INTERNATIONAL ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE

LESSONS LEARNED FROM THE ENERGY POLICIES OF IEA COUNTRIES

Key Cross-cutting Issues 2007/2008

IEA INFORMATION PAPER

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-eight of the thirty OECD 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 international oil markets.
- To provide data on other aspects of international energy markets.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies, including relating to climate change.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea (Republic of)
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates 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.

International Energy Agency (IEA)
9 rue de la Fédération, 75739 Paris Cedex 15, France

LESSONS LEARNED FROM THE ENERGY POLICIES OF IEA COUNTRIES

Key Cross-cutting Issues
2007/2008

INTERNATIONAL ENERGY AGENCY


INTERNATIONAL ENERGY AGENCY
Visit us at http://data.iea.org
to access to the IEA statistics
data of this publication
The Energy Statistics Division provides an online data service containing the complete databases which are used for preparing the statistics publications. State-of-the-art software allows you to access and manipulate all these data in a very user-friendly manner and includes graphic facilities.

Table of Contents

Acknowledgements

Some of the information in this paper is drawn from in-depth reviews conducted by experts of the IEA member countries and the IEA Secretariat, as well as from published material or information provided directly by the IEA countries reviewed. The information is the best available as of September 2008 and is subject to change.

The figures of Key Statistics and Indicators are based on data contained in the 2008 edition of the IEA online data service released in December 2008. Detailed information on this service can be found at the beginning of the statistics section.

Hisashi Yoshikawa, the former head of the Country Studies Division, and Shinji Fujino, its present head, supervised preparations for this publication with the help of Takatoshi Kano and Akira Yabumoto. Neil Hirst, the Director of the Global Energy Dialog, and Pieter Boot, the former director of the Directorate of Sustainable Energy Policy and Technology, provided support and encouragement throughout the project. The major contributors are Jolanka Fisher, Miika Tommila and Takatoshi Kano. Aad Van Bohemen, Richard Baron and Amos Bromhead provided very useful suggestions and feedback on the studies. Karen Treanton, Christine Caralis, Yasmina Abdelilah and Erdinç Pinar prepared Key Statistics and Indicators, Monica Petit prepared the figures and Marilyn Ferris provided administrative assistance for the project. Rebecca Gaghen, Muriel Custodio, Corinne Hayworth, Bertrand Sadin, Virginie Buschini, Marilyn Smith and Delphine Grandrieux from the Communication and Information Office provided substantial help in producing this publication. Viviane Consoli proofread the text.

Introduction

Energy policy studies

IEA member countries are all committed to IEA "Shared Goals" of energy policy. Each country's energy policies are subject to peer in-depth review by a team of experts drawn from other IEA members and supported by the staff of the IEA's Country Studies Division (CSD). The staff of CSD therefore have a unique "helicopter view" of the different approaches that member countries are adopting to attain these goals. In 2008, for the first time, we invited them to carry out some comparative studies in the belief that, for policy makers and managers facing tough energy policy challenges, it may be useful to have a wider perspective of how the same issues are being addressed by different IEA member countries. These studies do not necessarily prove that one approach is better than another – though there are some cases where we think this is so – but they do provide a wider international perspective.

The topics of studies carried out this year are:

- Government structures for co-ordinating energy and climate policies
- The use of long-term energy forecasts and scenarios
- Progress in the delivery of key energy security policies

The third of these topics has a slightly different origin and is partly based on an analysis, delivered by the IEA to the 2008 Hokkaido Summit, of self-evaluations by G8 member countries of their progress under the St. Petersburg Energy Security Principles.

These studies are made based on the information best available as of September 2008, before the global financial crisis.

Government structures for co-ordinating energy and climate policy

The objectives of governments' climate policies are largely matters of environmental policy, but most measures for reducing emissions fall within the energy sector and have therefore energy policy implications. As climate change mitigation has risen up the policy agenda, and increasingly demanding targets and policy measures have been adopted, the need to co-ordinate environmental and energy policies has become crucial as governments have adopted a variety of institutional approaches.

This study only covers countries that have been recently reviewed by the IEA. In most of the reviews (Italy, the Netherlands, Spain, Sweden, Turkey, and the European Union,) the Environment Ministry / Directorate has the overall lead on climate change policies. However, to varying degrees, formal structures are in place to co-ordinate with other key departments, such as energy, industry, housing, agriculture, local government and forestry. In Italy, Spain and Turkey, formal interministerial committees, or sometimes ministerial policy committees supported by a more technical official committee, play a major role. In Spain, the interministerial group responsible for the

implementation of the national strategy is chaired by the Ministry of Economic Affairs. In the Netherlands, an interministerial agreement provides clearly defined responsibilities to each ministry. In Sweden, much of the policy work is delegated to national agencies, notably the Environmental Protection Agency and the Energy Agency. The decision-making process in the EU Commission relies heavily on internal consultations with the relevant Directorates-General.

In Japan, the body in charge of climate change policy is the Global Warming Prevention Headquarters, chaired by the Prime Minister, with the Cabinet Secretary, the Minister of the Environment, and the Minister of Economy, Trade and Industry as vice chairs.

Although not covered in detail in this study, it is interesting to note that both France and the United Kingdom have recently restructured so as to bring climate change and energy together in the same ministry. The French ministry (Department of Ecology, Energy, Sustainable Development, and Planning) has much wider responsibilities than the UK ministry (Department for Energy and Climate Change), but it combines its energy and climate change responsibilities in the same directorate.

No doubt these approaches reflect national cultures and a range of structures can be made to work if implemented in the right spirit. But however this is achieved, it is essential that Energy Ministries should be able to perform their essential roles of ensuring that policies to mitigate climate change are compatible with other energy policy goals and are implemented, in the energy sector, through the most cost-effective measures.

The use of long-term forecasts and scenarios

This study shows that almost all of the countries reviewed use long-term energy forecasts and scenarios, but with interesting differences in their nature, their purpose and their audiences.

Most countries project trends to 2030, and a few to 2020 or 2040. In almost all cases, demand and supply balances, especially in the power sector, are among the major outputs. In many cases, the output also includes greenhouse gas emissions and the costs of meeting specified greenhouse gas targets. Some projections also focus on energy intensity and on international trade.

Most projections are undertaken by energy departments, sometimes jointly with environment departments. Some countries use independent national agencies. There are examples, especially in Scandinavia, of international cross-checking of results.

Almost all countries use a range, usually between 3 and 5, of scenarios or sensitivity studies to illustrate the effects of different assumptions with regard to economic growth, energy prices, energy policies, or specific greenhouse gas emission constraints.

There are considerable differences in the way these projections are used and in the audience for which they are intended but they all aim to assist government policy makers, sometimes also decision makers in industry, to inform the general public, and as a basis for international reporting. Some are focused on the feasibility and cost of attaining specific environmental targets. And some others, usually those with longer-term perspectives, are concerned particularly with technology deployment.

This means that forecasts and scenarios have different audiences. They are all made public in some form but some are treated essentially as internal government documents while others are published as guidance to industry and the general public.

The IEA itself makes regular use of scenario analyses, notably in the *World Energy Outlook,* which projects to 2030, and in *Energy Technology Perspectives,* which extends to 2050. Fifteen countries

are collaborating in the International Technology Systems Analysis Programme, an IEA Implementing Agreement, whose modelling tools are used by governments all over the world.

The IEA recommends that governments adopt and regularly revise energy forecasts to support their long-term energy and environmental strategies. The approaches will inevitably vary, depending on national priorities, but there are plenty of good examples described in this study.

Progress in the delivery of key energy security policies

Important progress has been made in a number of areas in recent years. For instance, there has been significant progress towards more competitive electricity and gas markets in Europe, with some improvement in the availability of market data and in the quality of market regulation, as in Europe and in Japan. Much needed investment in electricity infrastructure is taking place in Italy, and a number of countries, notably the United Kingdom and Germany, are acting to reduce planning delays for major energy projects. A number of European countries (the UK, Italy, Germany) are working to integrate their electricity and gas sectors more fully with the European market, including by investing in cross-border connections. In North America, the United States, Canada and Mexico are working together through the North American Energy Working Group particularly to reduce barriers to clean energy supply.

In the area of energy efficiency, notably Japan, many US states and Canadian provinces, Germany, France, Italy and the UK have either strengthened efficiency standards for buildings or are planning to do so. Many countries are making progress to raise the efficiency of appliances through standards and labelling requirements; lighting standards are being strengthened, with incandescent light bulbs being phased out in a number of countries; and vehicle fuel economy standards are being improved in Japan, the EU, the US and Canada.

New requirements for the deployment of renewables are contributing to the diversity of energy supply in all countries; for instance, the US, the EU and Japan now all have obligations to use renewables in the transport sector.

As far as CO_2 emissions are concerned, the EU Emissions Trading Scheme has been in operation since 2005 and is due to be strengthened. Several regions and states in the US are developing emissions trading schemes, and a federal system is now under consideration. Canada is pursuing its climate change strategy through its Clean Air Agenda. Through voluntary agreements, Japan continues to reduce industrial emissions and other measures are in place under the Kyoto Protocol Target Achievement Plan.

Overall, there has been good progress to enhance energy security in recent years, particularly in a few key areas: strengthening the functioning of gas and electricity markets and their physical integration, improving and shortening the planning process for major energy projects, and ensuring the maintenance of oil stocks. Governments are generally promoting the diversity of energy supply through the promotion of renewable and alternative sources. A renaissance of nuclear power is also contributing to future energy security. Energy efficiency – usually the most cost-efficient option to address energy security as well as climate change – is taking primacy in most governments' policies, a development that the IEA wholeheartedly endorses.

In spite of this good progress, there are a number of areas where more needs to be done, for instance, in some regions, towards the development of transparent and efficient energy markets. Here, independent and well-resourced regulators have an important role to play. Further investment and co-operation among countries are needed to enhance the physical integration of markets. And the adoption of measures that give a market price to carbon can enlist the power of market forces to deliver environmental objectives.

In spite of the progress that has been made, it is clear that governments are not yet taking full advantage of the low-cost opportunities that exist to reduce energy consumption and carbon emissions through energy efficiency policies. And much more also needs to be done to promote the development and deployment of renewable and alternative energy sources. This includes increased levels of government spending on energy research and development, which should leverage private funding wherever possible.

I. Government Structures for Co-ordinating Energy and Climate Policies

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the most comprehensive study of its kind to date, has firmly established the impact of human activities on our changing climate: "Most of the observed increase in global average temperature since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations."[1] CO_2 emissions from energy use are the main cause of this increase. Policies to mitigate climate change, therefore, are having and will continue to have a strong impact on energy policy and the energy sector – demand and supply sides alike.

Making climate and energy policies as effective as possible requires good co-ordination across ministries and agencies, the topic of this chapter. It seeks to describe how government ministries co-operate in formulating and implementing policies to reduce energy-related greenhouse gas (GHG) emissions. The chapter focuses on Japan, Italy, the Netherlands, Sweden and the European Union, the subjects of the most recent IEA in-depth energy policy reviews, and it also includes Spain and Turkey which were reviewed in 2007/2008. This chapter focuses on energy-related GHG emissions only.

1. Background

a) International climate policy negotiations

The Copenhagen meeting[2] at the end of 2009 is intended to arrive at an international agreement on reducing GHG emissions after 2012. Scientific evidence pointing towards the need for stronger efforts to mitigate climate change is laid out in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The report says that warming of the climate system is unequivocal, and that delay in reducing emissions significantly constrains opportunities to achieve lower stabilisation levels and increases the risk of more severe climate change impacts. To contain global warming within the range of 2-3°C, GHG emissions should peak over the next 10 to 15 years and fall by half from 2000 to 2050. For some observers, this means that reductions of 25% to 40% below 1990 levels by 2020 will be required in developed countries, together with a substantial deviation of emission trends from business-as-usual in developing countries. To meet the long-term target, a global energy technology revolution is necessary. Meeting this challenge cost-effectively, while maintaining energy security, puts heavy pressure on government climate and energy policy co-ordination, without which effectiveness of individual policies may be hampered, and overall mitigation cost would rise.

[1] IPCC, 2007, p. 5.

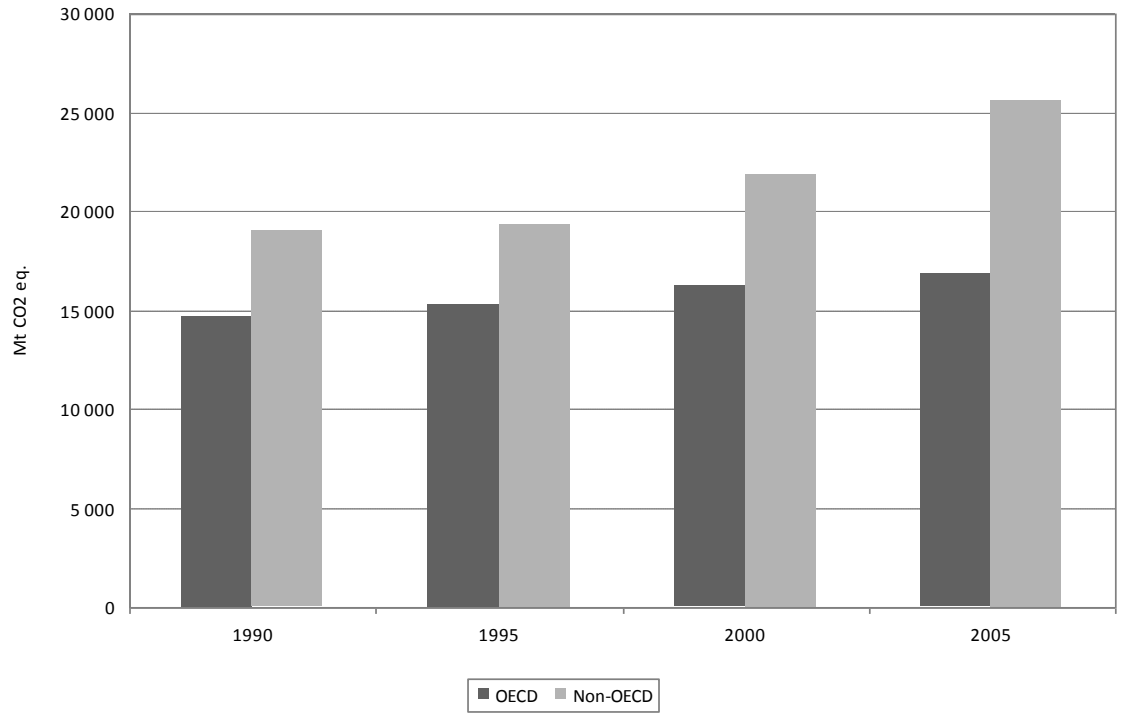
[2] The fifteenth session of the Conference of the Parties (to the United Nations Framework Convention on Climate Change) will be the fifth session to bring together the Parties to the Kyoto Protocol, from 30 November to 11 December 2009.

b) Energy-related GHG emissions as a share of total GHG emissions in IEA countries

GHG emissions continue to grow. From 1990 to 2005, they increased by 15% in the OECD countries and by 35% in non-OECD countries (see Figure I.1). Energy use accounted for 82% to 83% of all GHGs in OECD countries and for around 60% in non-OECD countries (see Figure I.2). Smaller shares correspond to agriculture, producing CH_4 and N_2O from livestock and rice cultivation, and to industrial processes not related to energy, producing mainly fluorinated gases and N_2O. These shares remained fairly stable over the whole period from 1990 to 2005. Therefore, at least in the short and medium term, mitigating climate change is primarily an energy question, in particular in the developed world.

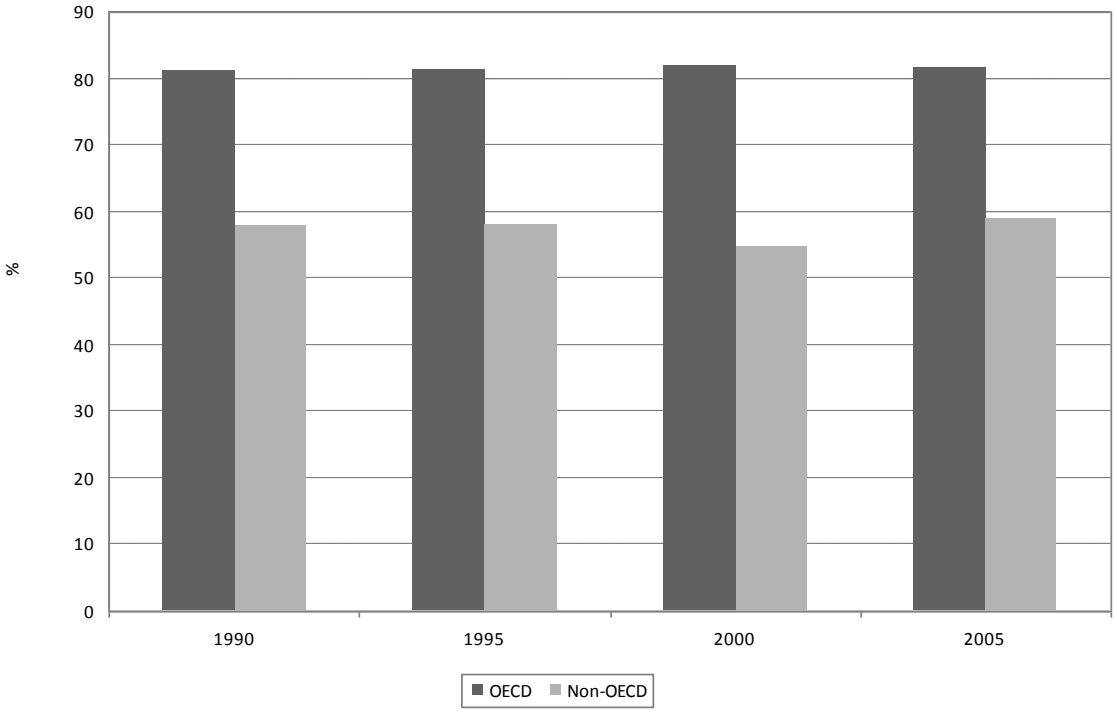
Turning to energy-related CO_2 emissions, they increased by 16% in OECD countries between 1990 and 2006, and by 52% in non-OECD countries (see Figure I.3). Energy-related GHGs, which consist mostly of CO_2, can be reduced through one or a combination of the following measures: improving energy efficiency; switching to less carbon-intensive fossil fuels; switching to emission-free energy sources; capturing and storing CO_2. Carbon sinks (including forests) can also be enhanced to absorb part of the energy-related CO_2 emitted to the atmosphere.

Figure I.1. Total greenhouse gas emissions in OECD and non-OECD countries, 1990 to 2005



Source: CO_2 Emissions from Fuel Combustion, IEA/OECD Paris, 2008.

Figure I.2. Energy-related greenhouse gases as a share of total greenhouse gases in OECD and non-OECD countries, 1990 to 2005



Source: CO_2 Emissions from Fuel Combustion, IEA/OECD Paris, 2008.

2. Country information

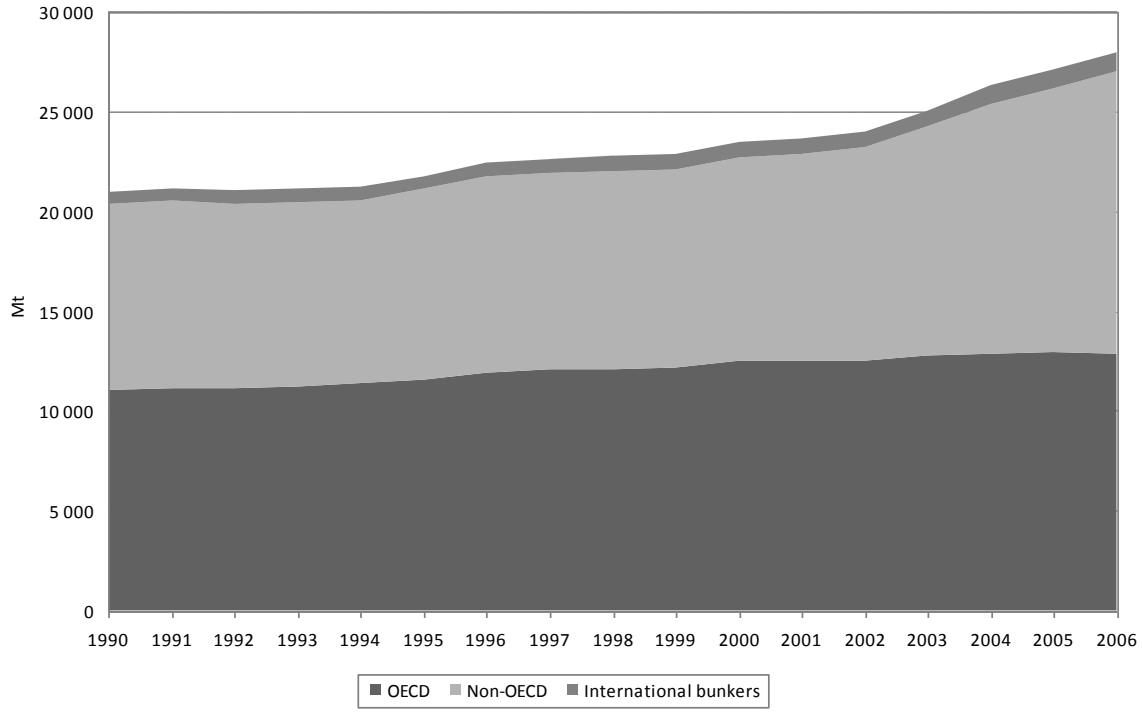
This section outlines government co-ordination, in particular interministerial co-operation, in formulating and implementing climate and energy policies. The focus is on Italy, Japan, the Netherlands, Spain, Sweden, Turkey and the European Union.

a) GHG reduction targets

All reviewed countries and the European Community are signatories to the United Nations Framework Convention on Climate Change (UNFCCC) and all have ratified the Kyoto Protocol under the UNFCCC. The Kyoto Protocol includes a target for average annual GHG emissions in 2008-2012 as compared to a base year. For the countries mentioned above, the base year is 1990 for CO_2, CH_4 and N_2O, but can be either 1990 or 1995 for the fluorinated gases.

For Japan, the target is to reduce its GHG emissions by 6% from the base year to 2008-2012. The EU15 (the 15 first member states to join) has an overall target of -8%. This target was divided among the 15 member states by the Burden-Sharing Agreement. The agreement gives the individual EU member states reviewed here the following targets: Italy -6.5%; the Netherlands -6%, Sweden +4% and Spain +15%.

Figure I.3. CO_2 emissions from fuel combustion in OECD and non-OECD countries, 1990 to 2006



Source: CO_2 Emissions from Fuel Combustion, IEA/OECD Paris, 2008.

b) Climate policy: government bodies, policies and decision-making processes

Italy

The central government has overall responsibility for the implementation of the Kyoto Protocol, although a range of policies are the responsibility of regions, provinces and municipalities. The Ministry for the Environment, Land and Sea is responsible for overall climate policy co-ordination, while the Ministry of Economic Development is responsible for national energy policy.

Italy's national climate strategy and a related National Action Plan (2003-2010) were developed and approved by the Interministerial Committee for Economic Planning in 2002. The strategy aims to reduce GHG emissions and also to fulfill other commitments in climate policy, for example setting the administrative frameworks.

The National Action Plan 2003–2010 set up an Interministerial Technical Committee for GHG emissions, chaired by the Ministry for the Environment, Land and Sea. The committee is responsible for regularly monitoring progress in the implementation of policies and measures, on the basis of indicators and sectoral-level emissions. It also carries out cost-effectiveness analyses to identify additional measures needed to meet the Kyoto target. The Interministerial Technical Committee includes representatives of the regions and of the Ministries of Economic Development, Agricultural and Forestry Policies, Infrastructures, Transport, University and Research, and Foreign Affairs. The

ministries are currently working on the review of the climate strategy to update the GHG projections and identify additional domestic policies and measures to reach the national GHG target.

Concerning the EU Emissions Trading Scheme (EU-ETS), Italy has set up a specific committee for the implementation and management of the Emissions Trading Directive (2003/87/EC). The committee includes members from all the relevant ministries. It was also responsible for preparing the National Allocation Plan for 2008–2012.

Japan

The government body in charge of climate change policy is the Global Warming Prevention Headquarters. It is chaired by the Prime Minister and vice-chaired by the Chief Cabinet Secretary, the Minister of the Environment and the Minister of Economy, Trade and Industry. All other state ministers serve as members, with all related ministries and agencies taking action against climate change in close co-operation with one another. The headquarters annually check the level of progress of the specified measures for ways to address global warming.

Advisory councils involved in climate policy making include the Central Environment Council of the Ministry of the Environment, the Industrial Structure Council and the Advisory Committee for Natural Resources and Energy of the Ministry of Economy, Trade and Industry (METI), and the Social Capital Development Council and the Council for Transport Policy of the Ministry of Land, Infrastructure and Transport.

The Agency for Natural Resources and Energy (ANRE) of METI is responsible for comprehensive energy policies to ensure strategic energy security and an efficient energy supply, and to promote environment-friendly energy policies.

The relevant legislation guiding efforts to reach the Kyoto target is the Kyoto Protocol Target Achievement Plan, passed in 2005 and later amended. In May 2007, the government launched the *Cool Earth 50* initiative, which has proposed a global target to cut greenhouse gas emissions by half by 2050 and calls for a "global consensus" on the sharing of the goal. Japan is working on a so-called mid-term target (2020), to be announced by mid-2009.

The Netherlands

When the new government took office in 2007, responsibilities between the ministries shifted. While the Ministry of Housing, Spatial Planning and the Environment (VROM) retains primary responsibility for the overall climate goal, including the goals for energy efficiency and renewable energy, a sectoral approach has been chosen in which every sectoral ministry is responsible for the implementation of the climate policy in its relevant sectors. As a result:

- The Ministry of Finance is in charge of the green taxation policy.
- The Ministry of Transport, Public Works and Water Management as well as the Ministry of Housing, Spatial Planning and the Environment are responsible for policies in the transport sector.
- The Ministry of Housing, Spatial Planning and the Environment is responsible for measures in the building sector.
- The Ministry of Agriculture, Nature and Food Quality is responsible for measures in the agricultural sector.
- The Ministry of Economic Affairs is in charge of all measures that cover industry and energy (accounting for roughly half of the total domestic emissions reduction target).

