 | 0.76 |
| 4.2 Solar Photo-Electric | 6.55 | 9.10 | 7.50 | 8.49 | 3.08 | 2.57 | 4.43 | 3.40 |
| 4.3 Solar Thermal-Electric | 10.15 | 14.11 | 12.81 | 14.51 | – | – | – | – |
| Total Solar | 17.00 | 23.63 | 20.69 | 23.42 | 5.17 | 4.31 | 5.42 | 4.16 |
| 5. Wind | 4.28 | 5.94 | 6.87 | 7.77 | 3.98 | 3.31 | 5.05 | 3.87 |
| 6. Ocean | – | – | – | – | – | – | – | – |
| 7. Biomass | 5.24 | 7.29 | 7.83 | 8.86 | 14.58 | 12.15 | 17.52 | 13.45 |
| 8. Geothermal | – | – | – | – | 1.46 | 1.22 | 0.07 | 0.05 |
| 9.1 Large Hydro (>10 MW) | – | – | – | – | – | – | – | – |
| 9.2 Small Hydro (<10 MW) | – | – | – | – | 1.07 | 0.89 | 0.80 | 0.61 |
| Total Hydro | – | – | – | – | 1.07 | 0.89 | 0.80 | 0.61 |
| **TOTAL RENEWABLE ENERGY** | **26.52** | **36.86** | **35.38** | **40.05** | **26.25** | **21.88** | **28.86** | **22.15** |
| 10.1 Nuclear LWR | – | – | – | – | 5.31 | 4.42 | 5.24 | 4.02 |
| 10.2 Other Converter Reactors | – | – | – | – | – | – | – | – |
| 10.3 Nuclear Fuel Cycle | 10.84 | 15.06 | 12.25 | 13.87 | – | – | – | – |
| 10.4 Nuclear Supporting Tech. | 7.97 | 11.08 | 9.47 | 10.72 | – | – | – | – |
| 10.5 Nuclear Breeder | – | – | – | – | – | – | – | – |
| Total Nuclear Fission | 18.81 | 26.14 | 21.73 | 24.59 | 5.31 | 4.42 | 5.24 | 4.02 |
| 11. Nuclear Fusion | 13.61 | 18.91 | 15.07 | 17.06 | 1.54 | 1.29 | 1.52 | 1.17 |
| **TOTAL NUCLEAR** | **32.42** | **45.06** | **36.80** | **41.65** | **6.85** | **5.71** | **6.77** | **5.19** |
| 12.1 Electric Power Conversion | – | – | – | – | 11.65 | 9.71 | 17.21 | 13.21 |
| 12.2 Electricity Transm., & Distr. | 0.64 | 0.89 | 0.70 | 0.79 | 1.80 | 1.50 | 1.07 | 0.82 |
| 12.3 Energy Storage | – | – | – | – | 1.50 | 1.25 | 0.83 | 0.64 |
| **TOTAL POWER & STORAGE** | **0.64** | **0.89** | **0.70** | **0.79** | **14.95** | **12.46** | **19.12** | **14.68** |
| 13.1 Energy Systems Analysis | 0.16 | 0.22 | 0.18 | 0.20 | 4.64 | 3.86 | 6.84 | 5.25 |
| 13.2 Other Tech. or Research | 3.18 | 4.41 | 3.47 | 3.92 | 10.60 | 8.84 | 17.86 | 13.71 |
| **TOTAL OTHER TECH./RESEARCH** | **3.34** | **4.64** | **3.64** | **4.12** | **15.24** | **12.70** | **24.69** | **18.96** |
| **TOTAL ENERGY R&D** | **71.96** | **100.00** | **88.35** | **100.00** | **119.97** | **100.00** | **130.26** | **100.00** |