In mitigating climate change, the Dutch government is following the *Clean and Efficient: New Energy for Climate Policy* programme. It sets ambitious climate and energy targets for 2020 and outlines measures to reach them. It intends to cut GHG emissions by 30% from 1990 to 2020; to double the rate of yearly energy efficiency improvement to 2% in the coming years; and to reach a 20% share of renewable energy in total primary energy supply (TPES) by 2020.

The interministerial agreement provides a system with clearly defined responsibilities for meeting the domestic target. Furthermore, an agreement between the central government and the regional and local governments has been signed in which the regional and local governments highlighted their climate policy ambitions in light of the new, more stringent national climate ambitions. Nonetheless, there is no specific target for the local and regional governments: they are autonomous in setting their own ambitions.

Concerning the EU-ETS, the National Allocation Plan for 2008–2012, which sets targets for all covered Dutch installations, was prepared by both the Ministry of Economic Affairs and the Ministry of Housing, Spatial Planning and the Environment.

Spain

The Ministry of the Environment, and Rural and Marine Affairs, and concretely its Secretariat of State for Climate Change, is responsible for formulating and co-ordinating climate change policy in Spain. Within the Secretariat of State, this work is delegated to the Spanish Climate Change Office which also functions as the secretariat for the National Climate Council and the Commission for the Co-ordination of Climate Change Policies. The National Climate Council prepares, evaluates and follows up on the national climate strategy. It consists of representatives from the relevant ministries, autonomous regions, municipalities, NGOs, academia, trade unions and industry.

The Commission for the Co-ordination of Climate Change Policies co-ordinates the work of the central government and the autonomous regions on climate change policy, and it is involved in preparing and monitoring the implementation of the national climate strategy from this perspective. It is chaired by the Ministry of the Environment and Rural and Marine Affairs.

There are two additional institutions for interministerial co-ordination within the government: the government's Delegated Commission for Climate Change, made up of nine ministers and nine state secretaries, that monitors the implementation of the national climate strategy at the highest level; and the Interministerial Group on Climate Change that includes other high-ranking representatives (state secretaries or secretaries-general, and directors-general) with preparatory functions for the work of the government's Delegated Commission for Climate Change.

For formulating specific policies and measures on national climate change policy, the government may set up specific working groups. They are usually co-chaired and co-ordinated by the relevant sectoral ministry together with the Ministry of the Environment, and Rural and Marine Affairs.

Sweden

Mitigating climate change is one of the priorities of the current government. Under the EU15 Burden-Sharing Agreement, Sweden is allowed to increase its emissions by up to 4% from their 1990 level over 2008-2012. Going beyond this obligation in the EU, Sweden has set itself a national target of -4% from 1990 to 2008-2012, to be reached without resorting to carbon sinks or using flexible mechanisms.

The Ministry of the Environment is in charge of climate change policy. It works in close co-operation with the Ministry of Enterprise, Energy and Communications. The ministries have delegated much of the policy work to several central agencies, primarily the Swedish Environmental Protection Agency (SEPA) and the Swedish Energy Agency (SEA). SEPA monitors the national environmental objective of reduced impact on climate, while SEA implements the majority of decisions on energy policy, including on energy efficiency. These two agencies are responsible for the evaluation of Sweden's national climate change strategy.

SEPA and SEA are also the main agencies involved in implementing the EU-ETS in Sweden. Other agencies involved are the Board of Industrial and Technical Development (NUTEK) and the County Administrative Boards. SEPA, SEA and NUTEK also set up a specific council for preparing the National Allocation Plan.

Turkey

Turkey is a signatory to the UNFCCC, and has recently ratified the Kyoto Protocol. However, it does not have a quantified obligation to limit or reduce its GHG emissions. Turkey's approach is to implement policies and measures to protect the climate system on the basis of equity and in accordance with common but differentiated responsibilities and respective capacities, as per the UNFCCC.

The Ministry of the Environment and Forestry is responsible for co-ordinating climate change policies. It chairs the Interministerial Co-ordination Board on Climate Change (CBCC), the body in charge of implementing climate change policies and measures, including the obligations under the UNFCCC. The CBCC includes a Technical Working Commission on Climate Change, which has seven expert working groups.

The Ministry of Energy and Natural Resources co-ordinates Working Group 3 (Mitigation of GHGs from the industry, building, waste management and service sectors) and Working Group 4 (Mitigation of GHGs from the energy sector).

European Union

Energy and climate policies of the EU member states are increasingly formulated at EU-wide level – from decisions on targets for GHGs under the EU-ETS, on the share of renewable energy sources, to directives to liberalise energy markets, for example. The EU Commission has the sole competence (monopoly) for proposing new EU legislation. The EU member states then try to reach a compromise on these proposals at the Council of Ministers. Most proposals also have to be approved by the European Parliament.

Within the Commission, the Directorate-General for Transport and Energy is responsible for preparing legislative proposals on energy, whereas the Directorate-General for the Environment is responsible for those on climate policy. In recent years, the Commission has given considerable importance to using wide consultations before adopting proposals for new legislation.

The Commission's decision-making process includes internal consultation across the relevant Directorates-General. Externally, it organises open consultations for stakeholders and the general public. The Commission also uses expert groups representing national governments and industry to help prepare policy decisions. In the energy sector, these include the Madrid Forum for the gas market, the Florence Forum for the electricity market, and the Berlin Forum for fossil fuels. A good

example of the efforts to improve climate and energy policy co-ordination was the setting-up of the High-Level Group on Competitiveness, Energy and the Environment in 2006. The group consisted of commissioners, several ministers and industry leaders, and it offered advice to policy makers to ensure an integrated approach within these three areas. It organised a number of workshops bringing together views from independent experts.

Very important are the specific documents – Green Papers and communications – that the Commission adopts to test various ideas for future legislation. The Council of Ministers and the European Parliament normally give feedback on these proposals by formally preparing Council Conclusions or Reports.

The decision-making process of the EU does not automatically guarantee that energy policy expertise is involved in decisions relevant to the energy sector. For example, negotiations on all legislative proposals based on the environment article of the European Community Treaty, such as those on climate policy, take place in the Environment Working Party of the EU Council of Ministers. The working party is an expert-level body of the member states and its function is to prepare ground for an eventual agreement at the Council of Ministers meeting. Member states normally send experts from the Ministry of the Environment, but not necessarily from other relevant ministries, to the regular meetings of the working party. At the ministerial level, it is the Environment Council (the environment ministers) that decides on these proposals. Whether and to what extent energy policy experts are involved in these negotiations depends on the level of co-ordination in each member state.

3. Critique

Responding to climate change requires cross-sectoral government policies and measures. To succeed, these must be closely co-ordinated among all relevant ministries. As a rule, responsibility for climate change policies tends to lie within the Ministry of the Environment. Climate change has been considered an environmental issue from the start, and it was at the UN Conference on Environment and Development in Rio de Janeiro in 1992 that the United Nations Framework Convention on Climate Change was adopted.

Most measures to reduce emissions, however, fall within the energy sector. It is generally the task of energy ministries to ensure that policies to mitigate climate change are compatible with other energy policy goals and that the measures in the energy sector are cost-effective. This is especially true in light of the eventual future emissions reduction targets. Meeting ever stricter targets requires intensified measures. Many countries and regions are planning to set up emissions trading systems and set new targets for renewable energy, or have already done so. The growing sense of urgency on climate change, and the much more ambitious mitigation goals envisioned in the future, will require full engagement of the energy sector. To be successful, climate policy must be an integral part of the energy policy.

A good example of a policy sector where close co-ordination is needed is electricity. Stronger targets for cutting GHG emissions, and pressure to rely more on domestic energy sources, ought to lead to increases in electricity generation from renewable sources. But large increases in renewable electricity from intermittent sources – wind, solar and tidal – put pressure on the reliability of the power system. Its ability to quickly balance fluctuations in supply and demand depends on the design and operation of networks, on the supply portfolio and on electricity markets. A rapidly growing share of intermittent sources of supply would require a profound change in the way electricity grids are developed and managed. Making all this work in an open electricity market is

crucial to enabling least-cost investment in renewable and other low-CO_2 electricity sources. Reconciling these goals requires effective co-ordination at the government level.

This chapter has focused on a small number of IEA member countries. For a more detailed review of climate and energy policy co-ordination in all member countries, more time and resources would be needed. It could also be worthwhile to compare the institutional set-up for trading emission allowances and using the Kyoto flexibility mechanisms to achieve country-wide compliance, for example. Generally, however, the conclusion is clear: in light of the future challenges, governments should ensure sufficient co-ordination of climate and energy policies across all relevant government bodies.

4. Recommendations

Governments should:

- Ensure sufficient co-ordination in climate and energy policies across all relevant government bodies.
- Increase or continue efforts to meet the Kyoto 2020 target.
- Prepare a comprehensive energy and climate strategy for the medium and long term.
- Increase the use of cost-effectiveness as a criterion for prioritising measures to reduce emissions and for designing effective policy packages.
- Ensure both the availability of funds for the eventual purchases of international emission credits and the institutional capacity for handling these purchases.

5. Sources

Publications

European Environment Agency: Application of the Emissions Trading Directive by EU Member States — reporting year 2007, EEA technical report 3/2008.

Fourth Netherlands' National Communication on Climate Change under the UNFCCC, January 2007.

IEA: *CO_2 Emissions from Fuel Combustion*, Paris, 2007.

IEA: *Energy Policies of IEA Countries – Japan*, Paris, 2008.

IEA: *Energy Policies of IEA Countries – Italy* (draft, forthcoming).

IEA: *Energy Policies of IEA Countries – Sweden*, Paris, 2008.

IEA: *Energy Security and Climate Policy: Assessing Interactions*, Paris, 2007.

IEA: *IEA Energy Policies Review – The European Union,* Paris, 2008.

IPCC: *Assessment Report 4 – Synthesis Report*, November 2007.

Italy's Fourth National Communication under the UN Framework Convention on Climate Change, November 2007.

Ministry of Housing, Spatial Planning and the Environment, the Netherlands*: New Energy for Climate Policy – the "Clean and Efficient" Programme*, December 2007.

Turkey's First National Communication on Climate Change under the UNFCCC, January 2007.

UNFCCC: Report of the Conference of the Parties on its thirteenth session, held in Bali from 3 to 15 December 2007.

Websites

EU Commission's Directorate-General for the Environment (*http://ec.europa.eu/environment/*)

EU Commission's Directorate-General for Transport and Energy (*http://ec.europa.eu*/energy/index_en.html)

IEA Climate Change Policies and Measures Database (*http://www.iea.org/textbase/* pm/index_clim.html)

Ministry of the Environment and Rural and Marine Affairs, Spain (*http://www.marm.es/index_en.htm*)

Ministry of Tourism, Industry and Trade, Spain (*http://www.mityc.es*)

Swedish Energy Agency (*http://www.energimyndigheten.se/*)

Swedish Environmental Protection Agency (*http://www.naturvardsverket.se*)

6. Government co-ordination of climate and energy policies

	Government body* responsible for climate change policy	**Government body* responsible for energy policy**	**Co-ordinating bodies/processes**
Italy	Ministry for the Environment, Land and Sea	Ministry of Economic Development	Interministerial Technical Committee for GHG emissions
Japan	Global Warming Prevention Headquarters	Ministry of Economy, Trade and Industry	Global Warming Prevention Headquarters
The Netherlands	Ministry of Housing, Spatial Planning and the Environment	Ministry of Economic Affairs	Close co-operation under the "Clean and Efficient" programme
Spain	Ministry of the Environment and Rural and Marine Affairs	Ministry of Industry, Tourism and Trade	Interministerial Group on Climate Change; National Climate Council
Sweden	Ministry of the Environment	Ministry of Enterprise, Energy and Communications	Close co-operation at the Ministry and Agency level
Turkey	Ministry of the Environment and Forestry	Ministry of Natural Resources and Energy	Interministerial Co-ordination Board on Climate Change
EU Commission	DG Environment	DG Transport and Energy	Internal consultation across DGs

* Directorate-General for the EU Commission.

II. The Use of Long-Term Energy Forecasts and Scenarios

1. Introduction and overview

Many IEA member countries use long-term energy forecasts and scenarios, though there are some differences in their time horizons and roles. Energy forecasts and scenarios show the possible energy future, which enables market players and energy consumers to take action with confidence. Therefore, it is natural for governments and public agencies to use long-term energy forecasts and scenarios, particularly in this period of growing uncertainty in the energy sector. Yet some questions need to be clarified: What role do long-term energy forecasts and scenarios play, especially in the context of energy market liberalisation? What effect do they have on energy policies and the 3Es (Energy security, Economic growth and Environmental sustainability)? What do current trends suggest to policy makers and forecast modellers?

This chapter attempts to answer these questions.

a) Generic aspects of long-term energy forecasts and scenarios

Historically, energy forecasts have aroused strong interest in the IEA member countries for a long time. At the IEA Governing Board Meeting at Ministerial Level on 6 October 1977, Ministers reviewed world prospects of energy demand and supply, and expressed the determination of the IEA member countries to reduce the risk of severe economic, social and political consequences of a shortage of energy supply. They agreed on the need to continuously improve forecasts of energy demand and supply on a global scale as a basis for decision making. Energy forecasts have thus been used to predict possible risks and avoid them by taking the right measures. In other words, energy forecasts have mainly served to ensure energy security, but their role today seems to cover broader, more complex and politicised energy issues. The importance of the environment is more and more recognised, and so is energy security. As energy consumption and CO_2 emissions are inextricably linked, it is expected that new technologies will improve energy efficiency and environment-friendliness. There are ongoing international negotiations on medium- and long-term energy and environmental issues such as the reduction of global greenhouse gas (GHG) emissions by 2050 that were discussed at the G8 2008 Summit, and numerical targets were set for the European Union member states.

b) Relationship with the 3Es

The way energy is supplied and consumed affects the energy future. Coping with the anticipated shifts in the consumption of energy requires preparation and implementation of well-thought-out policies. Long-term energy supply and demand forecasts can help specify issues in the field of energy security and to form relevant policies and institutions. They also provide quantitative information on the need to accelerate the development of energy technologies in order to enhance energy efficiency and mitigate climate change.

Clear-sighted and long-term visions of the energy future provide transparency in the market and the basis of policies which "help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives", as stated in the IEA *Shared Goals*. By ensuring transparency and stability in the energy policy arena, long-term energy forecasts and scenarios contribute to achieving the 3Es. They may also have an influence on energy markets as indirect policy instruments by predicting the possible or desirable energy future.

As for energy-related GHG emissions, given that they represent over 80% of total GHG emissions in Annex I countries under the Kyoto Protocol, long-term energy forecasts and scenarios can play a basic role in addressing climate change as supporting information. In fact, projections of GHG emissions are included in many energy forecasts. International negotiations on setting numerical targets are part of the process of addressing climate change, and credible GHG emission projections are essential in such negotiations.

c) Scenario approach

The 2006 St. Petersburg G8 Summit document stressed "the growing interdependence between producing, consuming and transiting countries". These dynamic changes in the energy sector make it difficult to forecast the energy future, especially in the long term. It is thus more effective to build several scenarios rather than just one. In this changing energy world, policy makers have to choose from among a series of events those that are likely to have an impact on the energy future and take them into account in their policies.

IEA member countries have all had to face changes in their energy markets that they were not always able to anticipate. Energy resources have become the epicentre of complicated problems all over the world; energy no longer seen as only a commodity as it is linked to same difficult political issues. But as development of energy resources largely depends on human activities and decisions, it is difficult to assess the future economic, social, political and technological contexts. And the longer the time horizon, the less accurate any forecast will be. It is therefore wiser to devise various scenarios making room for possible changes, in order to enable policy choices.

The IEA publishes a quantitative analysis of energy supply and demand in the medium and longer term each year in its *World Energy Outlook* (WEO). Results are provided sector by sector and region by region. The *WEO* provides various scenarios: the reference scenario which assumes no change in policy; and alternative policy scenarios which analyse the impact of a range of possible future policy interventions.

2. Matrix

a) Covered countries and topics of review

Eleven member countries have been reviewed:

- Australia
- Belgium
- Canada
- The Czech Republic
- Italy
- Japan

- Luxembourg
- The Netherlands
- Norway
- Spain
- Sweden

The role that long-term energy forecasts and scenarios now play and could play in the future is being investigated in this chapter in order to find common trends in the reviewed countries. Examples of challenges and efforts have also been collected to determine what is needed. The following aspects are considered:

- Roles and needs.
- Who is concerned.
- Period covered and major purpose.
- Major output items.
- Responsible organisations.
- Frequency of issuance.
- Explanation of the latest major revisions.
- Major parameters in scenarios/sensitivity analyses.
- Number of scenarios.
- Challenges, efforts and plans.

Detailed information is shown in Tables II.1 and II.2.

b) Major trends in energy forecasts and scenarios in IEA countries

Nine countries out of eleven use long-term energy forecasts – Australia, Belgium, Canada, the Czech Republic, Italy, Japan, the Netherlands, Spain and Sweden; Six of these have between one and six scenarios – Belgium, Canada, the Czech Republic, Italy, the Netherlands and Spain.

Roles and needs

The three items below have key roles in the reviewed countries:

- Information for policy makers (all nine countries with long-term energy forecasts).
- Information for industry decision makers (Australia, Belgium and Canada).
- Evaluation of energy policies (Belgium, Canada, the Czech Republic, Italy, Japan, the Netherlands, Spain and Sweden).

The first two factors imply that long-term energy forecasts are expected to indicate the possible or ideal future direction of the energy sector. The third is one of the tools used in most of the countries.

Three other items have also been found to play a role in some countries. These seem to have some relationship with international institutions such as the United Nations Framework Convention on Climate Change (UNFCCC) and the European Union Commission:

- Providing a basis for international reporting.
- Exploring the feasibility of numerical targets.
- Supporting the ministry in international negotiations.

Who is concerned

In Belgium and Canada, energy forecasts and scenarios are published for the general public, while in the other countries, the government is the main target. In Canada in particular, long-term energy forecasts and scenarios are regarded as tools to stimulate energy discussion. In terms of format, however, there are few differences among the other seven countries. All forecasts and scenarios provide a summary and many graphs that make them easier to understand.

Period covered and major purpose

Long-term energy forecasts and scenarios cover up to 2020 in Sweden, 2030 in six countries and to 2040 in Italy and the Netherlands. Their aim is:

- To analyse the energy future, particularly energy technology perspectives;
- To be consistent with the numerical targets set for the target year.

In the reviewed countries, many energy forecasts and scenarios with a longer time horizon tend to analyse the impact of energy technology development and deployment on the energy future. For instance, Canada, Italy, Japan and Spain, that forecast to 2030 or 2040, include "energy technology development and deployment" as one of the parameters in their scenarios/sensitivity analyses. According to the technology road-maps presented in the *IEA Energy Technology Perspectives 2008*, some key future technologies are estimated to step up the stages from demonstration to deployment or commercialisation between the late 2020s and year 2040. In this context, it would be worthwhile for long-term energy forecasts and scenarios to explore future energy technologies, especially in countries with cutting–edge energy technologies.

The following two items are cited as the main reasons for choosing 2030-2040 as the time horizon in some countries:

- To enable a long-term analysis of energy technology perspectives.
- To urge key decisions to be taken early.

Major output items

The energy supply and demand balance is one of the major output items, while some countries have also analysed the demand side in detail. As for the demand side, GHG emission projections are also part of the forecast output in eight countries, which implies the integration of energy issues and environmental issues. Moreover, two countries calculate the costs to achieve their energy and environmental targets. Belgium calculates the future energy system costs, and Italy assesses the costs of different policies and reaching different targets. Thus the output items now cover not only energy security, but also the 3Es – energy security, economic growth and environmental sustainability.

Responsible organisations

Ministries in charge of energy are responsible for long-term energy forecasts and scenarios in many reviewed countries, while in some other countries, they publish this information in association with ministries of the environment. For example, the Swedish Energy Agency publishes long-term energy forecasts in association with the Swedish Environmental Protection Agency, while Italy has its own National Agency for New Technologies, Energy and the Environment. The Ministry of Economic Affairs of the Netherlands launched a governmental project on energy and environment projections together with the Ministry of Housing, Spatial Planning and Environment. Dutch independent institutes now work on long-term energy forecasts and scenarios as a result of this project.

Frequency of issuance

More than half of the reviewed countries have revised their energy forecasts and scenarios once in less than four years. It is important to continue these revisions as the energy situation has significantly changed even during the past two years and continues to evolve.

Explanation of the latest major revisions

It is important to explain major revisions not only for the purpose of understanding the forecasts and scenarios but also for historical consistency and, therefore, credibility.

Over half the reviewed countries (Australia, Canada, Italy, Spain and Sweden) explain the major differences between the previous version of their forecast and the new one. Sweden explains the differences between the assumptions and the expected results. When forecasts are more frequent, such differences are usually explained, perhaps because they show fewer changes in the energy situation.

Major parameters in scenarios/sensitivity analyses

A series of scenarios does not only show possible energy futures, but also describes a set of likely trends, which enables more policy choices. Parameters also tend to differ from country to country depending on the impact of each factor. The following parameters are those that have been chosen in about half of the reviewed countries:

- Economic growth (Australia, Belgium, Canada, the Czech Republic, the Netherlands and Spain).
- Energy prices (Belgium, Canada, the Czech Republic and Spain).
- Technology development and deployment (Canada, Italy, Japan and Spain).

Each of these parameters pertains to the economic, social, political or technological field which all depend largely on human activities and decisions. “Energy prices” itself represents growing uncertainty.in the current energy sector. Also, energy RD&D and economic growth are thought to influence the energy future significantly, and are therefore major factors of uncertainty in the energy future.

Canada and the Netherlands regard “energy policies” as one of the parameters. Belgium adds “environmental policies”.

The two following parameters are considered in a few countries because of their significant influence on environmental policies:

- Nuclear energy production (the Czech Republic).
- GHG emission constraints (the Czech Republic and Italy).

Number of scenarios

Most of the reviewed countries use some scenarios or sensitivity analyses with varying time horizons: usually between three and five, including a reference case, but some countries use more. On the other hand, Sweden uses just one. Swedish forecasts are used mainly for international reporting and evaluation. The Czech Republic outlines around 40 scenarios and sensitivity analyses and uses one scenario for policy making.

Challenges, efforts and plans

Most of the IEA member countries share some real or potential challenges when they produce long-term energy forecasts and scenarios, such as the following:

- Collecting more accurate information on energy technologies, *e.g.* their costs and efficiency.
- Improving the collection and processing of national energy statistics.

Regarding efforts and plans for improvements, Nordic countries' good practice is to check their energy forecasts with each other as they have mutual cross-border energy trade. They also exchange ideas and experience in the field of forecasting and forecasting techniques and models. As a rule, more transparency is needed in the data and models used in all countries.

Countries' experiences imply:

- That current efforts to develop energy technology are thought to have significant influence on the future of the energy sector.
- That credible and transparent basic information should be shown in energy forecasts.
- That international co-operation could enhance the credibility of energy forecasts.

3. Critique

a) Overall evaluation of IEA countries

Most of the reviewed countries have conducted and continue to revise their long-term energy forecasts, some of which are combined with scenarios, as the foundation for policy making and as information to assist industry decisions. Some common trends are discernible in Tables II.1 and II.2, but each of the reviewed countries is different in its degree of dependence on energy imports, its energy mix, its energy demand, the purpose of its forecasts and its overall situation.

The major role of long-term energy forecasts and scenarios is to help policy makers and industry leaders to take the right decisions. Some forecasts and scenarios evaluate the effects of energy policies and environmental policies. The energy supply and demand balance is the major output, but some countries analyse in detail energy demand and its repercussions on the environment. There

are also some examples of scenarios that estimate the costs of achieving given environmental targets, which show that long-term energy forecasts and scenarios are effective in pursuing not only energy security, but also the 3Es. Therefore, the two countries without long-term energy forecasts, Luxembourg and Norway, should start using them as policy instruments if they want to orient their energy sector towards a sound future. Regularly revising long-term energy forecasts and scenarios is also important in view of the rapid changes the energy sector is faced with, such as the economic situation and fuel prices.

More than half of the reviewed countries have conducted some scenario analyses as a way to cope with the uncertainty of energy forecasts. Sound long-term energy scenarios as well as forecasts are essential for efficient policies and market operations. Energy market participants rely on these scenarios to take decisions on long-term and capital-intensive infrastructure. Long-term energy scenarios enable policies and investment strategies to be as compatible as possible with various likely futures. The parameters chosen in scenario analyses include energy prices, energy R&D, nuclear energy and GHG emissions. Canada has only one near-term forecast (to 2015) and three longer-term scenarios. It shows that longer time horizons make forecasts more uncertain and a scenario approach more effective.

Parameters, assumptions and methods should be transparent if the result is to be credible. This is crucial, particularly in developing policies, taking decisions or negotiating national targets on the basis of long-term forecasts. It is also essential to improve the collection and processing of national energy statistics.

b) Evaluation of positive examples

Improving co-operation between the ministries of energy and the environment is important. There are some good examples of long-term environment and energy forecasts issued by an energy agency in association with the national environmental protection agency, which implies that energy and environmental issues are integrated in policies. This could also lead to effective international negotiations on climate change.

As regards time horizons, longer-term forecasts tend to take account of the impact of energy technology development and deployment on the energy future. The UNFCCC requires Annex I countries to submit a National Communication Report on GHG emission projections to 2020. Though some energy forecasts are prepared to be used in national reports up to 2020, many reviewed countries' energy forecasts (and often scenarios) have a time horizon beyond 2020. This is commendable from the viewpoint of RD&D. Italy has a forecast up to 2040 for a long-term analysis of energy technology perspectives. As was described above, the period between the late 2020s and 2040 is when some key future energy technologies are expected to step up the stages from demonstration to deployment/commercialisation, and many countries have forecasts and scenarios that cover this period. Energy technology requires a longer preparation period to become reality than implementation of energy policies, and progress is rarely as planned. In this light, it might be prudent to analyse the energy future towards 2040 using the scenario approach, which would help market players to take decisions on investment, by leaving enough time for them to prepare. Energy technology RD&D will play an essential role in implementing energy and environmental policies. Those policy makers who place much emphasis on energy technology RD&D would welcome energy forecasts and scenarios with a longer time horizon.

c) Areas where governments should place more effort

Governments may find it useful to check their forecasts from the policy makers' viewpoint in order to improve credibility. This would require a closer exchange of information between policy makers and forecast modellers. They could also consider having their forecasts checked by other countries, especially by those on which they depend in the energy sector.

In addition, the information provided by long-term energy forecasts and scenarios could stimulate discussions and further increase public acceptance of national energy policies. Some countries even involve anyone concerned with energy forecasts in public discussions.

Most countries explain major differences between their previous long-term forecasts and the new ones. Such efforts may enhance consistency with the previous version and contribute to the reader's better understanding. Nevertheless, less frequent forecasts tend not to add explanations on such differences, although longer intervals easily lead to bigger differences.

The influence of long-term energy forecasts and scenarios on the energy market should be further enhanced by encouraging stakeholders to use them towards the realisation of political targets such as increased energy efficiency and a low carbon economy.

4. Recommendations

Governments should:

- Adopt and regularly revise long-term energy forecasts and scenarios to develop a robust long-term energy and environmental policy framework taking the 3Es into account.
- Include energy-related GHG emission projections in their energy forecasts and scenarios by further engaging with the related government ministries and agencies.
- Conduct various scenario analyses on factors that have a large impact on the energy future.
- Continue to analyse the demand side with impacts on environmental issues.
- Ensure that parameters, assumptions and methods are transparent to all energy stakeholders.

5. Definitions

Forecast: A forecast is a prediction which attempts to describe possible trends.

Sensitivity analysis: A sensitivity analysis aims to explore how a forecast is affected by changing a single key assumption in a reference case.

Scenario: A scenario shows a set of completely different possible trends that describes a range of potential futures. As a rule, all the major assumptions in a scenario are different from those in the others.

6. Sources

Greenhouse Gas Inventory Data, UNFCCC

Review of the implementation of commitments and of other provisions of the Convention, UNFCCC guidelines on reporting and review, UNFCCC

Australian Energy National and State Projections to 2029-2030, ABARE research report 07.24, ABARE, Australia, 2007

Perspectives énergétiques pour la Belgique à l'horizon 2030 dans un contexte de changement climatique, October 2007, Federal Planning Bureau, Belgium

Canada's Energy Future Reference Case and Scenarios to 2030, An Energy Market Assessment, November 2007/National Energy Board, Canada

STÁTNÍ ENERGETICKÁ KONCEPCE ČESKÉ REPUBLIKY (approved by the Government of the Czech Republic), 2004

Outlook for Long-Term Energy Supply and Demand, Advisory Committee for Natural Resources and Energy (upon consultation by the METI), Japan,2008

Referentieramingen Energie en Emissies 2005-2020, ECN and RIVM, The Netherlands, 2005

Den svenska klimatstrategins utveckling/Swedish Energy Agency in association with the Swedish Environmental Protection Agency, 2007

Country submissions by reviewed countries (As for Italy and Spain, all information is based on country submissions regarding the forthcoming energy report)

Energy Policies of IEA Countries JAPAN, 2008 Review, IEA

World Energy Outlook 2007, IEA

Energy Technology Perspectives 2008, IEA

Table II.1. Role of long-term energy forecasts and scenarios

	Australia	**Belgium**	**Canada**
i. Roles and needs			
As information for:			
Policy makers	○	○	○
Industry decision makers	○	○	○
Ordinary people		○	○
To estimate the effects of energy policies		○	○
To explore the feasibility of numerical targets			
As a basis for international reporting			
Others		To calculate the marginal costs of GHG emissions reductions	- To stimulate energy discussion - To urge key decisions to be taken early, taking account of long lead times for project development and stock turnover
ii. Who is concerned	Government and industry	Anyone interested in long-term energy forecasts (government, stakeholders, research groups, etc.)	Anybody interested in long-term energy forecasts
iii. Period covered and major purpose	To 2029/30	To 2030	To 2030
iv. Major output items	Primary and final energy consumption, electricity generation, long-term analysis of trends and likely development in Australia's energy sector	Level and structure (by fuel and sector) of final energy demand, power generation, fuel imports, impact on the energy system costs, CO_2 emissions, etc.	Energy supply, demand, exports and energy-related GHG emissions
v. Responsible organisations	Government economic research agency - Australian Bureau of Agricultural and Resource Economics , ABARE	Government - Federal Planning Bureau, FBP	Independent federal agency established by the Parliament of Canada - National Energy Board
vi. Frequency of issuance	Annual	Every 3 years	About every 4 years
vii. Explanation of the latest major revisions	Briefly explained	None	Briefly explained

Table II.1 *(continued)*

	Australia	**Belgium**	**Canada**
viii. Major parameters in scenarios/sensitivity analyses	Economic growth	Economic growth; Energy prices; Energy and environmental policies	Economic growth; Energy prices; Energy policies; Geopolitical context; Societal values; Energy technology development and deployment
ix. Number of scenarios	1 reference case and 2 sensitivity analyses	1 reference case, 6 scenarios and 3 sensitivity analyses	1 reference case to 2015 and 3 scenarios to 2030
Website	http://www.abareconomics.com/publications_html/energy/energy_07/auEnergy_proj07.pdf	http://www.plan.be/admin/uploaded/200711280958210.pp102_fr.pdf	http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2007/nrgyftr2007-eng.pdf
	Czech Republic	**Italy**	**Japan**
i. Roles and needs			
As information for ;			
Policy makers	○	○	○
Industry decision makers			
Ordinary people			
To estimate the effects of energy policies	○	○	○
To explore the feasibility of numerical targets		○	○
As a basis for international reporting			
Others		- For a long-term analysis of energy technology perspectives - To assess costs of different policies and for reaching different targets - To support the ministry in the international negotiations	
ii. Who is concerned	Government	Government	Government
iii. Period covered and major purpose	To 2030	To 2040 - For a long-term analysis of energy technology perspectives	To 2030
iv. Major output items	Primary energy supply, electricity generation, final demand, energy related emissions and power plant capacity	Description of the evolution of the energy system, with details on perspectives and competitiveness of all the main energy technologies Results aggregated in the National Energy Balance format (TPES, TFES, …) and emissions by main sector.	TPES, TFC, power plant capacity, power production and energy-related CO_2 emissions

Table II.1 *(continued)*

	Czech Republic	**Italy**	**Japan**
v. Responsible organisations	Government	Independent agency controlled by the ministry - the Italian National Agency for New Technologies, Energy and the Environment	Advisory Committee for Natural Resources and Energy (upon consultation by the METI, Ministry of Economy, Trade and Industry)
vi. Frequency of issuance	Not specified	Annual	About every 3 to5 years
vii. Explanation of the latest major revisions	None	Briefly explained	None
viii. Major parameters in scenarios/sensitivity analyses	Economic growth; Energy prices; Nuclear energy production; GHG emissions constraints	Energy technology development and deployment; GHG emission constraints	Energy technology development and deployment
ix. Number of scenarios	1 recommended scenario out of about 40 scenarios and sensitivity analyses	3 scenarios	1 reference case and 2 sensitivity analyses
Website	http://www.mpo.cz/dokument5903.html	Yet to be released.	http://www.enecho.meti.go.jp/topics/080523b.pdf
	The Netherlands	**Spain**	**Sweden**
i. Roles and needs			
As information for:			
Policy makers	○	○	○
Industry decision makers			
Ordinary people			
To estimate the effects of energy policies	○	○	○
To explore the feasibility of numerical targets	○		
As a basis for international reporting	○		○
Others			
ii. Who is concerned	Governmental project - launched by the Ministry of Economic Affairs (EZ) and the Ministry of Housing, Spatial Planning and Environment (VROM)	Government	Government
iii. Period covered and major purpose	To 2020	To 2030	To 2020 - To follow up national medium-term targets. - To be consistent with the time horizon of the discussions and targets in the EU.

Table II.1 *(continued)*

	The Netherlands	Spain	Sweden
iv. Major output items	energy use, GHG emissions and air pollution	Final and primary energy balances, energy imports, energy intensity and energy-related emissions	Energy supply and demand by fuel and sector, and CO_2 and GHG emissions
v. Responsible organisations	Independent institutes	General Secretariat of Energy, Ministry of Industry, Tourism and Trade	Swedish Energy Agency in association with the Swedish Environmental Protection Agency
vi. Frequency of issuance	About every 3 years	Not specified	Every 2 or 3 years
vii. Explanation of the latest major revisions	None	Briefly explained	Differences in results and in assumptions are explained
viii. Major parameters in scenarios/sensitivity analyses	Economic growth; Energy policies; Social system	Economic growth; Energy prices; Energy technology development and deployment	
ix. Number of scenarios	1 reference case and 2 scenarios with 2 sensitivity analyses for each scenario	Several scenarios and sensitivity analyses	1 scenario
Website	http://www.ez.nl/dsresource?objectid=94111&type=PDF	Yet to be released.	http://www.swedishenergyagency.se/WEB/STEMFe01e.nsf/V_Media00/C12570D10037720FC12573A20037941C/$file/The%20development%20of%20the%20Swedish%20Climate%20Strategy.pdf

Note: Luxembourg and Norway do not have forecasts nor scenarios on national energy supply and demand.

Table II.2. Challenges, efforts and plans

Challenges with forecasts and scenarios	Collecting information on energy technologies, their costs, efficiency, currently and in perspective, to be used in the models. Collecting more accurate information from industries and research institutes on energy technologies which will contribute to improving energy balances. Improvement in the collection and processing of energy statistics.
Efforts	(Cases in Sweden) The Swedish Energy Agency has for several years been involved in a co-operation project with the other Nordic countries. The project's aim is to give an opportunity to exchange ideas and experiences in the field of forecasting and forecasting models. The Agency has also taken part in the workshop on methodology and forecasting arranged by DG Environmen,t. The Nordic countries check with each other so that not all countries are forecasting to export electricity, etc.
Plans	Exchange of data between energy modellers to build internationally validated energy technology databases. Co-operation to extend the standard National Energy Balance format to include energy technology data. Increasing transparency in the data used by the modeller, not only in the major inputs but, if possible, in the whole set of data. Public availability of the model used to forecast. More international co-operation regarding energy and GHG emission forecasts. As the energy markets (especially of electricity) are becoming increasingly international, there may be a need for country-specific forecasts to be checked between countries.

III. Progress in the Delivery of Key Energy Security Policies

1. Introduction and overview

The initial role of the IEA was to help its member countries reduce their exposure to damage from any further oil supply shock. This was to be achieved by equipping them with a collective response mechanism for the short term through the establishment of emergency oil stocks as well as the development of demand restraint mechanisms. In addition, collecting and monitoring market data would help to improve the transparency of oil markets. Policies for the long term included increased efficiency, new geographical sources of oil supply, diversification of energy supplies away from oil and research, development and deployment (RD&D) of new energy technologies.

Since then, security considerations have become more broadly defined. Today, the supply security of other forms of energy, notably natural gas and electricity, is attracting more attention.

Improving relations with energy suppliers will also be essential for IEA member countries' security strategy. Over the last decade or so, an oil producer-consumer dialogue, fostered by the IEA and bringing together IEA countries and OPEC countries, has been successful in establishing a more co-operative relationship between the two groups. Better data collection and exchange for improving transparency in world markets will remain a key piece of this dialogue.

This chapter provides an assessment of the IEA member countries in terms of their energy security, which has been one of the most important issues since the IEA was founded.

This assessment covers a broad spectrum of aspects that impact energy security, from physical infrastructure and market reform to environmental protection. It serves as a synopsis and overview of country progress on what the IEA sees as the key aspects affecting energy security.[1]

2. Matrix

a) Covered countries and topics of review

Seven member countries have been reviewed:

- Canada
- France
- Germany
- Italy
- Japan
- United Kingdom
- United States

[1] This assessment was prepared in advance of the G8 Energy Ministers' Meeting in Japan in June 2008. As such it does not include recent policy advances, particularly with respect to the significant new funding and policy developments related to energy in government stimulus packages enacted in early 2009.

The following seven aspects were evaluated across the seven countries:

- Increasing transparency, predictability and stability of global energy markets.
- Improving the investment climate in the energy sector.
- Enhancing energy efficiency and energy saving.
- Diversifying the energy mix.
- Securing critical energy infrastructure.
- Reducing energy poverty.
- Addressing climate change and sustainable development.

Detailed information on a country-by-country basis is shown in Table III.1.

b) Increasing transparency, predictability and stability of global energy markets

Competition in energy markets: Overall competition in energy markets is improving in the reviewed countries. Downstream oil supply is largely competitive across these countries. In the electricity and gas sectors, large incumbents dominate in Canada, France, Germany, Italy, Japan and parts of the United States, but governments are working to reduce their dominant position. Germany has begun to tackle market liberalisation. A new, independent regulator and new gas transit rules bring significant improvements. Particularly in Italy, lack of competition in the gas sector hinders effective competition in the electricity sector, though the government is working to address this through actions by the Electricity Market Operator. Since the Italian market opened in 2004, the government, operator and regulator have continued to introduce new products and improvements to smooth market functioning and enhance competition. Competition in Italy's gas market is constrained by the strength of the incumbent, but rules are being developed to enhance competition here as well. Gas market liberalisation began in France in 2002, but has also been limited somewhat by the strength of the incumbents and poor market design. Domestic customers in France have been able to choose their gas and electricity suppliers since July 2007. In Japan, the government continues to improve the competitive framework for gas and electricity markets, such as by formulating guidelines for proper gas and electricity trade; nonetheless, competition within and between regions in gas and electricity is more limited than it could be.

Independence of gas and electricity networks: In Europe, progress is being made to develop a system for seamless trade between regions and a level playing field for network operations. The United Kingdom is becoming more interconnected with continental Europe. More work needs to be done, however, particularly with respect to the large incumbents in France and Germany that have a strong role in network operations. As anchors in continental Europe, more effective unbundling of network operations will be key. In Italy, very good progress has been made in the electricity market, with full ownership unbundling of the network and network operator; little competition has developed in the gas market in part because of the strength of the incumbent and the lack of independent network operations. In the United States, reducing seams across states and regions has long been a priority; the Eastern corridor is well integrated, but progress remains to be seen on the West Coast and in the Midwest. Canada is well integrated with the United States, with good cross-border co-ordination and internal seams that have been reduced. In Japan, regions are weakly interconnected, but competition is growing with the development of more independent system operations.

Greater international dialogue: All the reviewed countries participate in the International Energy Forum (IEF), which seeks to broaden the dialogue between energy-producing and consuming countries, an important process in ensuring energy market and supply stability. All countries but Canada and the United States have served on the Executive Board of the IEF at one point in time. Canada and the United States have a long-standing and stable relationship, through such frameworks as the North American Energy Working Group and the North American Free Trade Agreement. Japan is fostering greater energy dialogue in the Asia-Pacific region through its leadership in Asia-Pacific Economic Cooperation (APEC) discussions as well as through the Asia-Pacific Partnership (APP) on Clean Development and Climate (of which the United States and Canada are also members).

Independent regulation: Sound, independent energy market regulation is in place in Canada (the National Energy Board, NEB), France (the Commission for the Regulation of Energy, CRE), Italy (the Regulatory Authority for Electricity and Gas, AEEG), the United Kingdom (OFGEM) and the United States (the Federal Energy Regulatory Commission, FERC, and state regulators). Germany recently developed the Bundesnetzagentur, which has also brought independent regulation to electricity and natural gas markets. While Italy's regulator is independent, the government does have authority to adopt certain provisions if the AEEG does not respond in a timely manner. The IEA is supportive of efforts under way to develop a Europe-wide regulator. Japan's market regulator has been made more independent in recent years, but is still not fully independent from the government, residing inside the government's Agency for Natural Resources and Energy. The Fair Trade Commission is somewhat more independent.

Emergency response measures: The reviewed countries are all in compliance with their IEA oil stock obligation, requiring each country to hold 90 days of net oil imports. As a non-OPEC oil-exporting country, Canada supplies the world oil market, which contributes to its stabilisation. The United States, which is also not a member of OPEC, has plans to further expand stocks held in its Strategic Petroleum Reserve (SPR) in order to maintain the public stock's total days of cover in light of growing net imports. Work to enhance competition, reserve margins and investment in the refining sector would also enhance the ability to respond to oil emergencies. In addition, holding stocks in the form of refined product would be beneficial, and we are pleased to see these are mandatory in the European Union and that the United States and Japan are seriously considering doing this as well. Continued diplomatic efforts are helping ensure security of oil transport through strategic chokepoints in global sea routes, such as the Strait of Malacca, the Strait of Hormuz and the Bosporus Strait.

In addition to oil stocks, individual emergency plans are necessary to ensure energy security. The United Kingdom has developed such plans for natural gas and electricity under its Fuel Security Code, and for oil under its National Emergency Plan for Fuel. Under its Petroleum Stockpiling Law and Petroleum Supply and Demand Optimisation Law, the government of Japan is authorised to gather more energy information under emergency conditions. The government has put in place plans to prevent and manage liquefied natural gas (LNG) and oil emergencies. The government also has special authority under electricity supply emergencies. In Italy, there is an emergency procedure for residential electricity (PESSE). Demand restraint programmes are in place for natural gas. Many emergency guidelines in the United States cover oil, natural gas and electricity, and the Department of Energy is working on technology to improve emergency tools. Such plans have also been in place in France. Germany is well prepared in terms of both total stocks and demand restraint measures. As a net exporter, Canada has no IEA stockholding obligation. Because of its federal structure, most

emergency preparedness instruments are on state level; federal instruments are only implemented in a declared state of emergency.

Good governance of public revenues and action to reduce corruption: Japan recently (in 2006) strengthened its rules in the electricity sector to reduce corruption. Italy, along with Canada (an energy exporter), has committed to endorsing the Extractive Industries Transparency Initiative. Canada is also a signatory of the OECD Guidelines for Multinational Enterprises, which provides a framework of standards for responsible business conduct. In the United States, the Federal Energy Regulatory Commission and the Commodity Futures Trading Commission have enhanced efforts to combat corruption in energy markets. Other countries, including the United Kingdom, maintain strong anti-corruption policies in the energy sector, both through general anti-corruption regulations and enforcement and through energy sector-specific regulation.

Areas for improvement: High energy prices, along with the twin challenges of concentrated energy supplies and climate change have put energy security at the top of all reviewed countries' policy agendas. Efforts to move away from traditional fossil fuels to more diversity and sustainability have accelerated. We are pleased that all reviewed countries have sufficient oil stocks on hand. In periods of high energy prices, we urge all countries to avoid the political pressure to reduce oil taxes or release oil stock levels or intake to artificially lower prices temporarily – as this will undermine long-term energy security and provide only a tiny amount (if any) of short-term relief. Over the longer term, the IEA urges action in a few priority areas. Enhancing competition in the gas and electricity sectors is essential. Germany and France should continue their ongoing work to anchor the continental European gas and electricity markets through greater independence and transparency, along with enhanced interconnections across borders. Italy should continue to focus on improving the functioning of its gas market in particular, as this will enhance operation of its electricity market. In Japan, greater focus on independent regulation and market integration will enhance domestic security. The United States is encouraged to include product stocks into the Strategic Petroleum Reserve. Canada, while not obliged to hold emergency reserves, should consider the benefits these would have on its supply security. Both North American countries should continue their efforts to integrate electricity markets and remove seams across domestic and international borders.

c) Improving the investment climate in the energy sector

Facilitating investment in supply and demand infrastructure and measures: Much-needed investment is occurring in Italy, where significant electricity generating capacity is being constructed and planned. Grid investment, for both the gas and electricity sectors, is also expected. Given recent challenges in the country, this new investment is very welcome. Under its recent Energy Policy Act, the United States has developed and enhanced many incentives for investments in energy infrastructure – in particular, streamlining the siting and permitting process. In particular, the Energy Policy Act works to facilitate the process of obtaining approval for LNG facilities by giving the Federal Energy Regulatory Commission (FERC) sole siting authority. The Energy Policy Act also enhanced incentives for new infrastructure, such as by removing limitations on investment, establishing last-resort federal siting authority for certain transmission lines and generally clarifying regulatory authority for siting of new projects. Under new regulations that took effect in June 2007, Germany has taken steps to ease the process to connect new supply to the grid. It is also drafting a law to counteract delays in planning and authorisation procedures for new infrastructure – which will hopefully help address the poor north-south interconnections in Germany. Through the establishment of the Major Projects Management Office in 2007, Canada has streamlined infrastructure siting and permitting for major projects, while still ensuring the necessary

transparency and regulatory oversight. The United Kingdom facilitates investment through its support of competitive markets, as well as through a transparent and stable regulatory framework. Forthcoming planning and energy bills will improve transparency within the planning system for potential energy infrastructure projects, with the aim of reducing delays. In Japan, public interest privilege and investment incentives have been provided to companies that build pipelines in areas where a pipeline network does not exist and/or where it would interconnect existing pipeline systems. The government is also providing long-term low-interest funding through fiscal investments and loans (*e.g.* the Energy Reform Tax Credit Programme). In addition, it provides incentives for private Japanese companies to invest in upstream hydrocarbon exploration and production (E&P) through its Japan Oil, Gas and Metals Corporation (JOGMEC). Under its Long-term Programme on Investment (PPI), France identifies necessary investment needs for the security of the electricity sector. Under a similar programme for gas, the Long-Term Indicative Investment Planning programme (PIP), supply of gas for the coming decade is evaluated to ensure security.

Development of competitive power markets: As discussed, sound, competitive markets in energy already exist in the United Kingdom. Nevertheless, the government continues to work to enhance regulation of monopoly transmission of electricity and to enhance non-discriminatory access to network grids. To improve network regulation, Germany has been aggressively targeting network grid fees, lowering the costs of participating in electricity markets, along with improving grid regulation. Canada and the United States both support fair and competitive energy markets. In the United States, this is underpinned by FERC's network open access and real-time information rules. Both countries are working to remove seams between regions within each country and co-operatively to remove cross-border seams. Decisions to fully implement reform are, however, often made largely at the state level. Similarly, market liberalisation is progressing in Japan; the market in electricity began in 2000 and by 2006, 64% of retail sales had been liberalised. Liberalisation of the power markets in Italy and France continue to press forward.

Removing barriers to cross-national investments in the energy sector and market integration: Extended transmission capacity in electricity and gas between the United Kingdom and the continent further enhances the UK's markets, as do the country's LNG import terminals. The regulator and government are working to further integrate the gas market with continental Europe, and are in the process of developing electricity connections to continental Europe. Canada and the United States work together with Mexico on energy issues through the North American Energy Working Group, where collaboration is pursued, particularly addressing barriers to the expansion of clean energy supply. Canada also issued guidelines in 2007 clarifying rules for evaluating investments by foreign state-owned enterprises. All reviewed countries are signatories to the 1991 Energy Charter political declaration; all but the United States and Canada are parties to the 1994 Energy Charter Treaty, whose aim is to strengthen the rule of law on energy issues, by creating a level playing field of rules to be observed by all participating governments, thereby mitigating risks associated with energy-related investment and trade. Japan continues to work to enhance energy import source and route diversity, such as through the Sakhalin-2 project to bring crude oil and natural gas to the southern tip of Sakhalin Island in Russia. Italy is investing in cross-border power interconnections with Albania, Croatia, Sicily and Sardinia. In the gas sector, Italy is planning upgrades along its South-North and North-East backbones, and in the Po Valley. Many new LNG terminals are planned. In the context of the Pentalateral Forum, Germany is working to better integrate its market with those of France, Belgium, the Netherlands and Luxembourg. Additional regional initiatives, such as with Denmark, are also bringing greater market integration.

Adequately maintaining and developing the energy labour force: Government efforts to identify and address shortages of key energy skills in the United Kingdom have evolved into a new skills academy

(OPITO), driven by the private sector. After a review of energy and resource labour needs in 2007, the government of Japan planned to start supporting the efforts of academia and industry that are aimed at supporting international energy resource development. In 2006, the government started an effort aimed at training 20 000 nuclear workers, and works to cultivate talent in nuclear sciences by introducing programmes in primary, secondary and higher education. The United States has many programmes to develop the energy and technical workforce, such as through the Department of Energy, the Department of Labor, the National Science Foundation and the Nuclear Regulatory Commission. Italy and France do not have any government programmes specifically focused on developing the energy labour force.

Areas for improvement: Ensuring energy security will require continued and stable investment in all parts of the energy supply chain, including exploration and production of hydrocarbons, development of renewables, construction of LNG import terminals and maintenance and expansion of transmission and distribution grids for gas and electricity. We are pleased to see countries working to address NIMBY ("not in my backyard") issues, by developing streamlined and transparent siting and permitting processes for critical energy infrastructure. In particular, developing new power lines is a complex process; initiatives to create collaborative and clear processes are welcome. Investment in upstream hydrocarbon development is also important, thus we welcome the moves by Canada to create transparent processes to review investments by foreign state-owned firms. In general, limits on foreign ownership of energy assets hinders investment and should be avoided – the IEA does not see the current trend towards the creation of national champions as helpful to investment as it crowds out other options and deters market integration. Many reviewed countries are creating rules that detail limits on foreign investment. We urge these rules to be clear and transparent – and limited to truly strategic assets. Long-term energy security depends upon a skilled workforce; we urge countries to continue to support human resource development and, in Italy and France in particular, to develop new programmes where support is lacking. We urge Germany and France to continue efforts to integrate their markets with continental Europe, as expanding the market is the easiest way to enhance collective security and develop competition. As discussed in Section 1, improving market data is key to market functioning. We are pleased to see all reviewed countries focusing on developing better and more transparent data as this will enhance energy markets' ability to manage risk.

d) Enhancing energy efficiency and energy saving

Strengthened policies in the building sector: We are pleased to see countries working to strengthen building codes. Notably, Japan has initiated work to expand its building code requirements, which currently cover only large buildings, to cover a larger share of smaller residential buildings. Many states in the United States and provinces in Canada, along with Germany, France, Italy and the United Kingdom, have updated or strengthened their standards since 2006 and/or are planning to do so in the next few years.

Enhanced energy efficiency data collection: Germany, Italy, Japan, the United Kingdom and the United States now collect data on the energy performance of existing buildings. Further, many countries also have policies that aim to improve energy efficiency in existing buildings. A good example of recent developments in this regard is the EcoENERGY for Buildings and Retrofit programme of Canada's federal government. However, the uptake of these measures – *i.e.* the actual achievement or real efficiency improvements – in existing buildings is generally slow and all countries could substantially increase their efforts in this area. It is essential that such efforts include activities to increase the awareness of energy efficiency in the buildings sector and raise the market

profile of the energy performance of buildings. Similarly, more work should be done to develop a comprehensive package of complementary measures that together address the key barriers to improved energy efficiency in existing buildings.