1. Data for Turkey refer to New Turkish Lira.
Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

| Switzerland 2003 USD | % | 2004e USD | % | Turkey[1] 2003 USD | % | 2004e USD | % | United Kingdom 2003 USD | % | 2004e USD | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.87 | 1.25 | 2.01 | 1.33 | 0.01 | 0.22 | 0.01 | 0.13 | – | – | – | – |
| 7.58 | 5.09 | 7.64 | 5.07 | – | – | 0.00 | 0.02 | – | – | – | – |
| 6.57 | 4.41 | 7.24 | 4.80 | – | – | 0.00 | 0.02 | – | – | – | – |
| 4.49 | 3.01 | 4.83 | 3.20 | 0.38 | 9.69 | 0.04 | 0.72 | – | – | – | – |
| **20.50** | **13.76** | **21.72** | **14.40** | **0.39** | **9.90** | **0.05** | **0.89** | **–** | **–** | **–** | **–** |
| 11.86 | 7.96 | 11.67 | 7.73 | 0.06 | 1.45 | 0.04 | 0.61 | – | – | – | – |
| – | – | – | – | 0.03 | 0.71 | 0.03 | 0.56 | – | – | – | – |
| – | – | – | – | 0.02 | 0.61 | 0.03 | 0.46 | – | – | – | – |
| – | – | – | – | 0.31 | 7.94 | 0.41 | 6.90 | 1.70 | 2.66 | 1.83 | 2.77 |
| 11.86 | 7.96 | 11.67 | 7.73 | 0.42 | 10.71 | 0.51 | 8.54 | 1.70 | 2.66 | 1.83 | 2.77 |
| – | – | – | – | 0.65 | 16.64 | 0.57 | 9.67 | – | – | – | – |
| – | – | – | – | 0.03 | 0.71 | 0.04 | 0.64 | 3.85 | 6.02 | 5.09 | 7.69 |
| – | – | – | – | 0.03 | 0.77 | 0.04 | 0.59 | – | – | – | – |
| – | – | – | – | 0.02 | 0.45 | 0.04 | 0.65 | – | – | – | – |
| – | – | – | – | 0.73 | 18.59 | 0.69 | 11.55 | 3.85 | 6.02 | 5.09 | 7.69 |
| **11.86** | **7.96** | **11.67** | **7.73** | **1.15** | **29.30** | **1.19** | **20.09** | **5.55** | **8.69** | **6.92** | **10.46** |
| 5.42 | 3.64 | 5.63 | 3.73 | 0.11 | 2.81 | 0.11 | 1.80 | – | – | – | – |
| 11.15 | 7.48 | 12.07 | 8.00 | 0.06 | 1.49 | 0.09 | 1.58 | 7.48 | 11.71 | 7.33 | 11.07 |
| 6.68 | 4.48 | 6.84 | 4.53 | 0.00 | 0.10 | 0.01 | 0.22 | – | – | – | – |
| 23.25 | 15.60 | 24.54 | 16.27 | 0.17 | 4.38 | 0.21 | 3.59 | 7.48 | 11.71 | 7.33 | 11.07 |
| 0.83 | 0.56 | 1.21 | 0.80 | 0.07 | 1.75 | 0.09 | 1.58 | 4.49 | 7.03 | 4.40 | 6.64 |
| – | – | – | – | – | – | – | – | 3.74 | 5.85 | 3.66 | 5.53 |
| 5.82 | 3.91 | 6.03 | 4.00 | 0.16 | 4.01 | 0.28 | 4.79 | 5.61 | 8.78 | 5.49 | 8.30 |
| 2.23 | 1.50 | 2.41 | 1.60 | 0.32 | 8.25 | 1.42 | 23.94 | – | – | – | – |
| 2.08 | 1.39 | 2.41 | 1.60 | – | – | – | – | – | – | – | – |
| 1.62 | 1.09 | 1.61 | 1.07 | 0.03 | 0.69 | 0.03 | 0.44 | 0.37 | 0.59 | 0.55 | 0.83 |
| 3.70 | 2.48 | 4.02 | 2.67 | 0.03 | 0.69 | 0.03 | 0.44 | 0.37 | 0.59 | 0.55 | 0.83 |
| **35.84** | **24.05** | **38.21** | **25.33** | **0.75** | **19.08** | **2.04** | **34.35** | **21.70** | **33.96** | **21.43** | **32.37** |
| 4.87 | 3.27 | 4.83 | 3.20 | 0.00 | 0.04 | 0.00 | 0.02 | – | – | – | – |
| 2.28 | 1.53 | 2.41 | 1.60 | – | – | – | – | – | – | – | – |
| 5.99 | 4.02 | 5.63 | 3.73 | 0.05 | 1.24 | 0.57 | 9.66 | – | – | – | – |
| 12.12 | 8.13 | 11.26 | 7.47 | 0.29 | 7.39 | 0.50 | 8.37 | 0.36 | 0.56 | 0.11 | 0.16 |
| – | – | – | – | – | – | – | – | – | – | – | – |
| 25.26 | 16.95 | 24.14 | 16.00 | 0.34 | 8.67 | 1.07 | 18.05 | 0.36 | 0.56 | 0.11 | 0.16 |
| 18.43 | 12.37 | 18.50 | 12.27 | – | – | – | – | 29.94 | 46.84 | 29.30 | 44.26 |
| **43.69** | **29.32** | **42.64** | **28.27** | **0.34** | **8.67** | **1.07** | **18.05** | **30.30** | **47.40** | **29.41** | **44.42** |
| 8.07 | 5.42 | 8.05 | 5.33 | 0.00 | 0.02 | 0.00 | 0.01 | 1.31 | 2.05 | 1.28 | 1.94 |
| 6.25 | 4.19 | 6.44 | 4.27 | 0.80 | 20.40 | 0.38 | 6.47 | 2.43 | 3.81 | 4.60 | 6.94 |
| 8.03 | 5.39 | 7.24 | 4.80 | 0.02 | 0.59 | 0.08 | 1.42 | 1.87 | 2.93 | 1.83 | 2.77 |
| **22.35** | **15.00** | **21.72** | **14.40** | **0.82** | **21.01** | **0.47** | **7.90** | **5.61** | **8.78** | **7.71** | **11.65** |
| 12.47 | 8.37 | 12.47 | 8.27 | 0.03 | 0.84 | 0.01 | 0.20 | – | – | – | – |
| 2.31 | 1.55 | 2.41 | 1.60 | 0.44 | 11.22 | 1.10 | 18.54 | 0.75 | 1.17 | 0.73 | 1.11 |
| **14.77** | **9.92** | **14.88** | **9.87** | **0.47** | **12.07** | **1.11** | **18.73** | **0.75** | **1.17** | **0.73** | **1.11** |
| **149.01** | **100.00** | **150.84** | **100.00** | **3.92** | **100.00** | **5.93** | **100.00** | **63.92** | **100.00** | **66.21** | **100.00** |