Enhanced uptake of more energy-efficient appliances: Most developed countries have established standards and labelling programmes that cover traditional residential appliances, such as refrigerators and freezers, dishwashers, air conditioners and washing machines, among others. One challenge has been in maintaining the stringency of policy measures and expanding their scope. One of the better examples of succeeding on this front is found in Canada. The United States, which had not met its own expectations in this area in recent years, has now set strict timetables for updating standards and has adopted streamlined consultative processes in order to catch up with its backlog. Similarly the EU (covering France, Germany, Italy and the United Kingdom) has fallen behind many countries in terms of both the coverage and stringency of its mandatory programmes, but is now attempting to address these shortcomings. Turning to stand-by power, while most individual product policies are voluntary, the number of countries and products where stand-by power is the subject of regulation is growing. The United States and Japan, for example, have introduced stand-by requirements in mandatory labelling minimum energy performance standards (MEPS) or Top Runner Program for some products, or will do so in the near future.

Moving to best practice in lighting: In Canada, a range of amendments took effect in July 2006, including the harmonisation of efficiency standards for fluorescent lamp ballasts with those of the Energy Star Program in the United States. In March 2009, the European Commission adopted a regulation on non-directional household lamps which would replace inefficient incandescent bulbs by more efficient alternatives between 2009 and 2012. In April 2007, Canada's federal government announced the phase-out of the use of incandescent light bulbs by 2012. In fact, much activity is occurring with respect to phasing out inefficient incandescent lighting. In Germany, a phase-out will be implemented as part of its implementation of the EU Ecodesign Directive. In Italy, a phase-out is anticipated in the National Energy Efficiency Action Plan, submitted to the European Commission in July 2007. In the United Kingdom, the government announced in September 2007 its plan to phase out incandescent light bulbs by way of a voluntary agreement with major light bulb makers, retailers and energy utilities. In the United States, the Energy Law passed in December 2007 requires lighting to use up to 30% less energy, which effectively amounts to a phase-out of the traditional light bulb (by 2012 and 2014, depending on bulb type). The European Commission, covering France, the United Kingdom, Germany and Italy, has proposed more stringent energy efficiency requirements for incandescent lamps by 2009 and is in the process of considering regulatory options, while Japan is also considering taking action.

Improving transport sector efficiency: Target measures in the transport sector are improving tyre pressure and developing and strengthening fuel efficiency standards. The European Commission, covering France, Germany, Italy and the United Kingdom, announced in February 2007 that it would propose a legislative framework that includes setting maximum rolling resistance limits for tyres fitted on passenger cars and light commercial vehicles. The IEA is not aware of any other country-specific developments of note with regard to maximum rolling resistance, nor with regard to measures to promote proper inflation levels. Turning to fuel economy, mandatory fuel efficiency standards exist in Japan and the United States. With regard to stringency, the levels set in Japan provide the best example at present. Additionally, the United States will set a fuel economy standard of 35 miles per gallon by 2020, which will increase fuel economy standards by 40% according to a recent federal government announcement. Canada and the EU have voluntary agreements on fuel economy standards with vehicle manufacturers. The EU voluntary agreement, for example, aims to reduce the average CO_2 emissions of new cars to 140 g/km by 2008-2009. Although progress has

been made in reducing average emissions of new cars across the EU, it appears possible that the 140 g/km target will not be achieved. Both the EU and Canada have recently announced their intention to develop mandatory measures. In February 2007, as part of its announcement to achieve a target of 120 g/km by 2012, the European Commission said that 130 g/km of this target should come from vehicle fuel efficiency. Subsequently, it announced a proposed regulation in December 2007. In an April 2007 policy statement, the Canadian government announced its intention to develop regulation for the fuel efficiency of cars and light duty trucks, beginning with the 2011 model year. It is also noted that some countries have other types of policy measures in place that are designed to encourage fuel efficiency, such as vehicle tax differentiation and consumer information schemes.

Areas for improvement: Responding to G8 requests, the IEA presented 16 recommended energy efficiency policies to the St. Petersburg and Heiligendamm Summits in 2006 and 2007 respectively. If fully implemented, globally, these recommended actions could save up to 5 700 megatonnes (Mt) of carbon dioxide (CO_2) per year by 2030. Progress in implementing the IEA recommendations varies across countries and between recommendations, and no country has fully implemented all of the IEA recommendations, though some countries have established a range of pertinent measures. However, in most instances, these measures could be updated or further strengthened, the scope of their application broadened and compliance better monitored and enforced. This particularly applies to the recommendations on new and existing buildings, and to those on minimum energy performance and stand-by power requirements for appliances. In several other areas, for example fuel efficiency standards for light duty vehicles and low power modes for electronic equipment, certain countries have introduced voluntary measures, but there are still few or no instances of mandatory requirements. In the case of these recommendations, the IEA considers mandatory measures to be an important part of ensuring that the full savings potential in the relevant sub-sector is met. Across all of the IEA recommended areas of activity, there are instances where relevant policy measures have been drafted or are being considered but have not yet been implemented. If fully and properly implemented, these measures could achieve significant savings, but, of course, it remains to be seen if this will occur. This applies with regard to the recommendations on fuel-efficient tyres, on tyre pressure monitoring systems and international test procedures, on the phase-out of incandescent lamps and on the strengthening of building regulations. Finally, ensuring effective enforcement and compliance procedures remains a universal issue across many of the recommendations, particularly in the buildings and appliances sub-sectors. Such procedures are a central aspect of successful policy development and implementation in all energy efficiency sub-sectors, and should be further pursued by all countries.

e) Diversifying the energy mix

Diversifying energy supply: Supply of energy in the reviewed countries is relatively diverse, though oil continues to supply the lion's share in all countries. Nevertheless, this share has been decreasing in all countries. One major concern among energy-importing countries is their sources of supply. For example, in Japan, almost 90% of its supply of oil comes from OPEC countries. We are pleased to see it continue to be a top priority to expand sources of oil, including by import country and route, and of natural gas, including by import country, route and type (pipeline gas or LNG).

Developing domestic renewable resources: The IEA is pleased to see the importance being placed on rapidly deploying renewables. The renewables obligation is the primary mechanism for deploying renewables in the United Kingdom, and has led to a doubling of generation since its introduction in 2002. Some difficulties were encountered and adjustments to the scheme are in the works. With

respect to biofuels, the United Kingdom has put in place a renewable transport fuel obligation that rises from 2.5% in 2008/09 to 5% in 2010/11. In Canada, the ecoENERGY Renewable Initiative provides incentives to produce heat and power from renewable resources. It has also put in place a renewables obligation for biofuels in the transport sector, which has also been done in the United States, the European Union (France, Germany, Italy, the United Kingdom) and Japan. In Japan, the key means of promoting renewables is the renewable portfolio law, which calls for about 0.4% of electricity supply to come from renewables in 2006, climbing steadily through 2016. Japan is also supporting renewables through significant R&D funding. The feed-in tariff in Germany has resulted in dramatic deployment of renewables.

Developing domestic cleaner coal resources (including CCS): The United Kingdom has launched a competition to support a coal plant with carbon capture and storage (CCS) on a commercial scale and is in the process of developing a regulatory regime for CCS. The government is investing in new technologies, including CCS, through a number of mechanisms, including the newly created Energy Technologies Institute. Canada has been working to develop CCS options through international collaboration. Japan has prioritised CCS as a key technology under its Cool Earth Innovative Technology Programme, and provides significant support of large-scale demonstration projects.

Reducing natural gas flaring: All offshore gas flaring is tightly controlled in the United Kingdom and, since the beginning of 2008, is also included in the EU Emissions Trading Scheme. The government also supports the World Bank-led Global Gas Flaring Reduction partnership.

Developing nuclear resources: Canada has expanded its support of nuclear power, including operations and R&D, particularly through the support of Atomic Energy of Canada Limited. Nuclear power is a key component of the country's long-term energy strategy, and receives much government attention. To further promote nuclear safety following the Niigata earthquake in Japan, the government's inspection system was reviewed and the government is educating local communities about the improved inspection system.

Addressing long-term nuclear waste disposal: In 2007, Canada accepted the Nuclear Waste Management Organization's recommended approach of adaptive phased management for managing nuclear fuel waste over the long term. Japan's Specified Radioactive Waste Final Disposal Act was enacted in 2000 and sets out a process for selecting disposal areas and other processes.

Developing other alternative resources: In order to promote innovation and low-carbon technologies, public funding is increasing steadily in the United Kingdom. In Canada, innovative technologies are supported by the ecoENERGY Technology Initiative, which has identified eight priority areas for investment in sustainable energy.

Areas for improvement: The best way to ensure energy security is through diversity and development of alternative sources. The reviewed countries continue to work to reduce their reliance on imported and domestic fossil fuels – and efforts in this area should continue – and are raising the diversity of fuel sources generally. Diversity of import sources and routes is also essential, so the development of new routes, such as through construction of new LNG terminals and pipelines, is also very welcome. More importantly, development of domestic resources is key, and we are pleased to see the efforts being paid to develop renewables. We regret that European countries, including France, Germany, Italy and the United Kingdom, have not been able to develop a continental market for renewables yet, but are encouraged by continued discussions by the European Union of such a market, in order to lower the overall cost and accelerate the pace of development, as well as link it with that of the developing continental power market. In Japan, renewables remain a small share of the country's energy fuel mix. While the large investments in R&D that the country is making are welcome, more aggressive targets should also be considered. We

are pleased to see states in the United States developing regional renewables markets, but the development of a federal system should be the ultimate goal. International efforts aimed at reducing gas flaring have succeeded in reducing wasted gas and excess emissions, but more work remains to be done. Nuclear will need to be part of the long-term energy mix internationally and regionally – countries that can adequately address the nuclear waste disposal challenge through a transparent and reliable system will be successful in further expanding nuclear capacity. The IEA is pleased to see the attention being paid to developing a framework for introducing CCS to new and future fossil power plants. Successful deployment of CCS will require careful international collaboration, technology funding and engagement with the private sector.

f) Securing critical energy infrastructure

Inventory of security priorities: The United Kingdom keeps the major areas of energy infrastructure under constant review to determine what elements are critical for energy delivery. Where key sites are identified, security requirements with industry are put in place. Canada has developed a National Strategy for Critical Infrastructure Protection, which lays out a partnership programme for information sharing and protection between the public and private sectors. In addition, Canada and the United States are working collaboratively on security vulnerability assessments of critical cross-border energy infrastructure. Japan's inventory of security priorities focuses primarily on nuclear facilities. As such, it is establishing Nuclear Emergency Operations Facilities.

Ensuring security of transportation routes: To ensure such security, information sharing with other countries is a high priority for the United Kingdom. Given the source of most of Japan's oil imports, securing the Strait of Malacca is of vital importance for the country.

Areas for improvement: It is difficult for the IEA to adequately assess the effectiveness of the reviewed countries' efforts to secure vital energy infrastructure, as limited information has been provided to us. This is likely with some good reasons, given the sensitivity of the subject. However, given that the energy security of one country is closely linked to that of others, we urge governments to create more cross-country dialogue. We also urge all governments to continue to maintain up-to-date inventories of existing infrastructure, to undergo rigorous sensitivity analysis in order to understand and identify critical points in network infrastructure, to design emergency plans that take into account a variety of circumstances and to develop close collaboration with all actors in the energy sector.

g) Reducing energy poverty

Progress towards funding the Millennium Development Goals: While there is no specific goal focused on energy, expanding access to energy can contribute to the achievement of all the Millennium Development Goals (MDGs). Flowing from the United Nations MDGs, the United Kingdom supports several initiatives, including the EU Energy Initiative for Poverty Eradication and Sustainable Development and the Global Village Energy Partnership. Canada also supports the MDGs, including through financial support that goes to the World Bank's Clean Energy for Development Investment Framework and the Inter-American Development Bank's Sustainable Energy and Climate Change Initiative. Japan's official development assistance (ODA) charter designates poverty reduction as a priority issue; Japan supports the MDGs through its ODA. The United States' Millennium Challenge is one of the government's key tools to aggressively support poverty reduction in developing countries.

Other initiatives aimed at reducing energy poverty: The United Kingdom provides funding to the World Bank Energy Sector Management Assistance Programme, the new Clean Energy Investment Framework, the Infrastructure Consortium for Africa and through bilateral programmes in Bangladesh and Sierra Leone. Through its Canadian International Development Agency, Canada supports developing countries, with support focused more on enhancing the regulatory environment in which the power industry operates. Among industrialised countries, Japan's financial assistance to the energy sector in developing countries makes it the largest donor. The government also provides private-sector loans to the energy sector in developing countries. Further assistance will be provided through Japan's Cool Earth Partnership, launched in 2008.

***Areas for improvement*:** Limited information was provided by most governments on initiatives to expand access to electricity and clean cooking fuels, apart from funding to various programmes. We are pleased to see governments commit funds to general poverty eradication programmes and programmes that target energy poverty specifically. However, we see that more work can be done to facilitate the creation of sound energy policies, to enhance institutional and human resource capacities and to integrate hydrocarbon development with energy poverty eradication. Efforts made to develop technologies to harness renewable and distributed energy in developing countries should continue. This requires that governments remain aware of the value of energy technology transfers to developing countries.

h) Addressing climate change and sustainable development

Progress towards achieving Kyoto targets (if applicable): The United Kingdom is on track to reduce its greenhouse gas emissions by 23% by 2010, almost double its target under the Kyoto Protocol. With the use of the Kyoto flexibility mechanisms (joint implementation and the clean development mechanism), Japan has developed a plan to achieve its Kyoto target. Germany, France, Italy and Canada have put in place policies to achieve their Kyoto targets, most with the help of flexibility mechanisms.

Other policies to reduce carbon dioxide emissions: The European Union's Emissions Trading Scheme, which covers France, Germany, Italy and the United Kingdom and has been in operation since 2005, is a key mechanism by which EU countries are achieving parts of their targets under the Kyoto Protocol and the EU Burden-Sharing Agreement. This system exists alongside a range of other policies and strategies at each national level. In addition, the United Kingdom's Climate Change bill, when passed, will make it the first country in the world to have a legally binding long-term framework to reduce greenhouse gas emissions and adapt to climate change. Canada is pursuing its climate change strategy through its Clean Air Agenda under which it has established emission intensity targets for greenhouse gas emissions. The government has set a goal of reducing greenhouse gases by 20% from 2006 levels by 2020. Voluntary agreements in Japan continue to reduce emissions in industrial sectors, and other measures are in place under the country's Kyoto Protocol Target Achievement Plan.

Policies to implement a market signal for greenhouse gas emissions: Countries covered by the European Union's Emissions Trading Scheme (EU-ETS), the United Kingdom, France, Germany and Italy, have a price signal that covers a significant share of their emissions – industrial and energy installations. Additionally, the United Kingdom has a Climate Change Levy that taxes energy use to encourage energy efficiency. Some regions and states in the United States are developing emissions trading schemes, and a federal system is under consideration by several bills currently before

Congress. In Japan, a voluntary carbon offset system is in place and the government is considering a more expansive system that will cover small and medium-sized enterprises.

Areas for improvement: Addressing climate change is a challenge for the entire globe. The EU-ETS, which covers half of the reviewed countries (the United Kingdom, Germany, France and Italy) is a good starting point, as it provides a market signal for greenhouse gases across two large parts of the greenhouse gas-emitting economy. As the EU-ETS enters into Kyoto's first commitment period (2008-2012), we are pleased to see that governments have learned from earlier experience; particularly with respect to Germany, which had over-allocated emission rights to coal-fired power plants in the past. We are also pleased to see new initiatives to develop market signals for greenhouse gases in Japan, Canada and the United States. We urge these countries to implement meaningful systems quickly, and work together to create systems that can be unified over time. In the shorter term, other policies will be needed, such as those covered earlier that enhance energy efficiency and develop alternative and renewable resources. Governments must continue to develop urgently not only their own policies but also comprehensive global and international ones. Stabilising anthropogenic greenhouse gas emissions will require bold leadership and strong political will.

3. Critique

In short, the IEA is generally pleased with the progress made in recent years to enhance security, particularly in a few key areas: enhancing gas and electricity market functioning, enhancing gas and electricity market physical integration, working to improve and shorten the infrastructure siting process and maintaining sufficient oil stocks. We see real progress in electricity market functioning in many reviewed countries, though gas market functioning is progressing more slowly. With respect to fuel mix, government policies are generally enhancing the basket of options available through measures aimed at renewables and alternative sources. Energy security may also be enhanced by a new renaissance in nuclear power. All countries are stepping up attention and policies to address climate change, though the level of ambition, the quality of policies and the amount or type of financial support varies widely. Energy efficiency – usually the cheapest and easiest option – is taking primacy in most government policies, a move we wholeheartedly support.

In fact, one of the areas that the IEA is asked to address – both in this assessment and in other tasks – is energy efficiency. Here we can be clear: governments are not taking full advantage of the opportunities to significantly reduce energy consumption and carbon dioxide emissions through their energy efficiency policies, and to do so in the most cost-effective manner possible. Considerable progress has been made in strengthening standards and other measures, particularly in the lighting and appliance sectors. However, much work remains to capture the full benefit of the recommendations. Work is required in the transportation and building sectors among others. In short, across-the-board action is needed to ensure full implementation of all relevant energy efficiency policies. Particular attention is needed on institutional issues such as compliance and enforcement. We urge governments to continue to work towards enhanced efficiency across various sectors, with particular attention paid to implementing the IEA energy efficiency recommendations.

We are pleased to see that governments are generally pressing forward with reform of gas and electricity markets. With independent, well-resourced regulators in place and a proper framework that levels the playing field for all participants, competition can develop. This competition brings new players to the sector to build new infrastructure and enhance economic efficiency (and lower consumer prices). To foster this competition, governments must set up good rules and regulations, but resist temptations to unduly protect or promote particular national interests. In addition,

markets need economies of scale to develop – the progress on integrating physical infrastructure is encouraging, but more should be done, particularly as this is the best means of reducing the dominance of large incumbents. Increasing physical and market integration will require co-operation among countries; enhanced physical integration will also require early and deep engagement with local communities. Finally, for sustainable competitive energy markets to develop, we urge governments to continue working towards creating a value for carbon dioxide emissions that permeates through the economy.

Such a value for emissions will also help spur innovation in renewables and alternative energy technologies. While the private sector must have the right incentives to invest in energy innovation and clean technologies, governments will, at the same time, need to continue to play an active role in bringing these technologies to market. Investing public funds in energy R&D will bring long-term public benefits, and governments should further increase this funding, ensuring that it leverages private funding and does not unnecessarily attempt to pick technology winners. Governments are already working to increase this funding; we urge them to be even more courageous in their energy R&D budgets. As new technologies emerge, governments must be proactive in ensuring that the right legal and policy framework is in place for them to emerge. This will require continued international collaboration.

4. Recommendations

Governments should:

Investment

- Continue to streamline processes for siting energy infrastructure and make them more transparent.
- Keep improving the quality and timeliness of energy data, and become more transparent in reporting.
- Continue to reduce dependence on oil, particularly in the transport sector.
- Secure critical infrastructure through vigilant oversight of existing infrastructure, detailed and dynamic analysis of network flows and close collaboration with all actors in the energy sector.
- Ensure that expanding access to energy is a priority in all international energy projects with developing countries.

Market development

- Take additional action to ensure well-functioning energy markets through free market prices and data transparency, independent regulators, effective non-discriminatory operation of networks and good physical and market integration across borders.
- Resist the urge to reduce strategic oil stock levels as a tool to reduce domestic energy prices.

Good governance and regulation

- Continue to engage in global energy dialogue.
- Maintain a vigilant commitment to good governance of national energy companies.
- Refrain from limiting international investments in energy sectors where possible.
- Limit undue meddling in the consolidation and/or restructuring of the energy sector; and abstain from developing national energy champions.
- Work more closely together to accelerate the development of renewable and alternative energy options, including carbon capture and storage.
- Ensure a skilled energy workforce remains a government priority.

Climate change and energy efficiency

- Address climate change through a basket of different policies and measures across all sectors.
- Continue to raise significantly the profile of energy efficiency across all sectors of the economy through policies and measures, including standards, taxes, incentives and other policies; implement the IEA concrete recommendations on energy efficiency as quickly as possible.
- Implement a market signal that places a value on greenhouse gas emissions throughout the economy as quickly as possible, with a view to developing a system that can be harmonised and integrated.
- Expand R&D programmes on clean energy technologies as a priority.
- Support the development of renewable and alternative energy with a view to deployment in developing countries.

5. Sources

This chapter was prepared using the following sources:

- Self-evaluations completed by each of the seven reviewed countries;
- "Global Energy Security", St. Petersburg Summit, 16 July 2006; and
- St. Petersburg Plan of Action, Global Energy Security, IEA evaluation of G8 countries' progress on the seven key action areas.

Table III.1. Matrix – Global energy security

	Canada	France
I. Increasing transparency, predictability and stability of global energy markets **Competition in energy markets* **Independence of gas and electricity networks* **Data transparency and free flow of information* **Greater international dialogue* **Independent regulation* **Emergency response measures* **Good governance of public revenues and action to reduce corruption*	*Large incumbents dominate gas and electricity markets *Working to reduce seams with the US *Excellent data availability through Natural Resources Canada *Independent regulator in place *In compliance with stockholding obligation	*Large incumbents dominate gas and electricity markets *More work to be done to improve network operational independence *Energy exchange developing *Gas and electricity data provided by system operators *Independent regulator in place *In compliance with stockholding obligation
II. Improving the investment climate in the energy sector **Facilitating investment in supply and demand infrastructure and measures* **Development of competitive power markets* **Removing barriers to cross-national investment in the energy sector and market integration* **Adequately maintaining and developing the energy labour force*	*Streamlining infrastructure siting *Work with US and Mexico on energy issues through North American Energy Working Group	*Identifies necessary infrsatructure investment through Long-Term Programme on Investment
III. Enhancing energy efficiency and energy saving **Development of integrated energy policy* **Strengthened policies in the building sector* **Enhanced energy efficiency data collection* **Enhanced uptake of more energy-efficient appliances* **Moving to best practice in lighting* **Improving transport sector efficiency*	*Updating building code requirements *Good system in place to enhance scope and stringency of appliance efficiency standards *Harmonised lighting standards with US	*Updating building code requirements *Working to meet timelines for efficiency standards *Developing rules on tyre pressure
IV. Diversifying energy mix **Diversifying energy supply* **Removing barriers to cross-national investment in the energy sector and market integration* **Developing domestic cleaner coal resources (including CCS)* **Reducing natural gas flaring* **Developing nuclear resources* **Addressing long-term nuclear waste disposal* **Developing other alternative resources*	*ecoEnergy Renewable Initiative provides incentives for heat and power from renewables *Working to develop CCS options through international collaboration *Expanded support of nuclear power *Accepted Nuclear Waste Management Organisation's recommendation on nuclear fuel management	*Biofuels obligation in place *Renewable energy target in place
V. Securing critical energy infrastructure **Inventory of security priorities* **Ensuring security of transportation routes*	*Developed a National Strategy for Criticfal Infrastructure Protection *Working collaboratively with the US on security vulnerability assessments	
VI. Reducing energy poverty **Progress towards funding the Millennium Development Goals* **Other initiatives aimed at reducing energy poverty*	*Supports MDGs, including through financial support for the World Bank's Clean Energy for Development Investment Framework and the Inter-American Development Bank's Sustainable Eneryg and Climate Change Initiative *Provides support through its International Development Agency	
VII. Addressing climate change and sustainable development **Progress towards achieving Kyoto targets (if applicable)* **Other policies to reduce carbon dioxide emissions* **Policies to implement a market signal for greenhouse gas emissions*	*Pursuing climate change strategy through its Clean Air Agenda (currently under development)	*Developed a plan to achieve its Kyoto target *EU Emissions Trading Scheme in effect

Table III.1. Matrix – Global energy security (*continued*)

	Germany	**Italy**
I. Increasing transparency, predictability and stability of global energy markets **Competition in energy markets* **Independence of gas and electricity networks* **Data transparency and free flow of information* **Greater international dialogue* **Independent regulation* **Emergency response measures* **Good governance of public revenues and action to reduce corruption*	*Large incumbents dominate gas and electricity markets *Has begun to tackle liberalisation of gas and electricity markets *More work to be done to improve network operational independence *Energy exchange developing *Efforts to improve data availability undertaken *Recently established independent regulator *In compliance with stockholding obligation	*Large incumbents dominate gas and electricity markets *Lack of competition in the gas sector hinders competition in electricity sector *Full ownership unbundling of electricity network operator *Data provided through Sistan system *Independent regulator in place *In compliance with stockholding obligation
II. Improving the investment climate in the energy sector **Facilitating investment in supply and demand infrastructure and measures* **Development of competitive power markets* **Removing barriers to cross-national investment in the energy sector and market integration* **Adequately maintaining and developing the energy labour force*	*Working to ease process of connecting new supply to the grid *Working to lower grid investment fees *Working to import markets with those of France	*Significant electricity generation constructed and planned *Plans to being supporting academic and industry efforts at international resource development
III. Enhancing energy efficiency and energy saving **Development of integrated energy policy* **Strengthened policies in the building sector* **Enhanced energy efficiency data collection* **Enhanced uptake of more energy-efficient appliances* **Moving to best practice in lighting* **Improving transport sector efficiency*	*Updating building code requirements *Collects data on the energy performance of existing buildings *Working to meet timelines for efficiency standards *Phasing out incandescent lightbulbs *Developing rules on tyre pressure	*Updating building code requirements *Collects data on the energy performance of existing buildings *Working to meet timelines for efficiency standards *Phase-out of incandescent bulbs anticipated *Developing rules on tyre pressure
IV. Diversifying energy mix **Diversifying energy supply* **Removing barriers to cross-national investment in the energy sector and market integration* **Developing domestic cleaner coal resources (including CCS)* **Reducing natural gas flaring* **Developing nuclear resources* **Addressing long-term nuclear waste disposal* **Developing other alternative resources*	*Biofuels obligation in place *Renewable energy target in place	*Biofuels obligation in place *Renewable energy target in place
V. Securing critical energy infrastructure **Inventory of security priorities* **Ensuring security of transportation routes*		
VI. Reducing energy poverty **Progress towards funding the Millennium Development Goals* **Other initiatives aimed at reducing energy poverty*		
VII. Addressing climate change and sustainable development **Progress towards achieving Kyoto targets (if applicable)* **Other policies to reduce carbon dioxide emissions* **Policies to implement a market signal for greenhouse gas emissions*	*Developed a plan to achieve its Kyoto target *EU Emissions Trading Scheme in effect	*Developed a plan to achieve its Kyoto target *EU Emissions Trading Scheme in effect

Table III.1. Matrix – Global energy security (*continued*)

	Japan	**United Kingdom**
I. Increasing transparency, predictability and stability of global energy markets **Competition in energy markets* **Independence of gas and electricity networks* **Data transparency and free flow of information* **Greater international dialogue* **Independent regulation* **Emergency response measures* **Good governance of public revenues and action to reduce corruption*	*Large incumbents dominate gas and electricity markets *Working to improve competitive market framework *Regions are weakly interconnected, but competition is growing in electricity sector *Working to update data collection and organisation *Provides weekly oil data *Steps taken to improve independence of regulator *In compliance with stockholding obligation	*Becoming more integrated with continental Europe *Good energy data available from government *Independent regulator in place *In compliance with stockholding obligation
II. Improving the investment climate in the energy sector **Facilitating investment in supply and demand infrastructure and measures* **Development of competitive power markets* **Removing barriers to cross-national investment in the energy sector and market integration* **Adequately maintaining and developing the energy labour force*	*Public interest privileges and investment incentives encourage infrastructure investment *Working to enhance import source and route diversity	*Developed a new skills academy (OPITO)
III. Enhancing energy efficiency and energy saving **Development of integrated energy policy* **Strengthened policies in the building sector* **Enhanced energy efficiency data collection* **Enhanced uptake of more energy-efficient appliances* **Moving to best practice in lighting* **Improving transport sector efficiency*	*Working to enhance building code requirements *Collects data on the energy performance of existing buildings *Implementing stand-by power standards *Currently has the most stringent fuel efficiency requirements for vehicles	*Updating building code requirements *Collects data on the energy performance of existing buildings *Working to meet timelines for efficiency standards *Phasing out incandescent bulbs through a voluntary agreement *Developing rules on tyre pressure
IV. Diversifying energy mix **Diversifying energy supply* **Removing barriers to cross-national investment in the energy sector and market integration* **Developing domestic cleaner coal resources (including CCS)* **Reducing natural gas flaring* **Developing nuclear resources* **Addressing long-term nuclear waste disposal* **Developing other alternative resources*	*Prioritised CCS as a key technology under its Cool Earth programme *Nuclear Waste Disposal Act enacted in 2000	*Has doubled renewables electricity generation since 2002 *Renewable energy target in place *Biofuels obligation in place *Launched a competition to support CCS on a commercial scale and developing regulatory regime for CCS *Offshore gas flaring is tightly controlled
V. Securing critical energy infrastructure **Inventory of security priorities* **Ensuring security of transportation routes*	*Inventory in place, with a focus on nuclear facilities	*Major areas of energy infrastructure are under constant review
VI. Reducing energy poverty **Progress towards funding the Millennium Development Goals* **Other initiatives aimed at reducing energy poverty*	*Poverty reduction is a prioirty issue of its official development assistance charter	*Suppports several initiatives under the MDGs, including the EU Energy Initiative for Poverty Eradication and Sustainable Development, and the Global Village Energy Partnership *Provides funding to the World Bank Energy Sector Management Assistance Programme, the new Clean Energy Investment Framework, the Infrastructure Consortium for Africa, among others
VII. Addressing climate change and sustainable development **Progress towards achieving Kyoto targets (if applicable)* **Other policies to reduce carbon dioxide emissions* **Policies to implement a market signal for greenhouse gas emissions*	*Developed a plan to achieve its Kyoto target *Voluntary carbon offset programme in place	*On track to reduce its GHG emissions by 23% below 1990 levels *EU Emissions Trading Scheme in place *Climate change levy encourages energy efficiency

Table III.1. Matrix – Global energy security (*continued*)

	United States
I. Increasing transparency, predictability and stability of global energy markets **Competition in energy markets* **Independence of gas and electricity networks* **Data transparency and free flow of information* **Greater international dialogue* **Independent regulation* **Emergency response measures* **Good governance of public revenues and action to reduce corruption*	*Large incumbents dominate gas and electricity markets *Working to reduce seams across markets internally and with Canada *Excellent data transparency through Energy Information Administration *Provides weekly oil data *Independent regulator in place *In compliance with stockholding obligation
II. Improving the investment climate in the energy sector **Facilitating investment in supply and demand infrastructure and measures* **Development of competitive power markets* **Removing barriers to cross-national investment in the energy sector and market integration* **Adequately maintaining and developing the energy labour force*	*Enhanced incentives for infrastructure, including siting rules *Work with Mexico on energy issues through North American Energy Working Group *Programmes in plaec to to develop energy and technical workforce
III. Enhancing energy efficiency and energy saving **Development of integrated energy policy* **Strengthened policies in the building sector* **Enhanced energy efficiency data collection* **Enhanced uptake of more energy-efficient appliances* **Moving to best practice in lighting* **Improving transport sector efficiency*	*Updating building code requirements *Collects data on the energy performance of existing buildings *Working to meet new stricter timelines for efficiency standards *Implementing stand-by power standards *Phasing out incandescent lightbulbs
IV. Diversifying energy mix **Diversifying energy supply* **Removing barriers to cross-national investment in the energy sector and market integration* **Developing domestic cleaner coal resources (including CCS)* **Reducing natural gas flaring* **Developing nuclear resources* **Addressing long-term nuclear waste disposal* **Developing other alternative resources*	*Renewables obligations and other incentives in place at state and federal levels *New incentives in place for nuclear power
V. Securing critical energy infrastructure **Inventory of security priorities* **Ensuring security of transportation routes*	*Working collaboratively with Canada on security vulnerability assessments
VI. Reducing energy poverty **Progress towards funding the Millennium Development Goals* **Other initiatives aimed at reducing energy poverty*	*Millennium Challenge is a key tool in poverty reduction plan
VII. Addressing climate change and sustainable development **Progress towards achieving Kyoto targets (if applicable)* **Other policies to reduce carbon dioxide emissions* **Policies to implement a market signal for greenhouse gas emissions*	*Regions and states developing greenhouse gas trading systems and targets

Table III.1. Matrix – Global energy security (*continued*)

	Areas for improvement
I. Increasing transparency, predictability and stability of global energy markets **Competition in energy markets* **Independence of gas and electricity networks* **Data transparency and free flow of information* **Greater international dialogue* **Independent regulation* **Emergency response measures* **Good governance of public revenues and action to reduce corruption*	*Germany and France should continue their ongoing work to anchor the continental European gas and electricity markets through greater independence and transparency, along with enhanced interconnections across borders *Italy should continue to focus on improving functioning of its gas market in particular, as this will enhance operation of its electricity market *In Japan, greater focus on independent regulation and market integration will enhance domestic security *The United States is encouraged to include product stocks into the Strategic Petroleum Reserve. *Canada, while not obliged to hold emergency reserves, should consider the benefits these would have on its supply security *Canada and the US should continue their efforts to integrate electricity markets and remove seams across domestic and international borders
II. Improving the investment climate in the energy sector **Facilitating investment in supply and demand infrastructure and measures* **Development of competitive power markets* **Removing barriers to cross-national investment in the energy sector and market integration* **Adequately maintaining and developing the energy labour force*	*Initiatives to create collaborative and clear processes for infrastructure siting are welcomed *Investment in upstream hydrocarbon development is important; moves by Canada to create transparent processes to review investments by foreign state-owned firms is welcomed *In general, limits on foreign ownership of energy assets hinders investment and should be avoided – the current trend towards creation of national champions crowds out other options and deters market integration *We urge that rules on foreign investments be clear and transparent – and limited to truly strategic assets. *We urge countries to continue to support human resource development and, in Italy and France in particular, develop new programmes where support is lacking *We urge Germany and France to continue efforts to integrate their markets with continental Europe *We are pleased to see all G8 countries focusing on developing better and more transparent data
III. Enhancing energy efficiency and energy saving **Development of integrated energy policy* **Strengthened policies in the building sector* **Enhanced energy efficiency data collection* **Enhanced uptake of more energy-efficient appliances* **Moving to best practice in lighting* **Improving transport sector efficiency*	*In general, energy efficiency measures could be updated or further strengthened, the scope of their application broadened and compliance better monitored and enforced *This particularly applies to the recommendations on new and existing buildings, and to those on minimum energy performance and stand-by power requirements for appliances *In several other areas, for example fuel efficiency standards for light-duty vehicles and low-power modes for electronic equipment, certain countries have introduced voluntary measures, but there are still few or no instances of mandatory requirements. In the case of these recommendations, the IEA considers mandatory measures to be an important part of ensuring that the full savings potential in the relevant subsector is met *Policies are under development with regard to fuel-efficient tyres, tyre-pressure monitoring systems and international test procedures, to the phase-out of incandescent lamps, and to the strengthening of building regulations *Ensuring effective enforcement and compliance procedures remains a universal issue across many of the recommendations, particularly in the buildings and appliances subsectors
IV. Diversifying energy mix **Diversifying energy supply* **Removing barriers to cross-national investment in the energy sector and market integration* **Developing domestic cleaner coal resources (including CCS)* **Reducing natural gas flaring* **Developing nuclear resources* **Addressing long-term nuclear waste disposal* **Developing other alternative resources*	*We are pleased to see the efforts being paid to develop renewables *We are encouraged by continued discussions by the European Union of a continental market for renewables in the longer term *In Japan, renewables remain a small piece of the country's energy fuel mix. While the large investments in R&D that the country is making are welcome, more aggressive targets should also be considered *We are pleased to see states in the US developing regional renewables markets. Development of a federal system should be the ultimate goal *Nuclear will need to be part of the long-term energy mix internationally and regionally; countries that can adequately address the nuclear waste disposal challenge through a transparent and reliable system will be successful in further expanding nuclear capacity *We are pleased to see attention being paid to developing a framework for introducing CCS to new and future fossil power plants

Table III.1. Matrix – Global energy security (*continued*)

	Areas for improvement
V. Securing critical energy infrastructure **Inventory of security priorities* **Ensuring security of transportation routes*	*Governments should continue to maintain up-to-date inventories of existing infrastructure *Rigorous sensitivity analysis to understand and identify critical points in network infrastructure should continue *Emergency plans that take into account a variety of circumstances and to develop close collaboration with all actors in the energy sector.
VI. Reducing energy poverty **Progress towards funding the Millennium Development Goals* **Other initiatives aimed at reducing energy poverty*	*Limited information provided by most governments on initiatives to expand access to electricity and clean cooking fuels, apart from funding levels to various programmes. *We are pleased to see governments commit funds to general poverty eradication programmes and programmes that target energy poverty specifically. *More work can be done to facilitate the creation of sound energy policies, to enhance institutional and human resource capacities and to integrate hydrocarbon development with energy poverty eradication. *Efforts made to develop technologies to harness renewable and distributed energy in developed countries should continue to be cognisant of the technology's value in being transferred to developing countries.
VII. Addressing climate change and sustainable development **Progress towards achieving Kyoto targets (if applicable)* **Other policies to reduce carbon dioxide emissions* **Policies to implement a market signal for greenhouse gas emissions*	*The EU Emissions Trading Scheme, which covers the United Kingdom, Germany, France and Italy, is a good starting point in developing a market signal for greenhouse gases *We are pleased to see new initiatives to develop market signals for greenhouse gases in Japan, Canada and the US. We urge these countries to implement meaningful systems quickly, and work together to create systems that can be unified over time. *In the shorter term, other policies will be needed, such as those covered earlier by enhancing energy efficiency and developing alternative and renewable resources. Governments must continue to urgently develop their own policies while developing comprehensive global and international ones as well. *Stabilising anthropogenic greenhouse gas emissions will require bold leadership and strong political will.

Annex A. Key Energy Statistics*

*The graphs in Annex A used the data in the 2008 edition of the IEA on-line data service released in December 2008.

Australia

Figure 1. Energy production

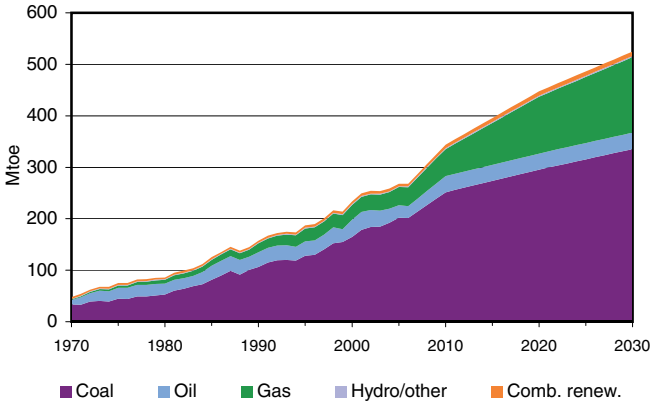


Figure 2. Total primary energy supply

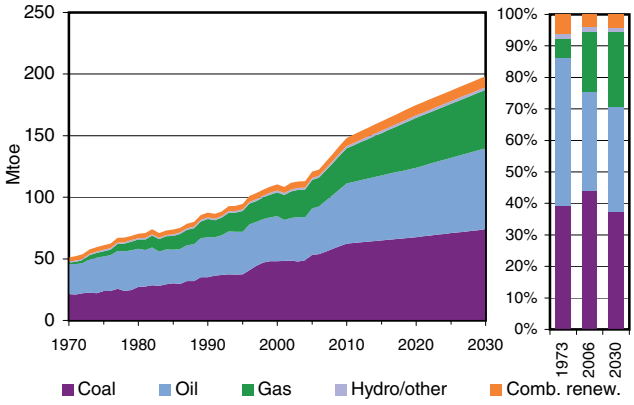


Figure 3. Energy self-sufficiency*

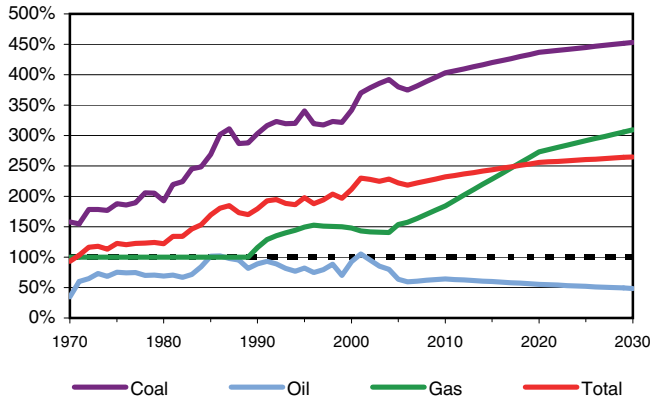


Figure 4. Electricity generation by fuel

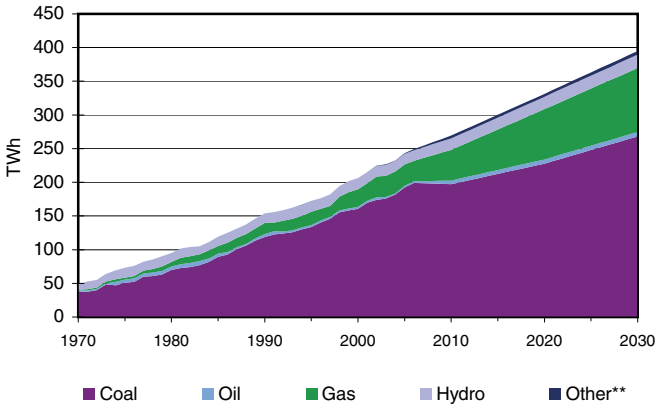


Figure 5. Breakdown of final consumption by sector and by source

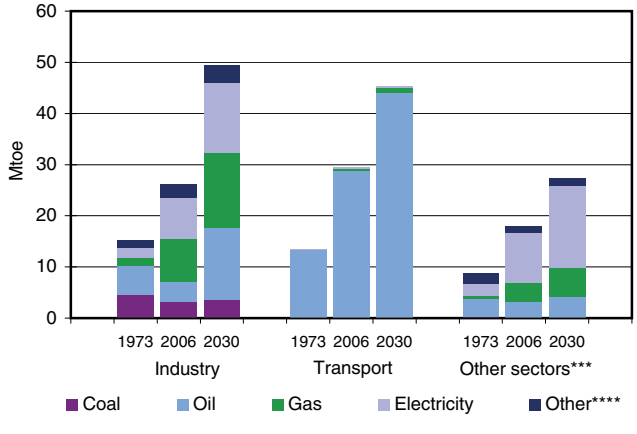
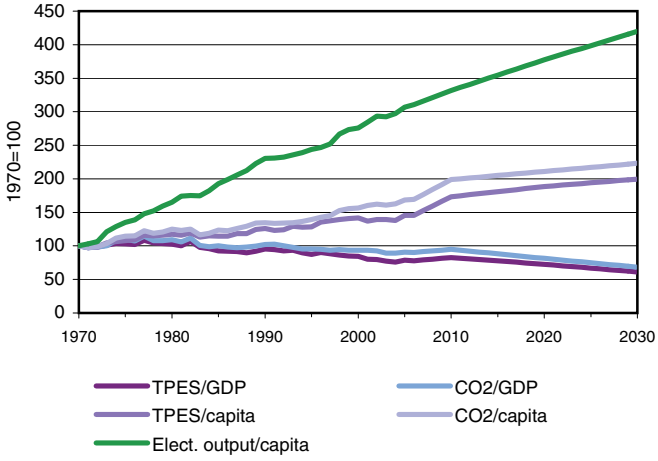


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Austria

Figure 1. Energy production

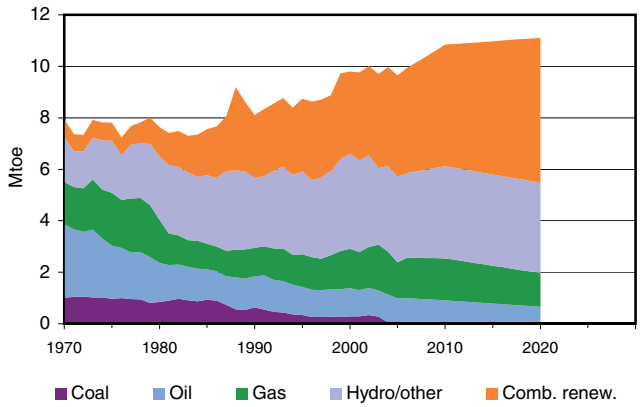


Figure 2. Total primary energy supply

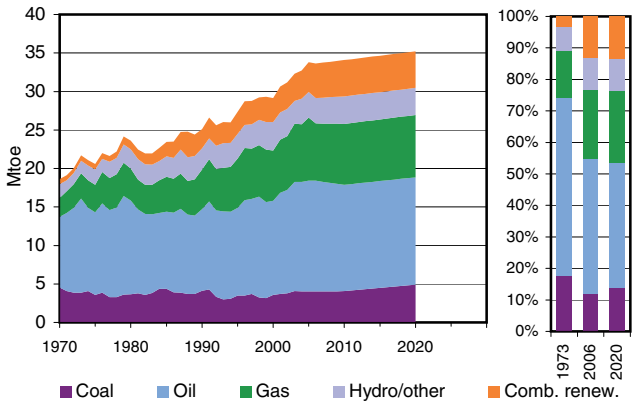


Figure 3. Energy self-sufficiency*

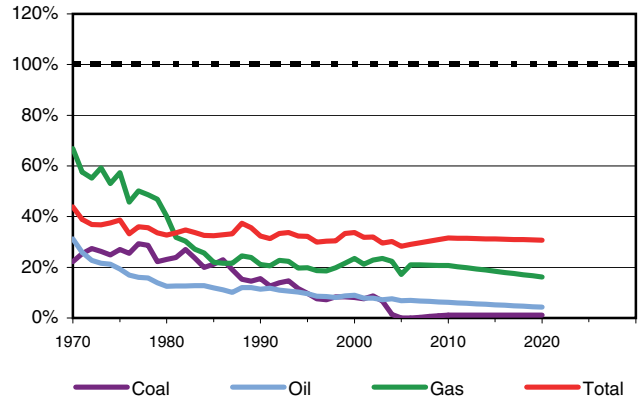


Figure 4. Electricity generation by fuel

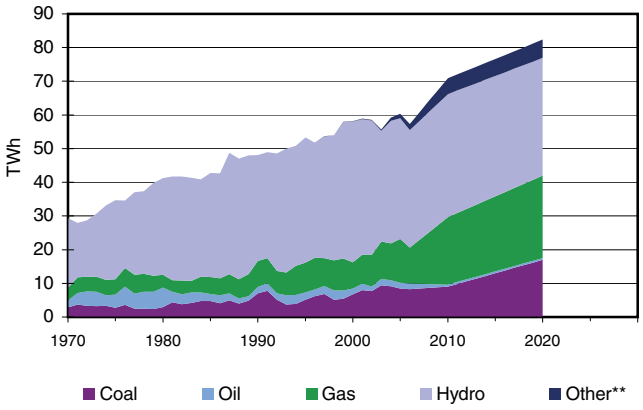


Figure 5. Breakdown of final consumption by sector and by source

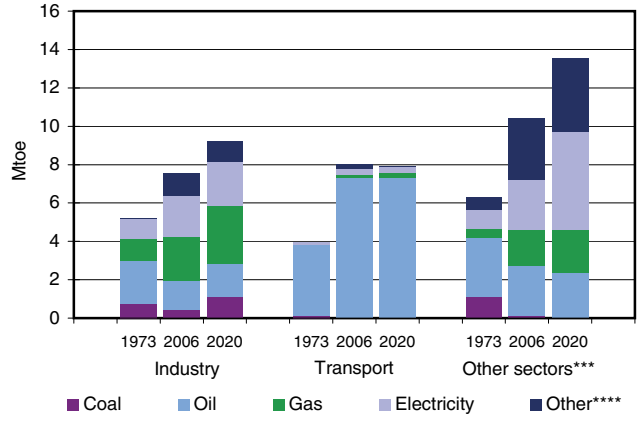
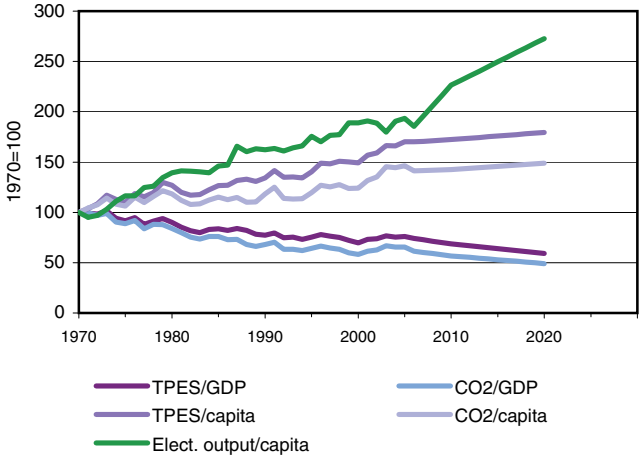


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Belgium

Figure 1. Energy production

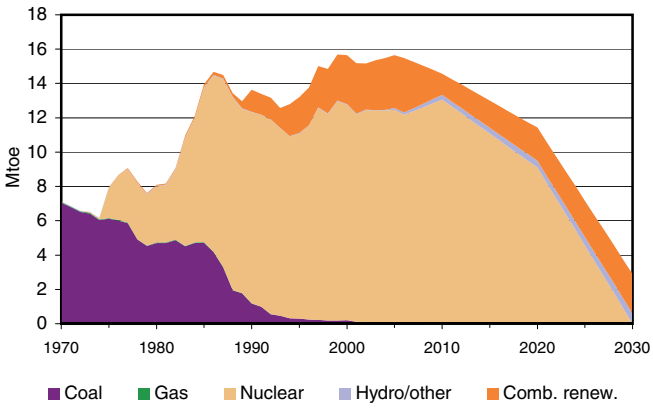


Figure 2. Total primary energy supply

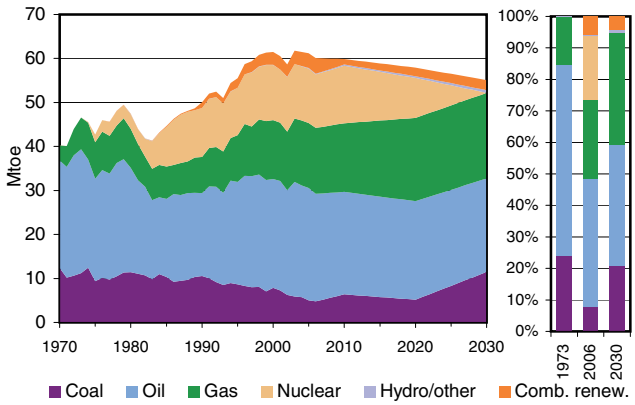


Figure 3. Energy self-sufficiency*

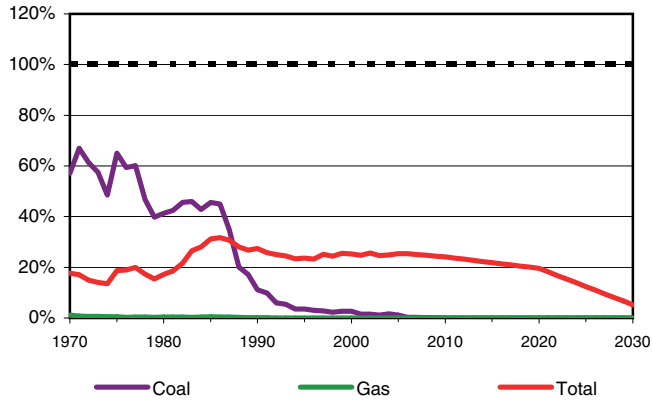


Figure 4. Electricity generation by fuel

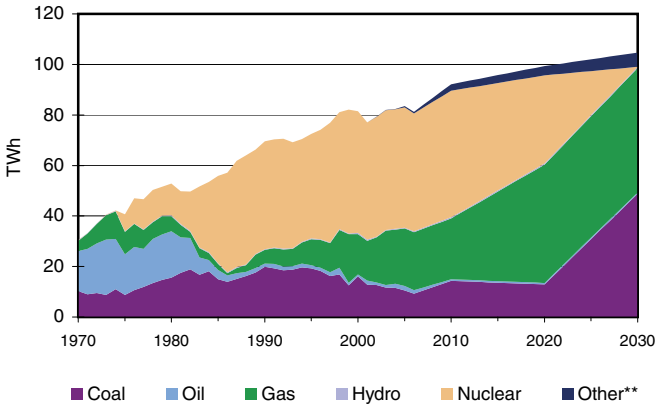


Figure 5. Breakdown of final consumption by sector and by source

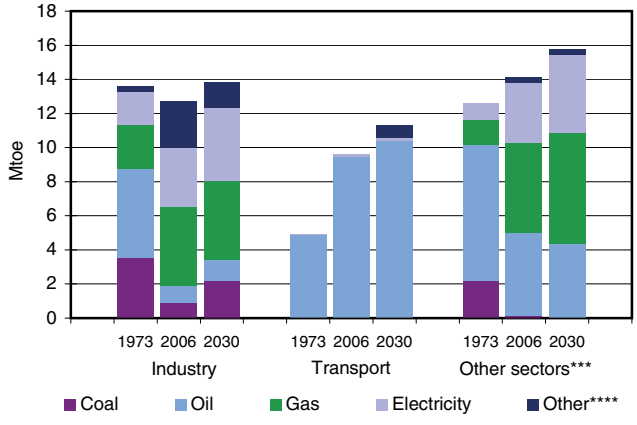
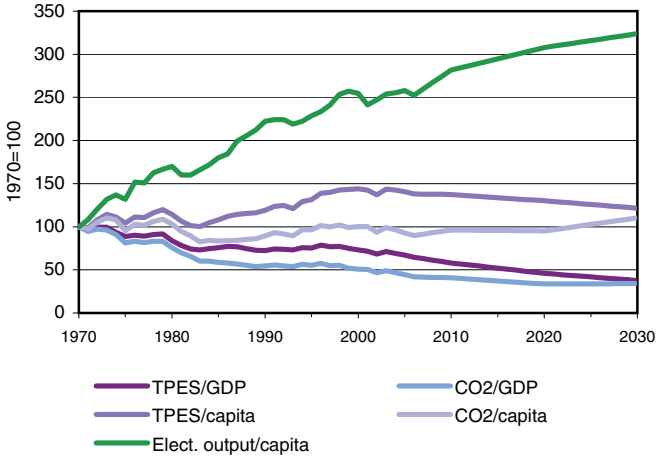