Table B13 *(continued)*

## IEA Government Energy R&D Expenditure by Country, 2003 and 2004

(USD million at 2004 prices and exchange rates)

| | United States | | | |
|---|---|---|---|---|
| | 2003 USD | % | 2004e USD | % |
| 1.1 Industry | 98.83 | 3.52 | 93.07 | 3.27 |
| 1.2 Residential, Commercial | 59.54 | 2.12 | 59.87 | 2.10 |
| 1.3 Transportation | 177.79 | 6.33 | 178.00 | 6.24 |
| 1.4 Other Conservation | 63.79 | 2.27 | 61.02 | 2.14 |
| **TOTAL CONSERVATION** | **399.95** | **14.25** | **391.96** | **13.75** |
| 2.1 Enhanced Oil & Gas | 64.64 | 2.30 | 56.95 | 2.00 |
| 2.2 Refining, Transp. & Stor. | 11.61 | 0.41 | 8.94 | 0.31 |
| 2.3 Oil Shale & Tar Sands | – | – | – | – |
| 2.4 Other Oil & Gas | 12.40 | 0.44 | 12.18 | 0.43 |
| Total Oil & Gas | 88.65 | 3.16 | 78.07 | 2.74 |
| 3.1 Coal Prod., Prep., & Trans. | 5.93 | 0.21 | 5.99 | 0.21 |
| 3.2 Coal Combustion | 228.63 | 8.14 | 265.44 | 9.31 |
| 3.3 Coal Conversion | 21.88 | 0.78 | 21.93 | 0.77 |
| 3.4 Other Coal | 79.46 | 2.83 | 79.61 | 2.79 |
| Total Coal | 335.89 | 11.97 | 372.96 | 13.08 |
| **TOTAL FOSSIL FUELS** | **424.53** | **15.12** | **451.03** | **15.82** |
| 4.1 Solar Heating & Cooling | .. | .. | .. | .. |
| 4.2 Solar Photo-Electric | .. | .. | .. | .. |
| 4.3 Solar Thermal-Electric | .. | .. | .. | .. |
| Total Solar | 84.04 | 2.99 | 83.39 | 2.93 |
| 5. Wind | 42.50 | 1.51 | 41.31 | 1.45 |
| 6. Ocean | – | – | – | – |
| 7. Biomass | 87.05 | 3.10 | 86.47 | 3.03 |
| 8. Geothermal | 28.98 | 1.03 | 25.51 | 0.89 |
| 9.1 Large Hydro (>10 MW) | .. | .. | .. | .. |
| 9.2 Small Hydro (<10 MW) | .. | .. | .. | .. |
| Total Hydro | 5.12 | 0.18 | 4.91 | 0.17 |
| **TOTAL RENEWABLE ENERGY** | **247.70** | **8.82** | **241.59** | **8.48** |
| 10.1 Nuclear LWR | .. | .. | .. | .. |
| 10.2 Other Converter Reactors | .. | .. | .. | .. |
| 10.3 Nuclear Fuel Cycle | .. | .. | .. | .. |
| 10.4 Nuclear Supporting Tech. | 132.73 | 4.73 | 129.99 | 4.56 |
| 10.5 Nuclear Breeder | – | – | – | – |
| Total Nuclear Fission | 132.73 | 4.73 | 129.99 | 4.56 |
| 11. Nuclear Fusion | 245.69 | 8.75 | 262.56 | 9.21 |
| **TOTAL NUCLEAR** | **378.42** | **13.48** | **392.55** | **13.77** |
| 12.1 Electric Power Conversion | 80.19 | 2.86 | 83.95 | 2.95 |
| 12.2 Electricity Transm., & Distr. | .. | .. | .. | .. |
| 12.3 Energy Storage | 87.02 | 3.10 | 76.39 | 2.68 |
| **TOTAL POWER & STORAGE** | **167.22** | **5.96** | **160.35** | **5.63** |
| 13.1 Energy Systems Analysis | .. | .. | .. | .. |
| 13.2 Other Tech. or Research | 1 189.31 | 42.37 | 1 212.88 | 42.55 |
| **TOTAL OTHER TECH./RESEARCH** | **1 189.31** | **42.37** | **1 212.88** | **42.55** |
| **TOTAL ENERGY R&D** | **2 807.12** | **100.00** | **2 850.35** | **100.00** |

Note: Budgets provided for recent years by some countries may have been estimated.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