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Canada

Figure 1. Energy production

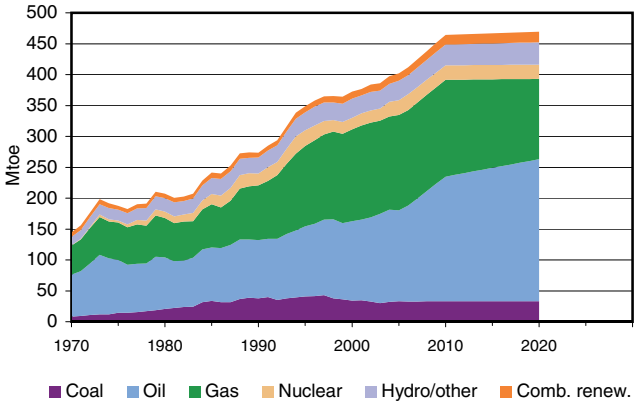


Figure 2. Total primary energy supply

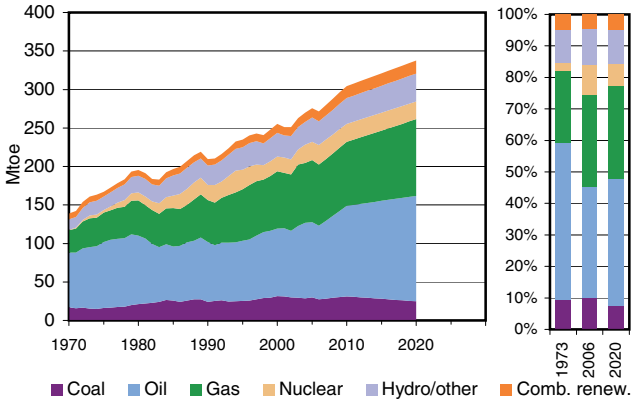


Figure 3. Energy self-sufficiency*

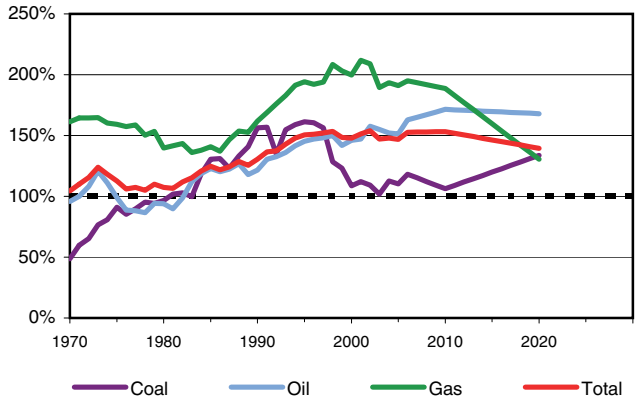


Figure 4. Electricity generation by fuel

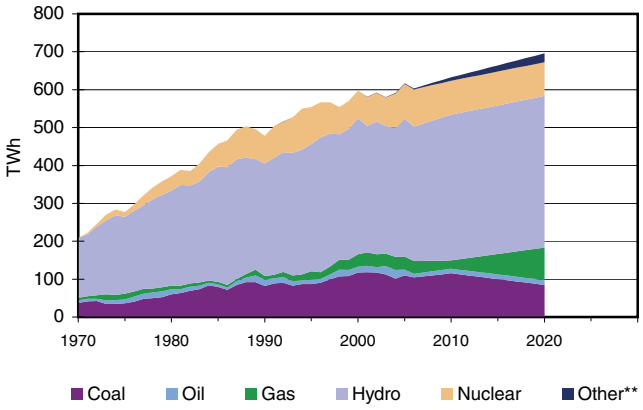


Figure 5. Breakdown of final consumption by sector and by source

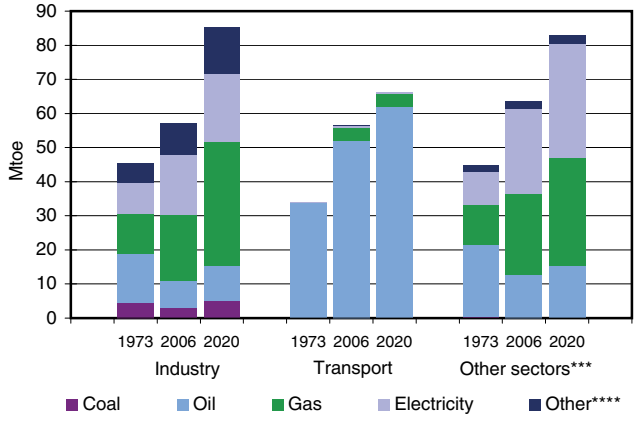
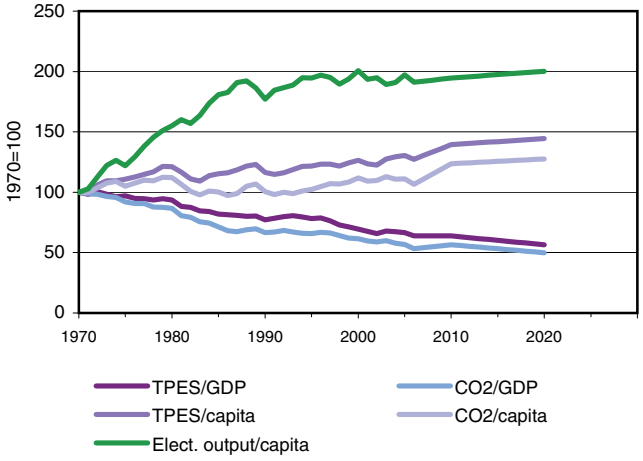


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Czech Republic

Figure 1. Energy production

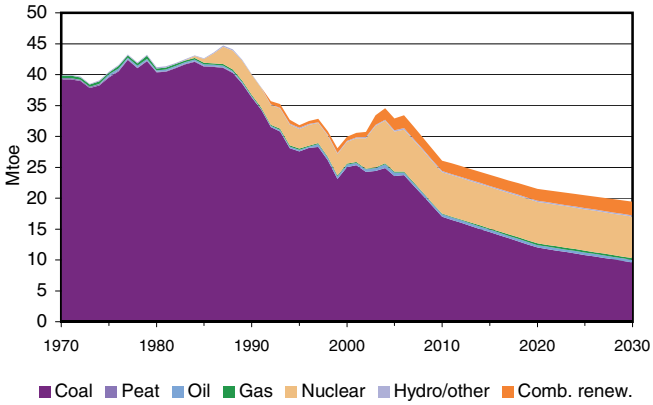


Figure 2. Total primary energy supply

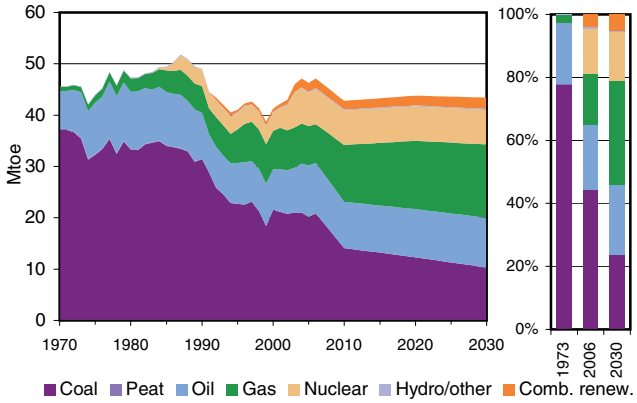


Figure 3. Energy self-sufficiency*

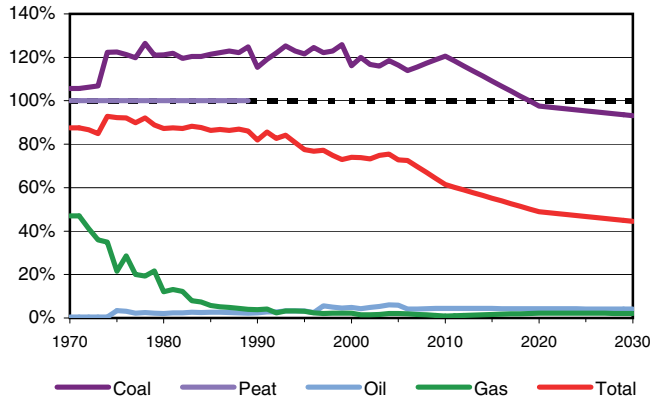


Figure 4. Electricity generation by fuel

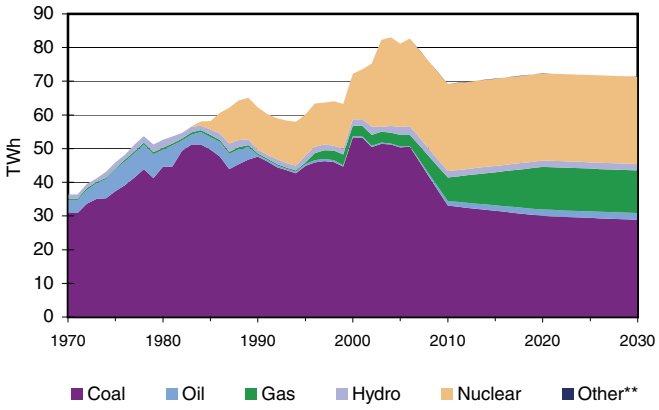


Figure 5. Breakdown of final consumption by sector and by source

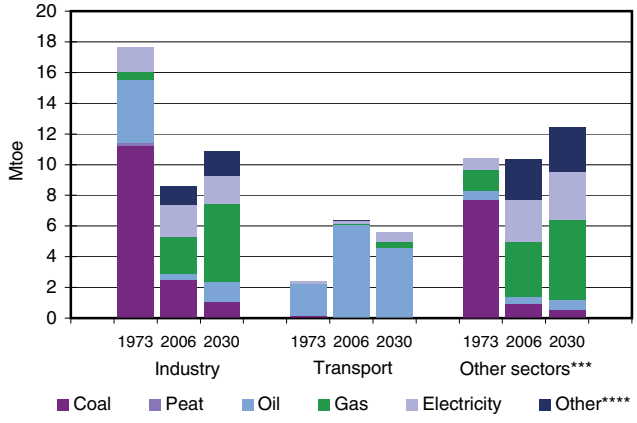
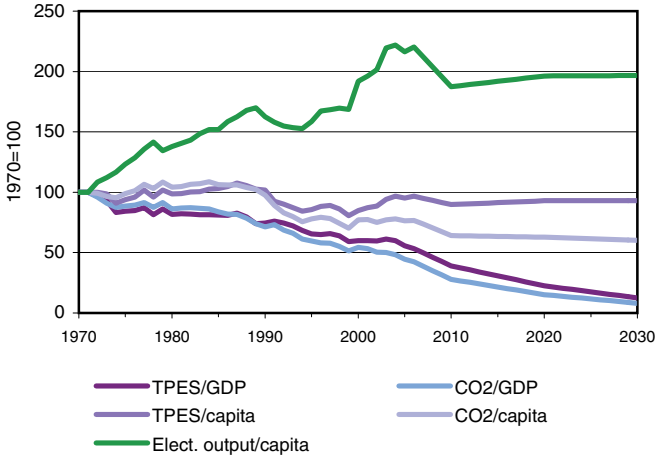


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Denmark

Figure 1. Energy production

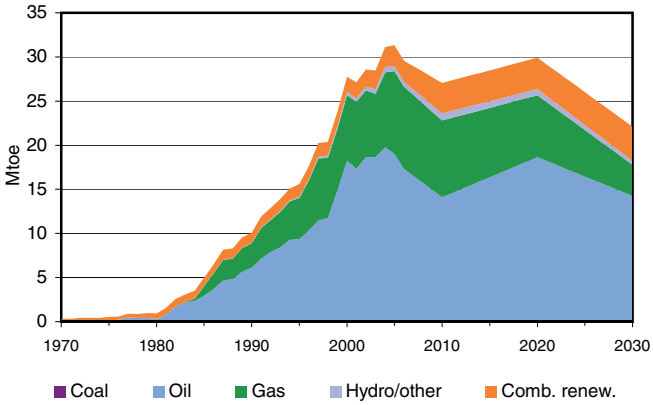


Figure 2. Total primary energy supply

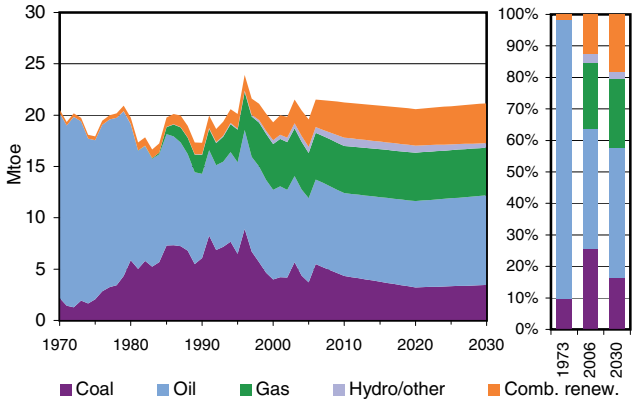


Figure 3. Energy self-sufficiency*

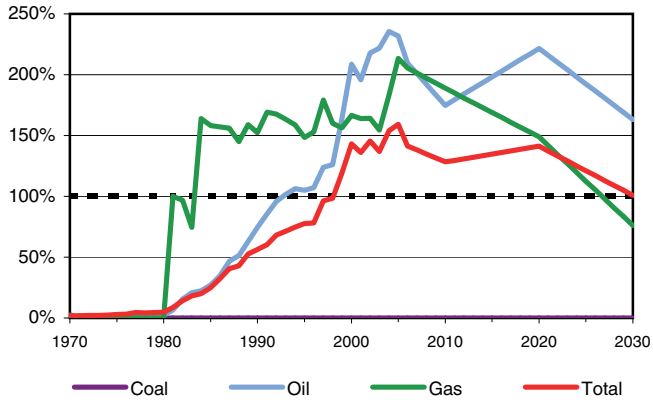


Figure 4. Electricity generation by fuel

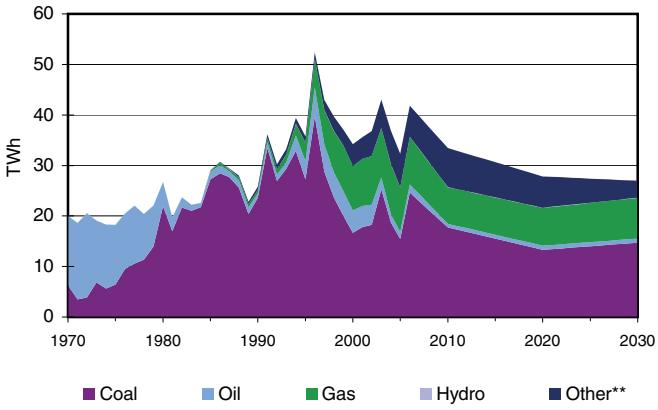


Figure 5. Breakdown of final consumption by sector and by source

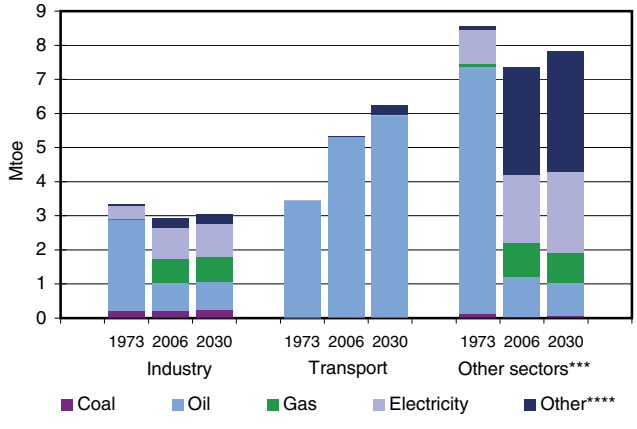
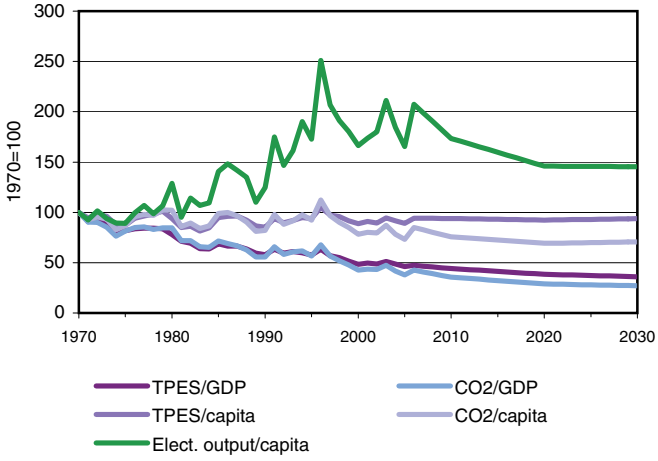


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Finland

Figure 1. Energy production

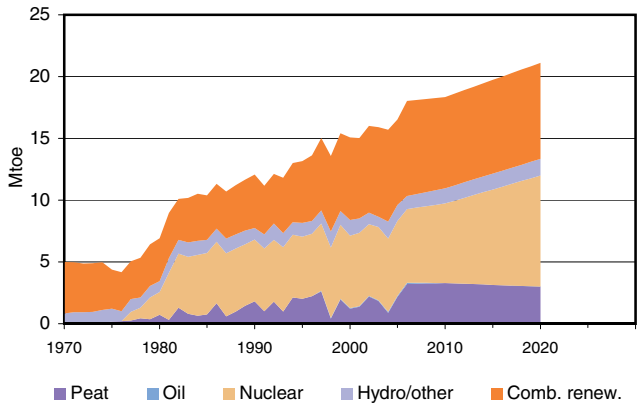


Figure 2. Total primary energy supply

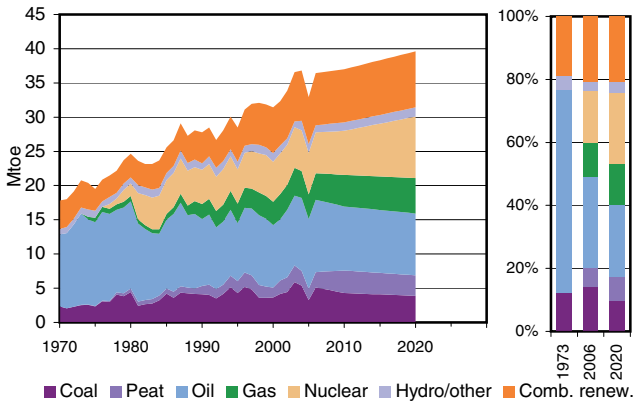


Figure 3. Energy self-sufficiency*

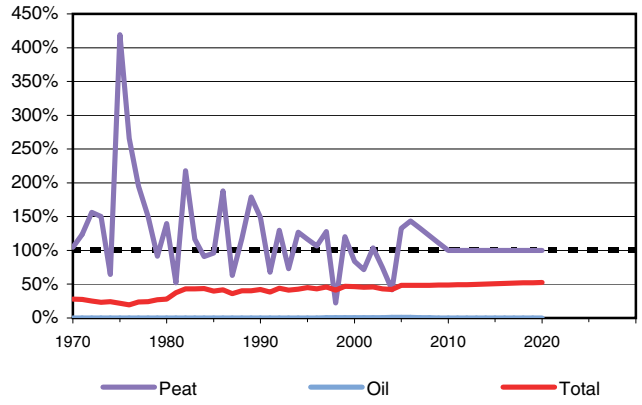


Figure 4. Electricity generation by fuel

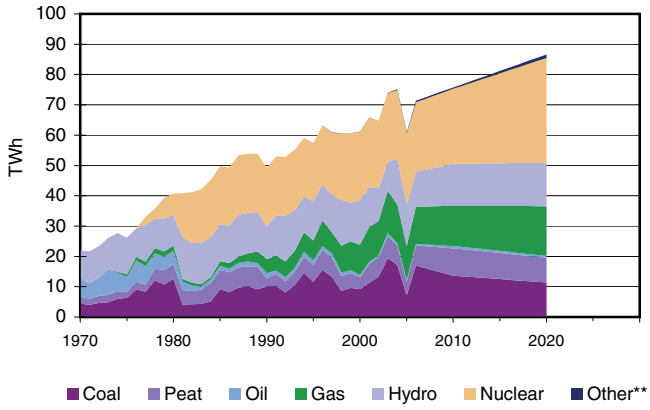


Figure 5. Breakdown of final consumption by sector and by source

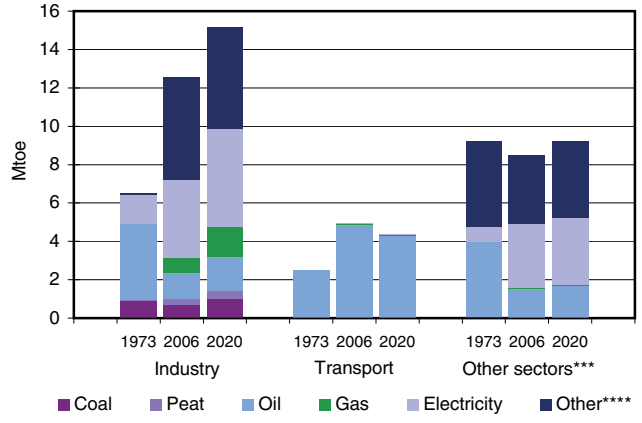
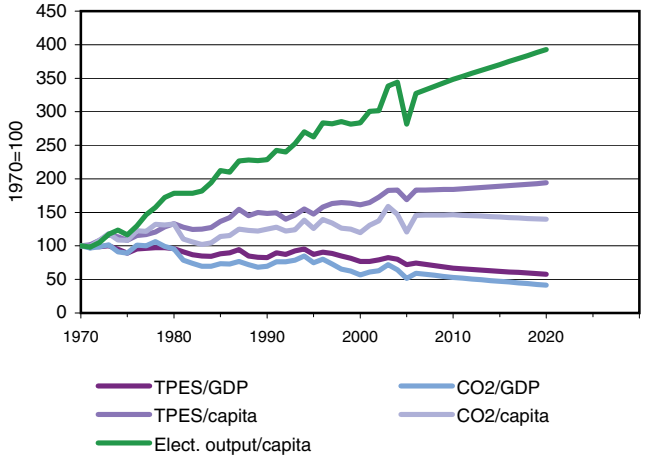


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

France

Figure 1. Energy production

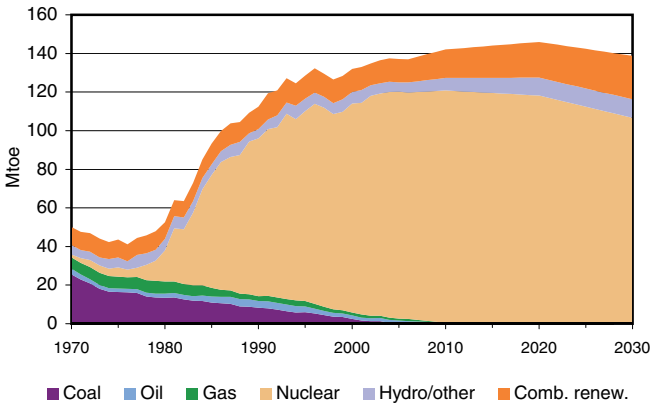


Figure 2. Total primary energy supply

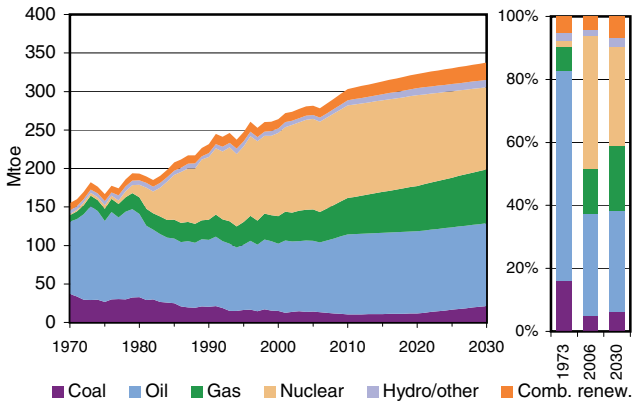


Figure 3. Energy self-sufficiency*

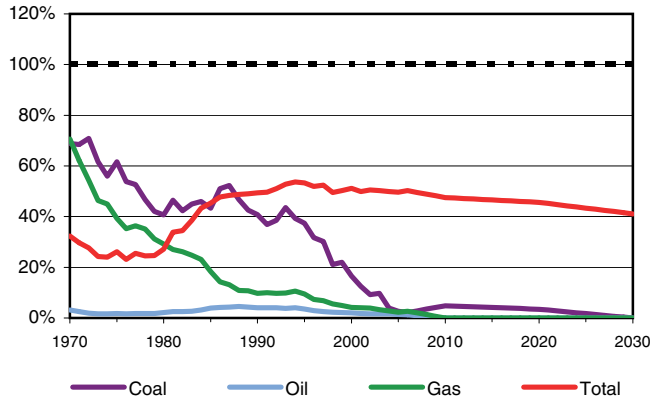


Figure 4. Electricity generation by fuel

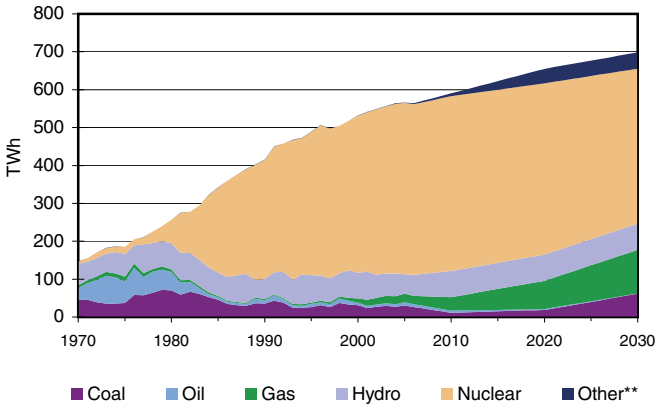


Figure 5. Breakdown of final consumption by sector and by source

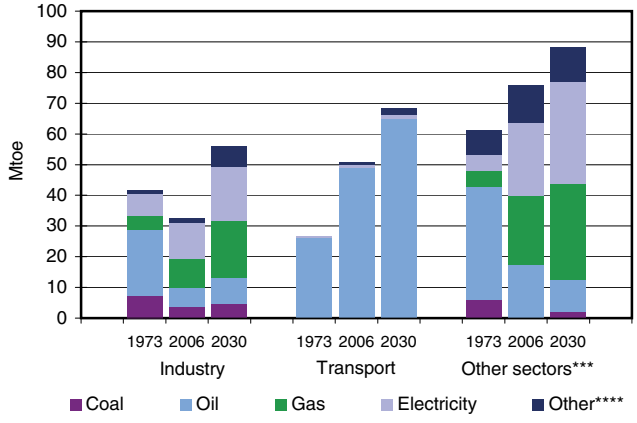
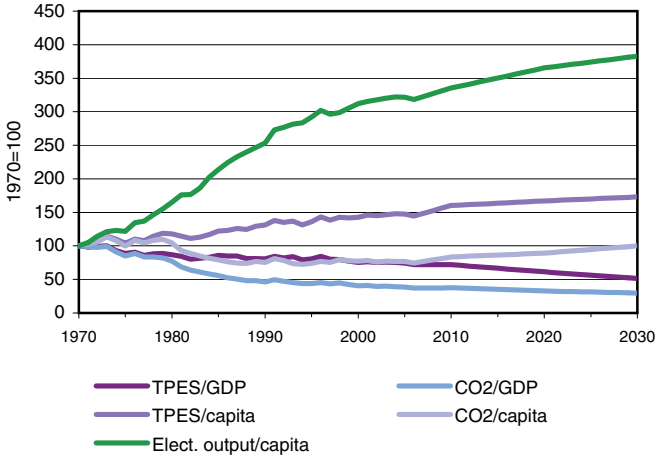


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Germany

Figure 1. Energy production

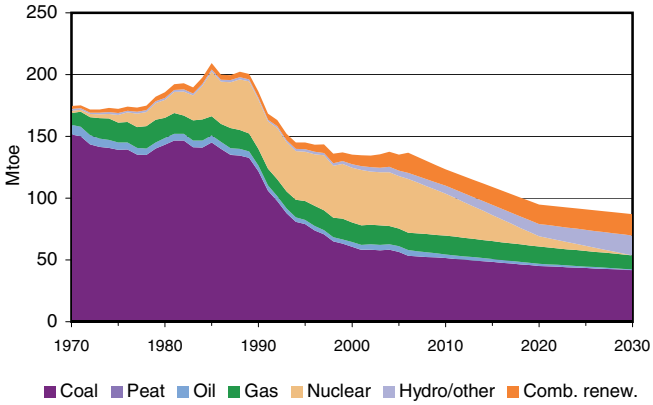


Figure 2. Total primary energy supply

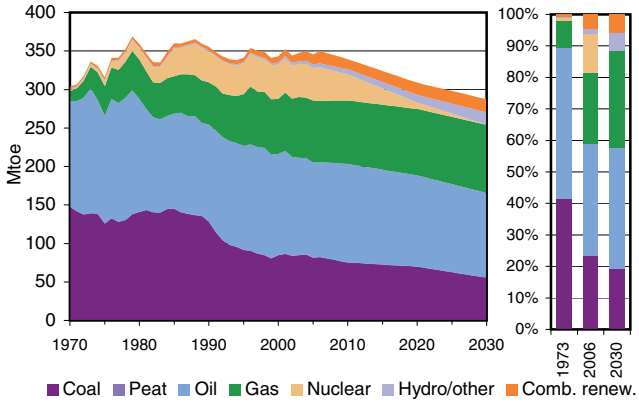


Figure 3. Energy self-sufficiency*

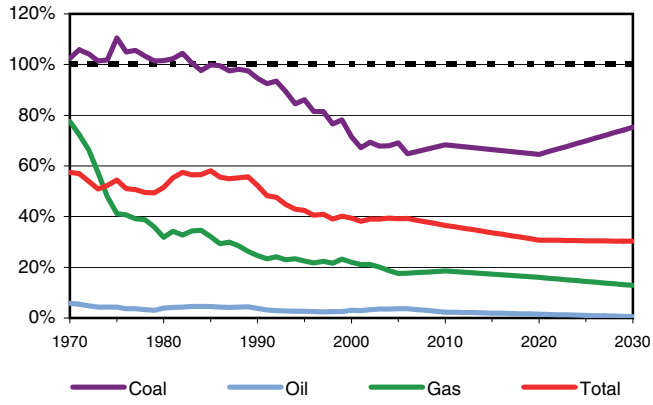


Figure 4. Electricity generation by fuel

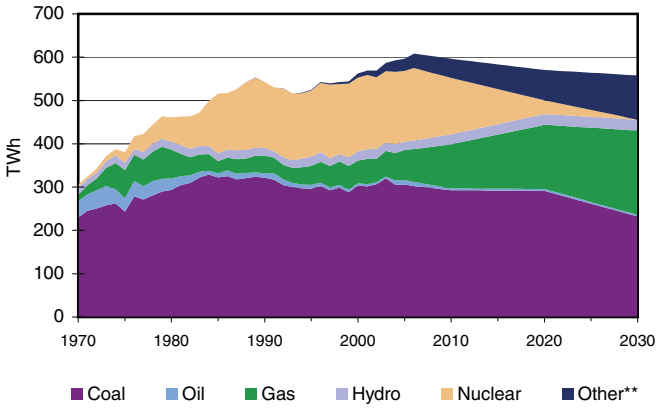


Figure 5. Breakdown of final consumption by sector and by source

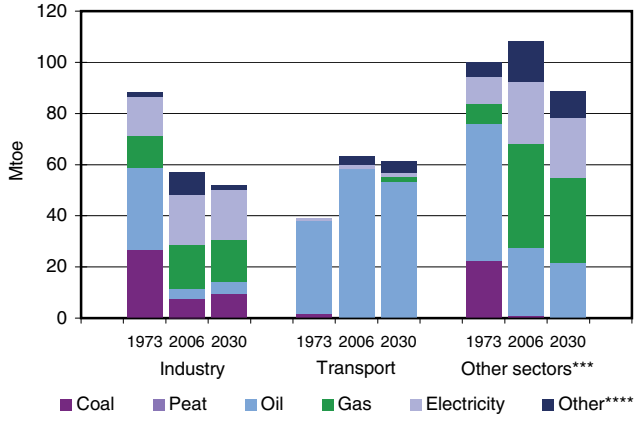
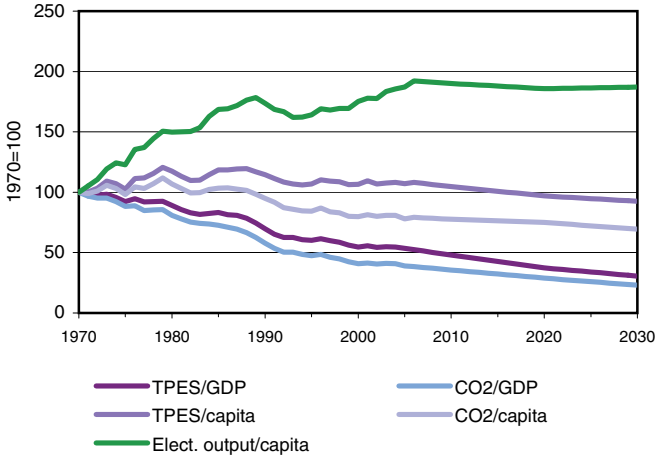


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Greece

Figure 1. Energy production

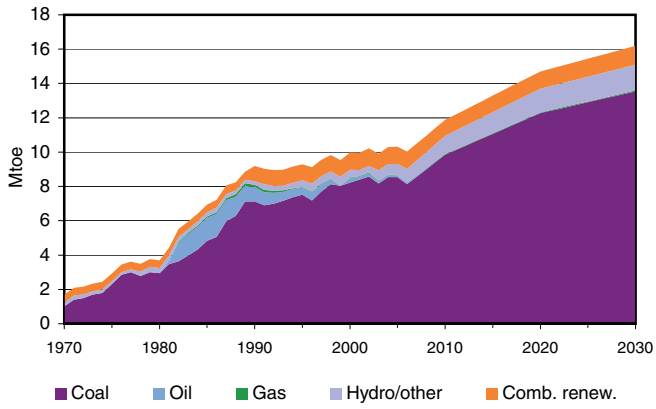


Figure 2. Total primary energy supply

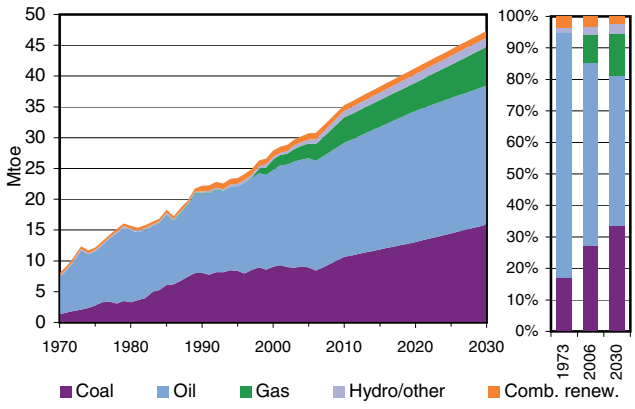


Figure 3. Energy self-sufficiency*

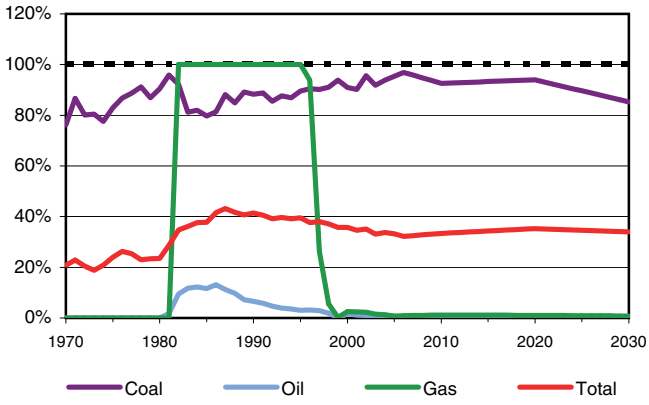


Figure 4. Electricity generation by fuel

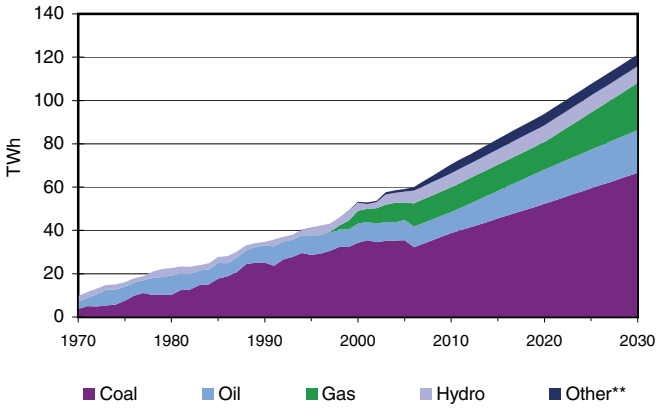


Figure 5. Breakdown of final consumption by sector and by source

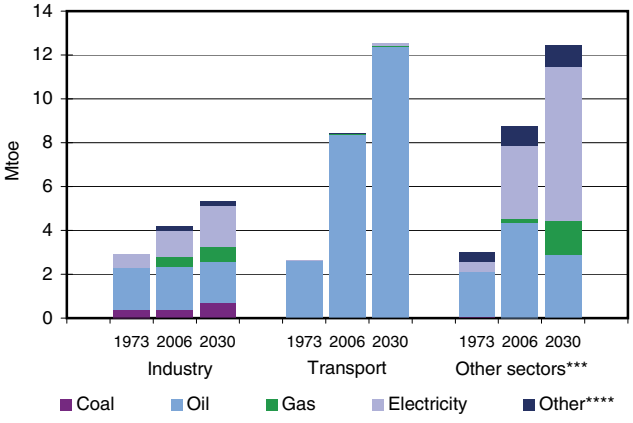
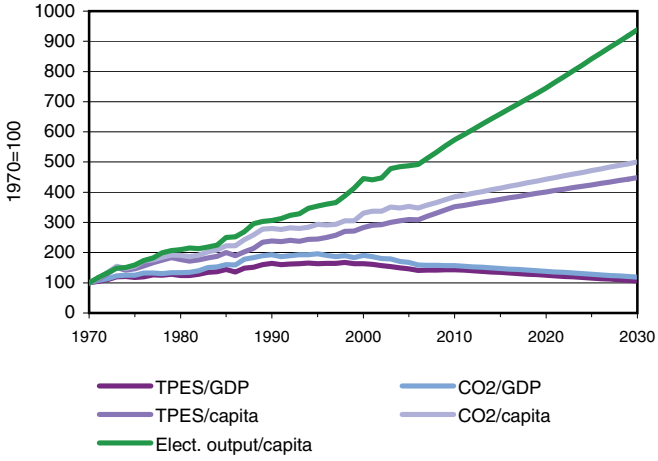


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Hungary

Figure 1. Energy production

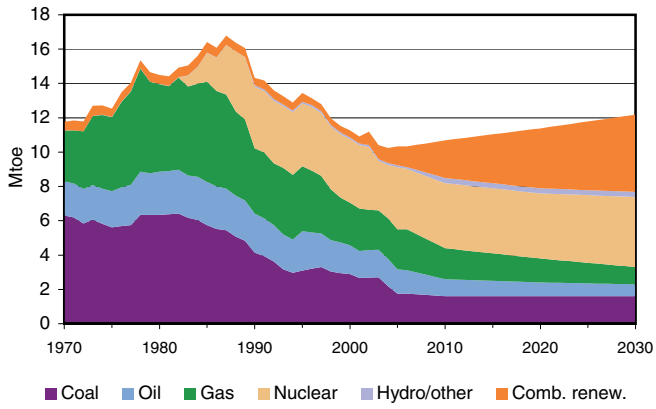


Figure 2. Total primary energy supply

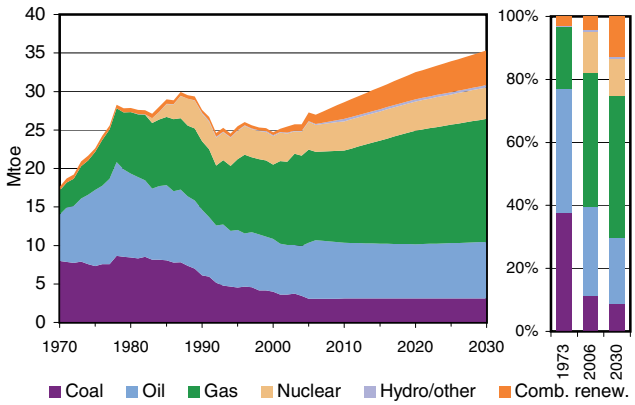


Figure 3. Energy self-sufficiency*

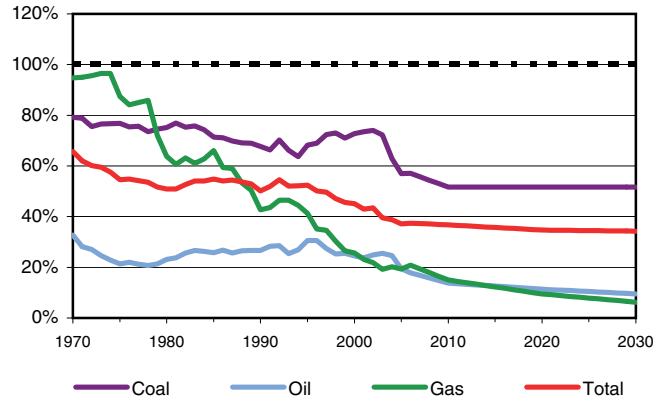


Figure 4. Electricity generation by fuel

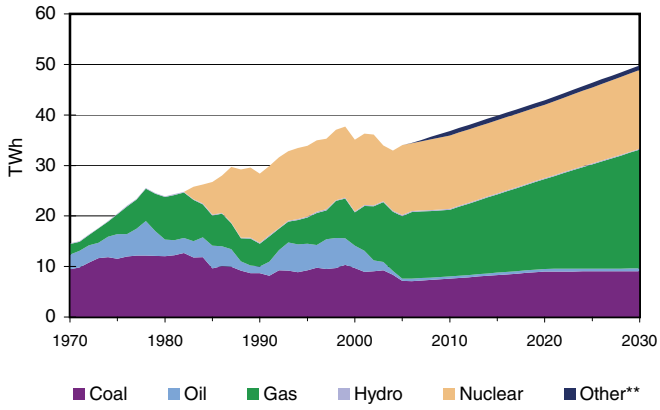


Figure 5. Breakdown of final consumption by sector and by source

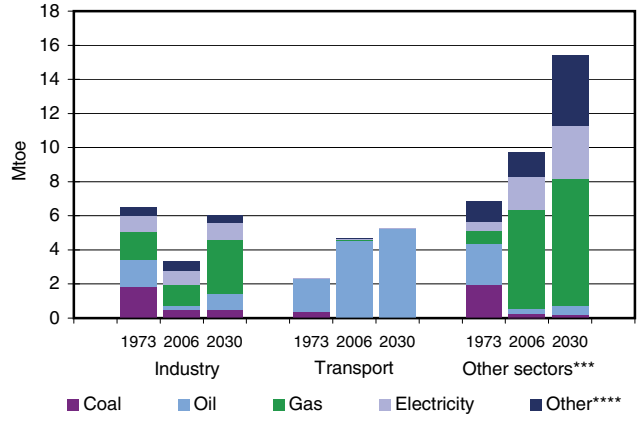
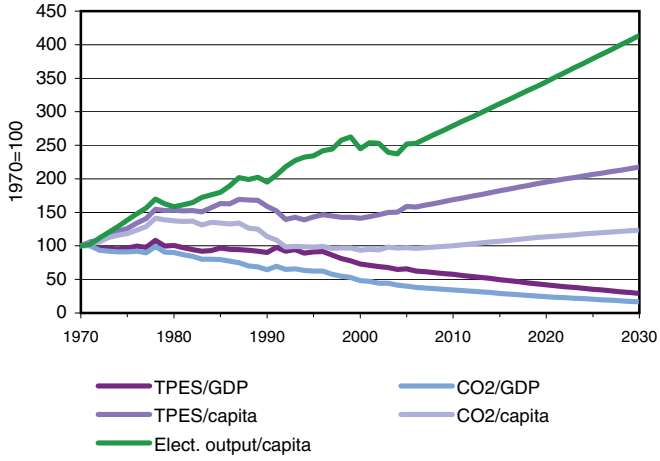


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Ireland

Figure 1. Energy production

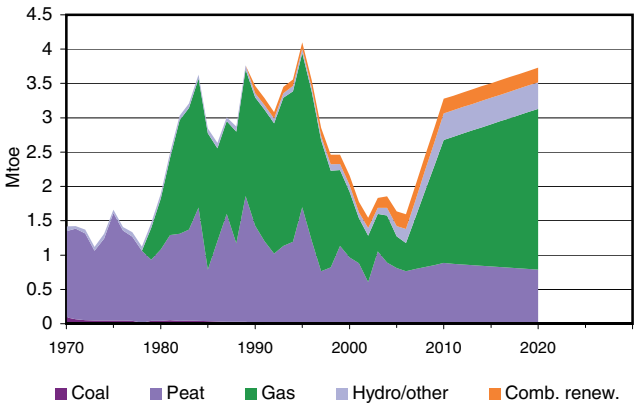


Figure 2. Total primary energy supply

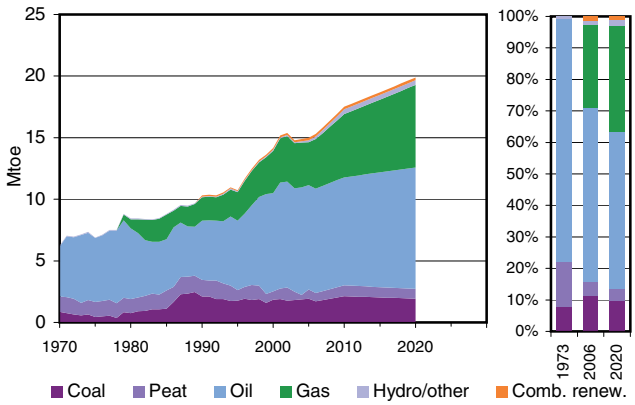


Figure 3. Energy self-sufficiency*

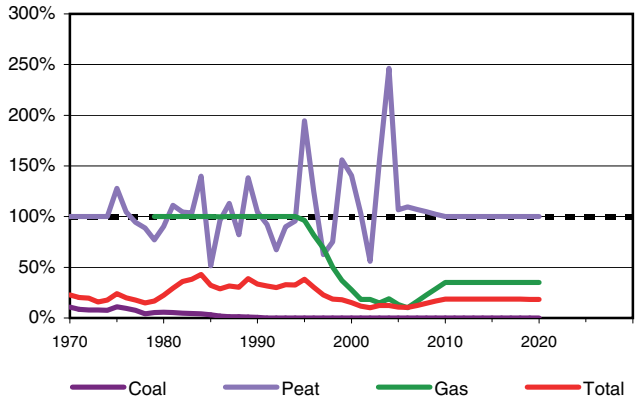


Figure 4. Electricity generation by fuel

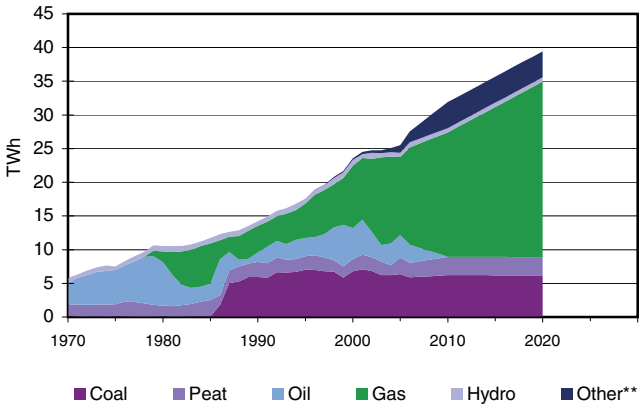


Figure 5. Breakdown of final consumption by sector and by source

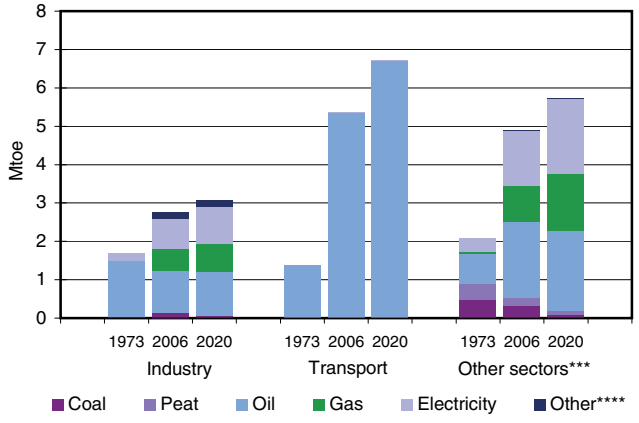
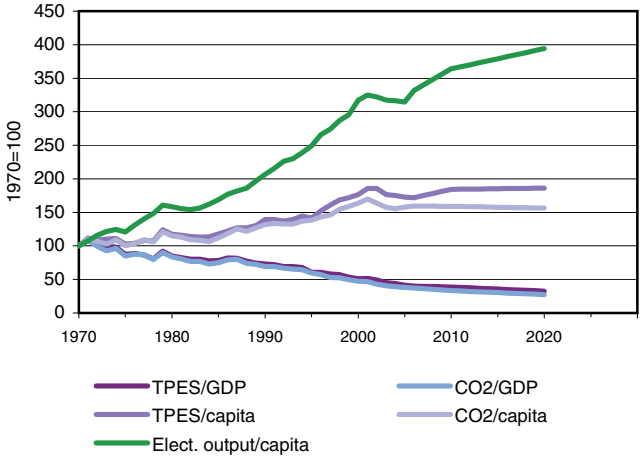