## Table B14

# Estimated IEA[1] Government Energy R&D Expenditure

(USD million at 2004 prices and exchange rates)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004e |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry | 301.6 | 401.5 | 423.2 | 438.9 | 455.3 | 677.6 | 763.3 | 784.5 | 829.6 | 710.8 | 538.8 | 505.1 |
| Residential/Commercial | 169.9 | 292.7 | 321.6 | 295.4 | 247.9 | 249.1 | 284.6 | 247.8 | 281.3 | 230.2 | 163.1 | 164.8 |
| Transportation | 258.6 | 350.1 | 394.6 | 350.4 | 325.3 | 317.9 | 331.5 | 350.5 | 387.1 | 398.0 | 303.0 | 296.5 |
| Other Conservation | 87.9 | 71.8 | 75.6 | 66.4 | 64.5 | 68.5 | 67.3 | 101.0 | 110.2 | 273.7 | 198.2 | 185.4 |
| **TOTAL CONSERVATION** | **818.1** | **1116.1** | **1215.1** | **1151.1** | **1093.0** | **1313.0** | **1446.7** | **1483.8** | **1608.1** | **1612.7** | **1203.1** | **1151.8** |
| Enhanced Oil & Gas | 240.6 | 152.1 | 159.7 | 115.3 | 108.0 | 136.6 | 137.5 | 128.7 | 139.3 | 120.0 | 98.3 | 93.3 |
| Other Shale & Tar Sands | 19.3 | 21.6 | 17.2 | 27.0 | 32.0 | 33.5 | 16.4 | 17.6 | 20.7 | 18.0 | 22.3 | 18.2 |
| Other Oil & Gas[2] | 270.3 | 282.9 | 300.0 | 296.4 | 309.2 | 230.5 | 177.1 | 178.7 | 199.6 | 457.9 | 396.5 | 385.8 |
| Coal Combustion | 137.8 | 510.7 | 260.8 | 341.6 | 161.4 | 145.3 | 150.9 | 114.8 | 231.9 | 279.1 | 272.7 | 341.6 |
| Coal Conversion | 165.2 | 173.7 | 182.9 | 169.2 | 128.3 | 119.8 | 98.3 | 70.7 | 38.0 | 77.0 | 71.8 | 100.7 |
| Other Coal[3] | 368.0 | 145.9 | 111.5 | 87.8 | 74.0 | 69.8 | 85.2 | 81.2 | 104.9 | 125.9 | 127.1 | 126.5 |
| **TOTAL FOSSIL FUELS** | **1201.2** | **1286.9** | **1032.1** | **1037.3** | **813.0** | **735.8** | **665.4** | **591.6** | **734.4** | **1077.8** | **988.6** | **1066.0** |
| Solar Heating and Cooling | 70.9 | 71.1 | 59.5 | 40.6 | 42.8 | 40.5 | 37.6 | 49.4 | 42.1 | 39.4 | 38.4 | 43.4 |
| Solar Photo Electric | 275.2 | 256.3 | 276.3 | 255.8 | 253.8 | 286.3 | 305.8 | 320.6 | 294.5 | 308.4 | 300.6 | 376.8 |
| Solar Thermal Electric | 62.9 | 72.7 | 58.6 | 51.7 | 50.7 | 36.3 | 38.5 | 26.0 | 52.0 | 86.8 | 73.5 | 80.5 |
| Wind | 99.6 | 104.3 | 132.2 | 128.5 | 109.2 | 118.5 | 119.9 | 102.2 | 120.4 | 115.8 | 121.5 | 122.9 |
| Ocean | 5.2 | 4.7 | 2.7 | 2.5 | 2.4 | 12.9 | 8.0 | 8.7 | 12.1 | 5.2 | 4.1 | 3.8 |
| Biomass | 100.1 | 158.4 | 163.3 | 149.7 | 150.9 | 204.6 | 198.4 | 173.8 | 207.3 | 225.6 | 231.5 | 261.5 |
| Geothermal | 86.2 | 69.3 | 85.8 | 75.9 | 73.9 | 73.5 | 72.9 | 60.6 | 71.9 | 75.1 | 56.5 | 46.6 |
| Large Hydro (>10MW) | 9.9 | 11.8 | 14.7 | 10.7 | 8.7 | 7.6 | 8.1 | 13.9 | 11.7 | 11.5 | 10.1 | 11.7 |
| Small Hydro (<10MW) | 1.8 | 2.1 | 2.2 | 3.6 | 4.0 | 4.0 | 8.7 | 5.6 | 7.1 | 15.3 | 17.5 | 17.9 |
| **TOTAL RENEWABLE ENERGY** | **711.9** | **750.7** | **795.2** | **719.0** | **696.4** | **784.2** | **798.0** | **760.9** | **819.2** | **883.1** | **853.6** | **1024.1** |
| **Total Nuclear Fission** | **3691.8** | **3528.1** | **3656.2** | **3603.3** | **3456.8** | **3371.3** | **3428.2** | **3454.0** | **3252.6** | **3560.2** | **3564.8** | **3114.9** |
| **Nuclear Fusion** | **1165.6** | **1115.5** | **1110.1** | **998.6** | **965.1** | **895.8** | **812.9** | **885.4** | **830.4** | **697.5** | **710.5** | **707.3** |
| Electric Power Conversion | 155.7 | 230.0 | 205.4 | 209.8 | 220.5 | 259.1 | 261.2 | 309.3 | 351.3 | 232.7 | 232.3 | 230.8 |
| Electricity Transm. & Distr. | 60.8 | 104.4 | 107.3 | 96.3 | 91.2 | 105.8 | 109.6 | 164.7 | 190.5 | 122.8 | 109.6 | 141.7 |
| Energy Storage | 53.2 | 57.2 | 53.6 | 50.4 | 62.0 | 61.1 | 75.7 | 85.0 | 82.0 | 156.3 | 150.9 | 117.8 |
| **TOTAL POWER & STORAGE** | **269.6** | **391.7** | **366.2** | **356.4** | **373.7** | **426.1** | **446.5** | **559.0** | **623.8** | **511.8** | **492.8** | **490.2** |
| **TOTAL OTHER TECH./RESEARCH** | **1381.3** | **1270.2** | **1239.0** | **1238.9** | **1273.7** | **1222.0** | **1366.0** | **1282.8** | **1575.8** | **1774.9** | **1836.5** | **1810.1** |
| **TOTAL ENERGY R&D** | **9239.5** | **9459.2** | **9414.0** | **9104.7** | **8671.6** | **8748.2** | **8963.7** | **9017.5** | **9444.3** | **10118.0** | **9649.9** | **9364.4** |

1. IEA totals include estimates where data are not available. Due to missing data, the following countries have not been inlcuded in the total: the Czech Republic, Greece, Hungary, Ireland, Korea and Luxembourg.
2. Other Oil & Gas includes refining, transportation and storage.
3. Other Coal includes production, preparation and transport.
Sources: *OECD Economic Outlook No 77*, OECD Paris, 2005, and country submissions.

# INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

Member countries of the IEA* seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a sub-stantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. **The environmentally sustainable provision and use of energy** is central to the achieve-ment of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.

4. **More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA members wish to retain and improve the

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. **Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are signifi-cant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. **Co-operation among all energy market participants** helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

# GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. Although these terms are generally written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

| | |
|---|---|
| AHGSET | Ad-Hoc Group on Science and Energy Technologies |
| AMEM | ASEAN Ministers on Energy Meeting |
| APEC | Asian Pacific Economic Co-operation |
| APG | ASEAN Power Grid |
| APSA | ASEAN Petroleum Security Agreement |
| ASCOPE | ASEAN Council on Petroleum |
| ASEAN | Association of South East Asian Nations |
| | |
| bcf | billion cubic feet |
| bcm | billion cubic metres |
| | |
| CCGT | combined-cycle gas turbine |
| CCS | carbon capture and storage |
| CDM | Clean Development Mechanisms |
| CERM | Co-ordinated Emergency Response Mechanism |
| CHF | Swiss franc |
| CHP | combined production of heat and power; sometimes, when referring to industrial CHP, the term "co-generation" is used |
| $CO_2$ | carbon dioxide |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CSLF | Carbon Sequestration Leadership Forum |
| | |
| EEA | European Economic Area |
| EFTA | European Free Trade Association |
| ERGEG | Energy Regulators Groups for Electricity and Gas |
| ETSO | European Transmission System Operators |
| EU | The European Union, whose 25 members are Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, |

| | |
|---|---|
| | Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom |
| EU-ETS | European Union GHG Emissions Trading Scheme |
| EuroPex | European Power Exchanges |
| FERC | Federal Electricity Regulatory Commission |
| FSU | former Soviet Union |
| GDP | gross domestic product |
| GGP | Guidelines for Good Practice |
| GHG | greenhouse gas |
| HAPUA | Heads of ASEAN Power Utilities and Authorities |
| IA | Implementing Agreement |
| IEA | International Energy Agency whose members are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States |
| IEF | International Energy Forum |
| IEP | International Energy Program |
| IPP | independent power producers |
| ISO | independent system operator |
| JCC | Japanese crude cocktail |
| JI | Joint Implementation |
| JODI | Joint Oil Data Initiative |
| kb/d | thousand barrels per day |
| kWh | kilowatt-hour, or one kilowatt x one hour, or one watt x one hour x $10^3$ |
| LNG | liquefied natural gas |
| LPG | liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature |
| LSFO | low-sulphur fuel oil |

| | |
|---|---|
| mb/d | million barrels per day |
| MBtu | million British thermal units |
| mcm | million cubic metres |
| MEDT | Ministry of Economic Development and Trade |
| MENA | Middle East and North Africa |
| Mt | million tonnes |
| Mtoe | million tonnes of oil equivalent; see toe |
| NAP | National Allocation Plan |
| NBP | National Balancing Point (UK) |
| NGO | non-governmental organisation |
| NIMBY | not in my back yard |
| NYMEX | New York Mercantile Exchange |
| OECD | Organisation for Economic Co-operation and Development |
| OPEC | Organization of the Petroleum Exporting Countries |
| PPPs | purchasing power parities |
| PV | photovoltaic |
| R&D | research and development |
| RD&D | research, development and demonstration |
| RES | renewable energy sources |
| RETD | Renewable Energy Technology Deployment |
| REWD | Renewable Energy Working Party |
| RTO | regional transmission organisations |
| SARS | Severe Acute Respiratory Syndrome |
| SLT | Standing Group for Long-term Co-operation |
| SOME | ASEAN Senior Officials Meeting on Energy |
| TAGP | Trans ASEAN Gas Pipeline |
| tcf | trillion cubic feet |
| TFC | total final consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses |
| toe | tonne of oil equivalent, defined as $10^7$ kcal |

| | |
|---|---|
| TPA | third-party access |
| TPES | total primary energy supply |
| TSO | transmission system operator |
| UNCTAD | United Nations Conference on Trade and Development |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WEO | World Energy Outlook |
| WTI | West Texas Intermediate |
| WPFF | Working Party on Fossil Fuels |
| ZET | zero emissions technologies |
| 1Q | first quarter |
| 2Q | second quarter |
| 3Q | third quarter |
| 4Q | fourth quarter |

## Average exchange rates in 2004 were as follows:

| | | |
|---|---|---|
| Australia | AUD 1 | = USD 0.734 |
| Euro | EUR 1 | = USD 1.237 |
| Canada | CAD 1 | = USD 0.768 |
| Czech Republic | CZK 1 | = USD 0.039 |
| Denmark | DKK 1 | = USD 0.166 |
| Hungary | HUF 1 | = USD 0.005 |
| Japan | JPY 1 | = USD 0.009 |
| Korea | KRW 1 | = USD 0.0009 |
| New Zealand | NZD 1 | = USD 0.661 |
| Norway | NOK 1 | = USD 0.148 |
| Sweden | SEK 1 | = USD 0.136 |
| Switzerland | CHF 1 | = USD 0.802 |
| Turkey | TRL 1 000 | = USD 0.0007 |
| United Kingdom | GBP 1 | = USD 1.824 |

# FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Includes lignite and peat, except for Finland, Ireland and Sweden. In these three cases, peat is shown separately.
2. Comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Other includes tide, wave and ambient heat used in heat pumps.
4. Total net imports include combustible renewables and waste.
5. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
6. Includes non-energy use.
7. Includes less than 1% non-oil fuels.
8. Includes residential, commercial, public service and agricultural sectors.
9. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
10. Losses arising in the production of electricity and heat at main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear, 10% for geothermal and 100% for hydro.
11. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
12. Toe per thousand US dollars at 2000 prices and exchange rates.
13. Toe per person.
14. "Energy-related $CO_2$ emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2003 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

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