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Italy

Figure 1. Energy production

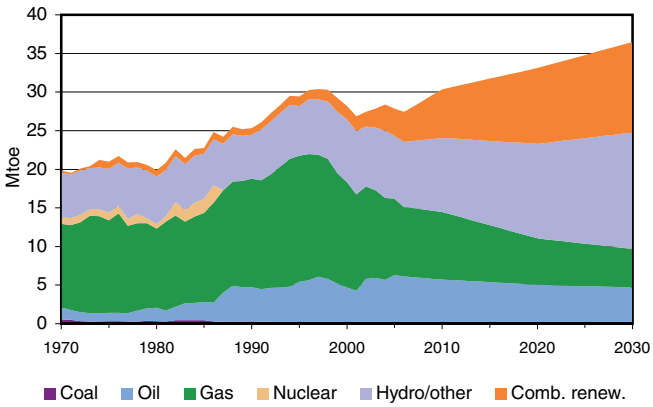


Figure 2. Total primary energy supply

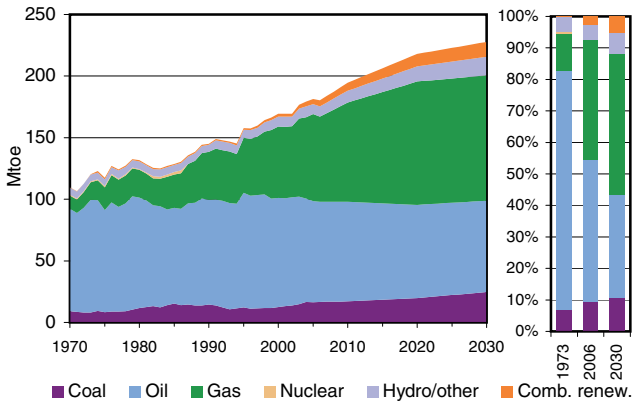


Figure 3. Energy self-sufficiency*

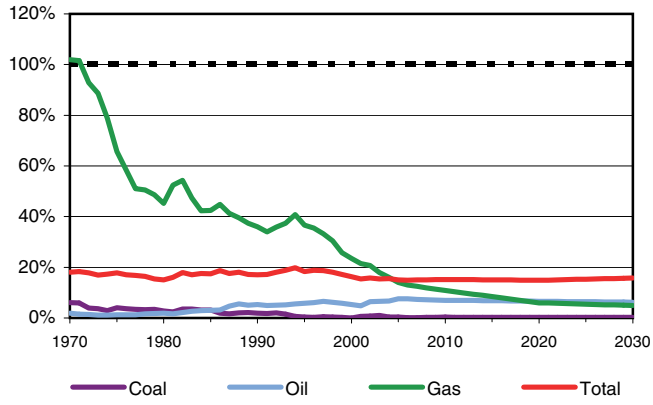


Figure 4. Electricity generation by fuel

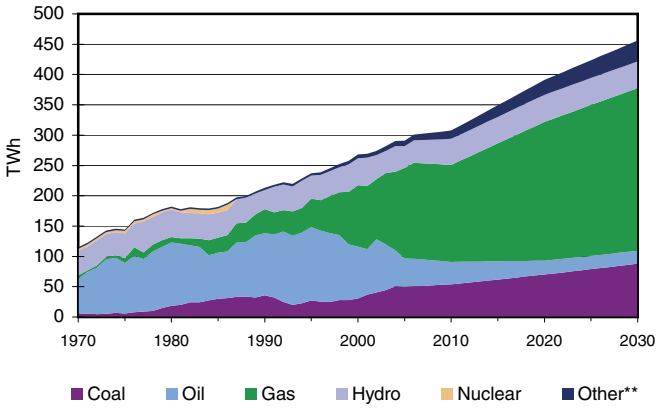


Figure 5. Breakdown of final consumption by sector and by source

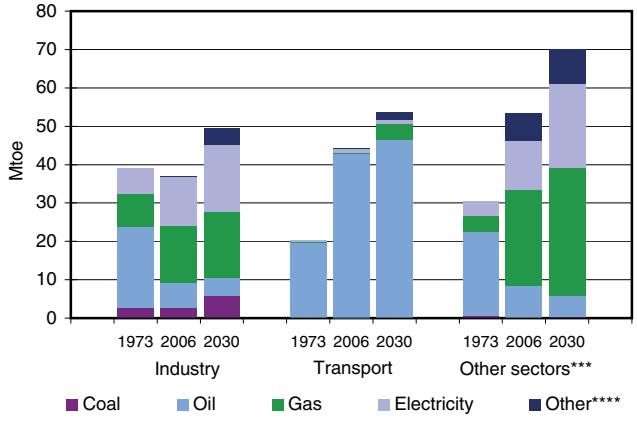
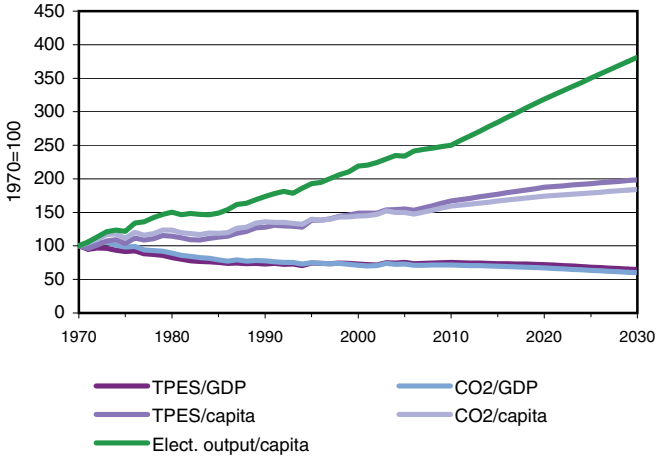


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Japan

Figure 1. Energy production

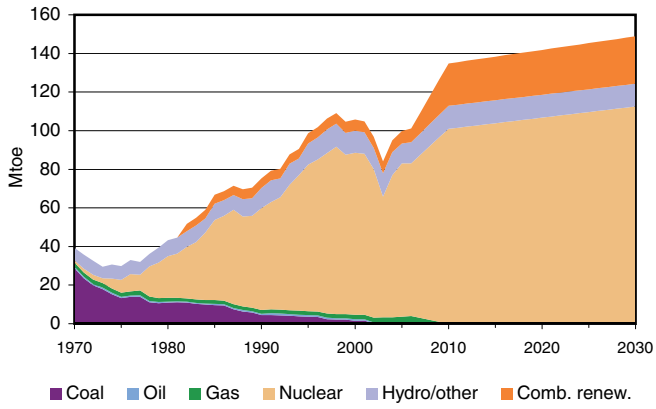


Figure 2. Total primary energy supply

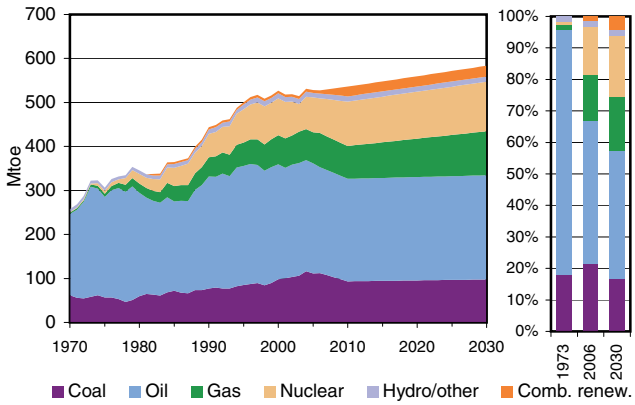


Figure 3. Energy self-sufficiency*

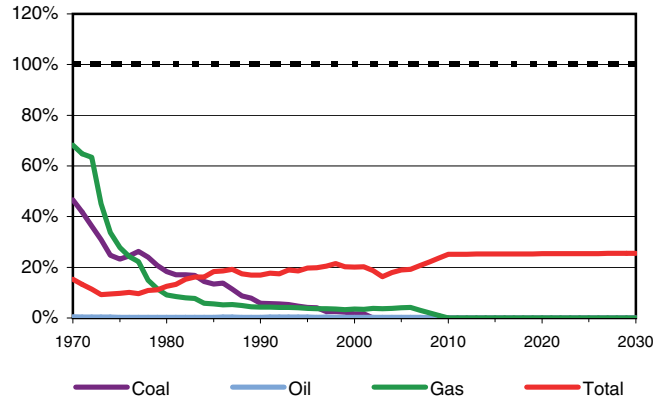


Figure 4. Electricity generation by fuel

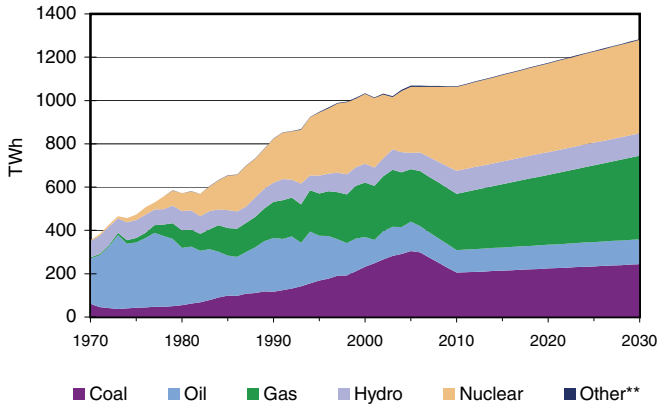


Figure 5. Breakdown of final consumption by sector and by source

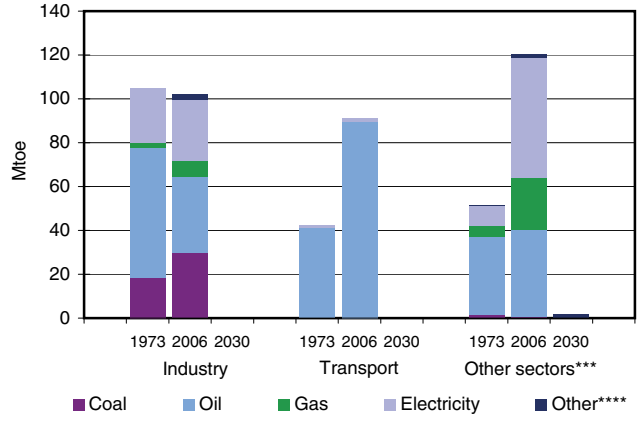
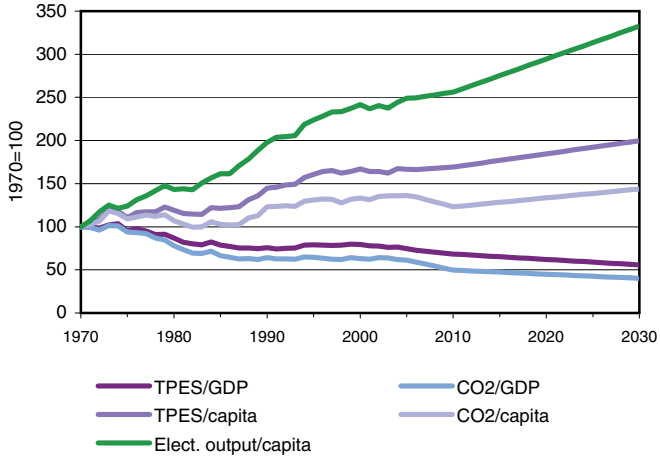


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Korea

Figure 1. Energy production

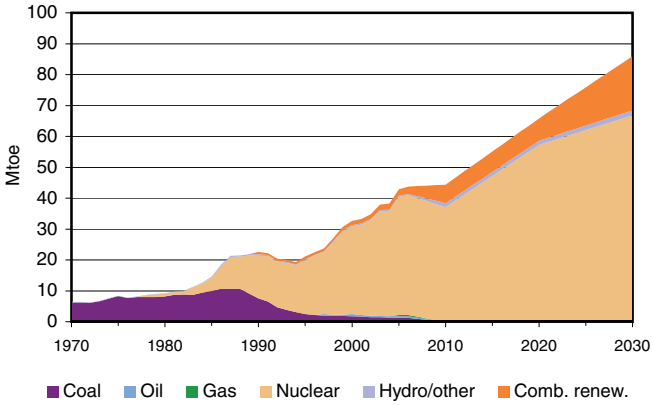


Figure 2. Total primary energy supply

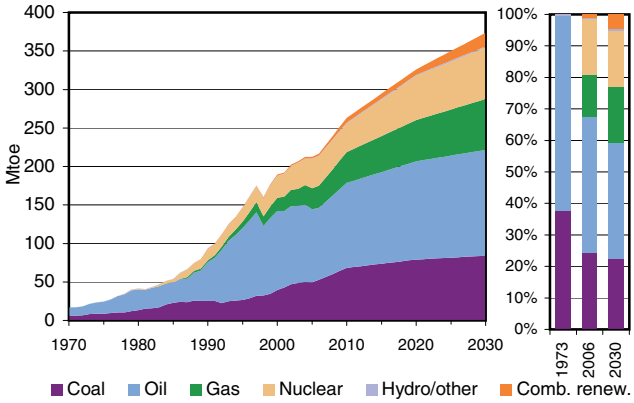


Figure 3. Energy self-sufficiency*

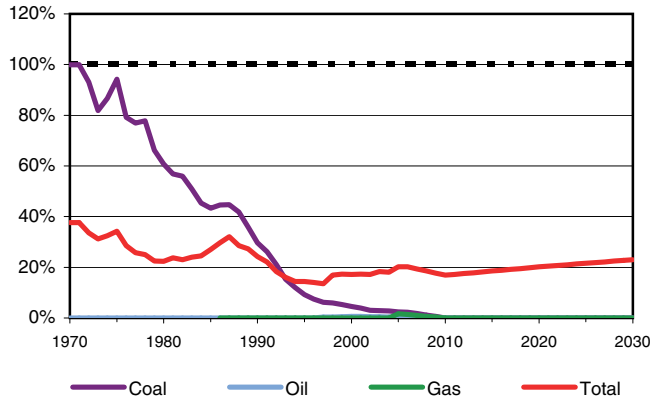


Figure 4. Electricity generation by fuel

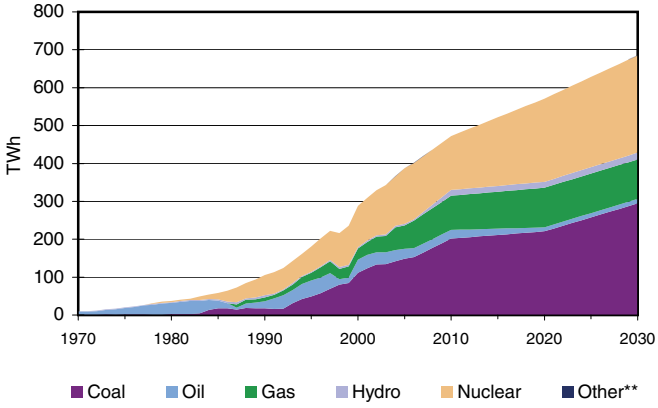


Figure 5. Breakdown of final consumption by sector and by source

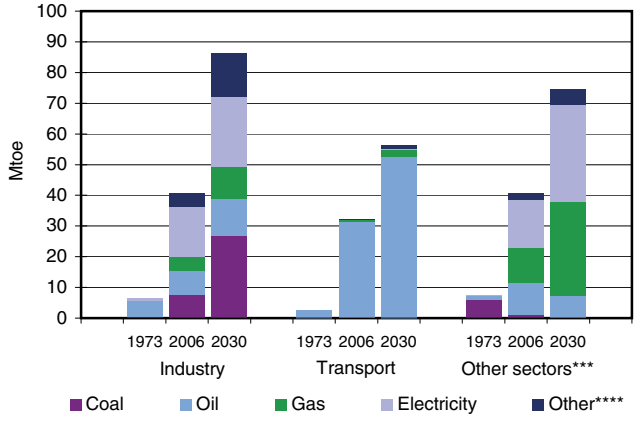
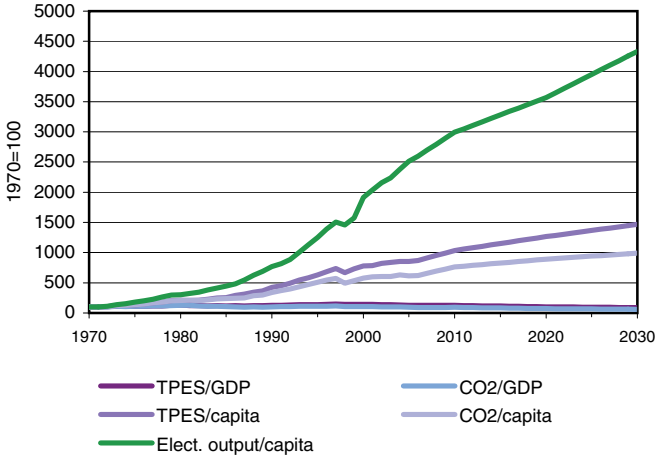


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Luxembourg

Figure 1. Energy production

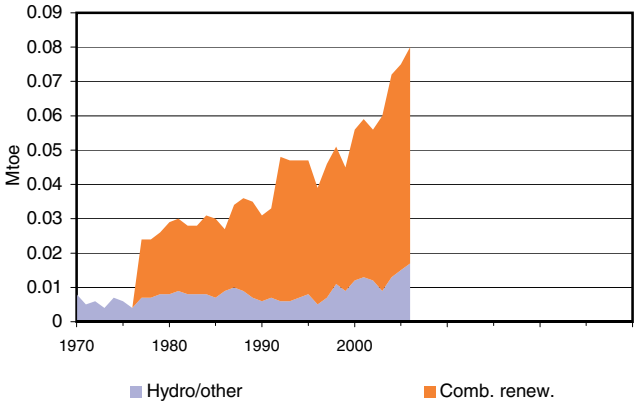


Figure 2. Total primary energy supply

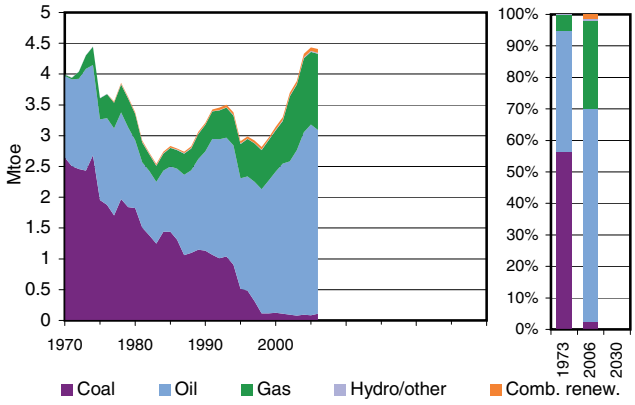


Figure 3. Energy self-sufficiency*

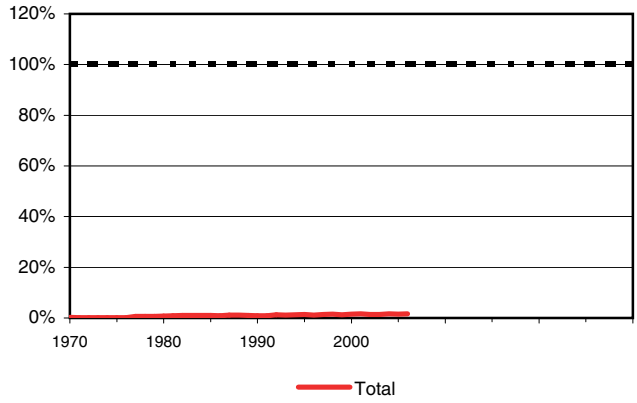


Figure 4. Electricity generation by fuel

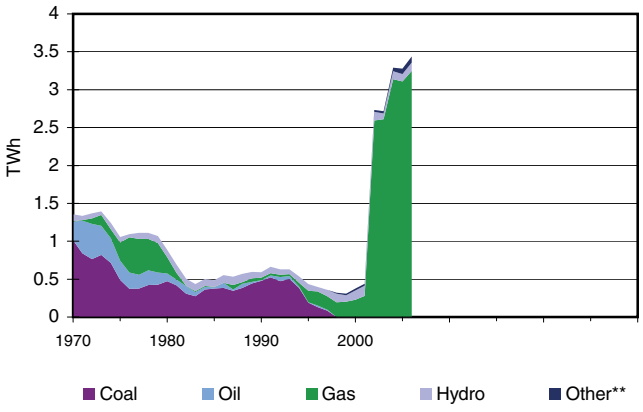


Figure 5. Breakdown of final consumption by sector and by source

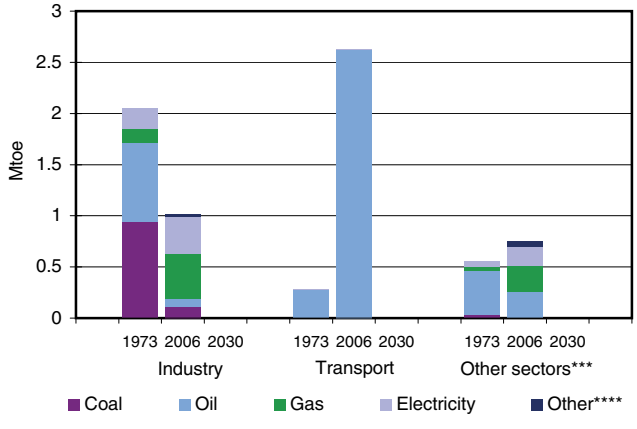
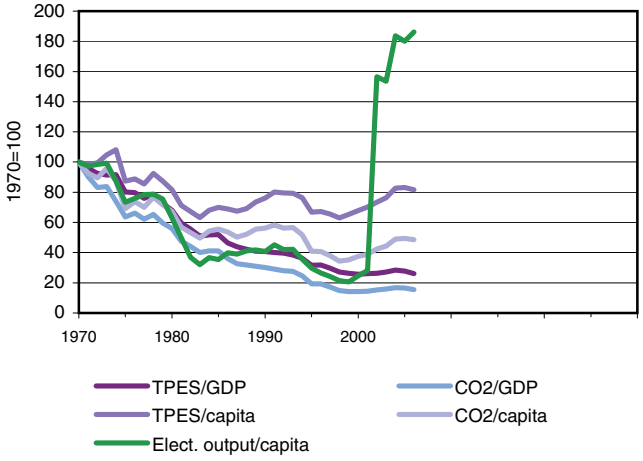


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Netherlands

Figure 1. Energy production

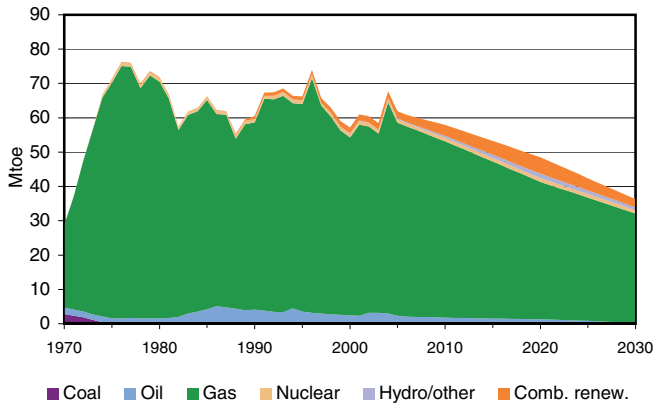


Figure 2. Total primary energy supply

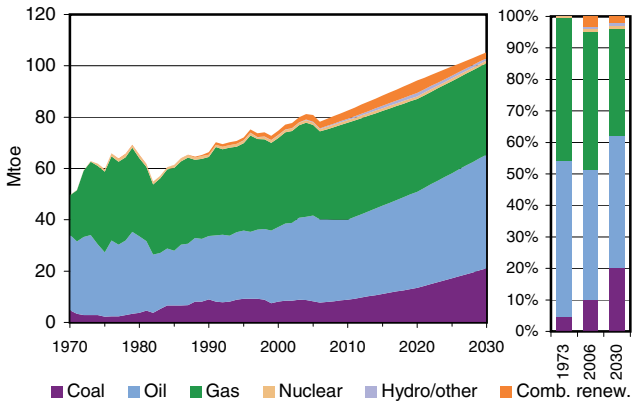


Figure 3. Energy self-sufficiency*

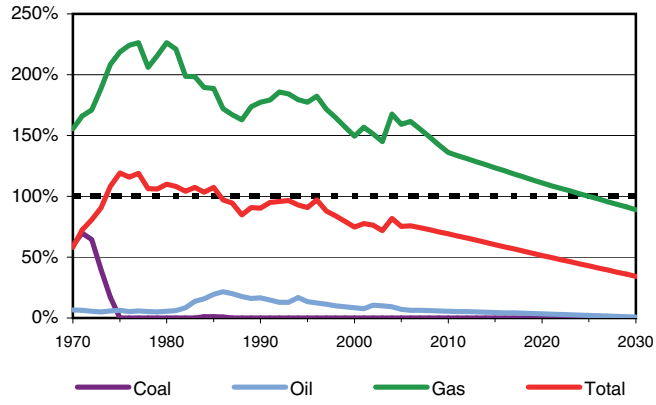


Figure 4. Electricity generation by fuel

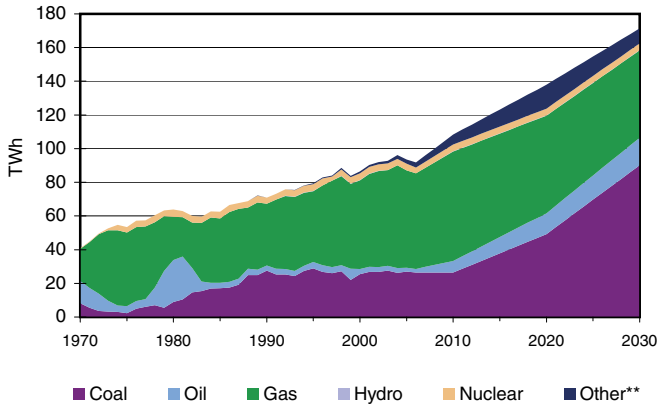


Figure 5. Breakdown of final consumption by sector and by source

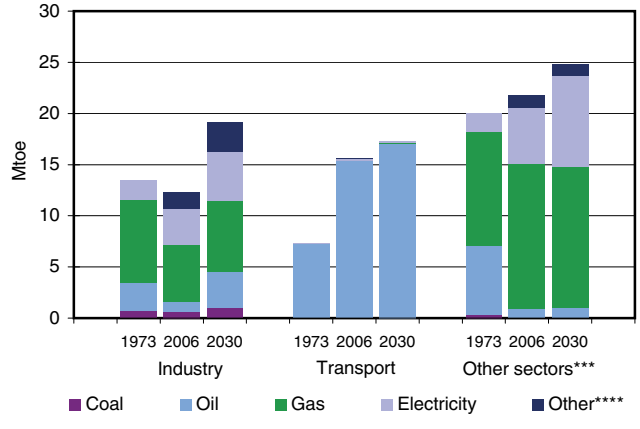
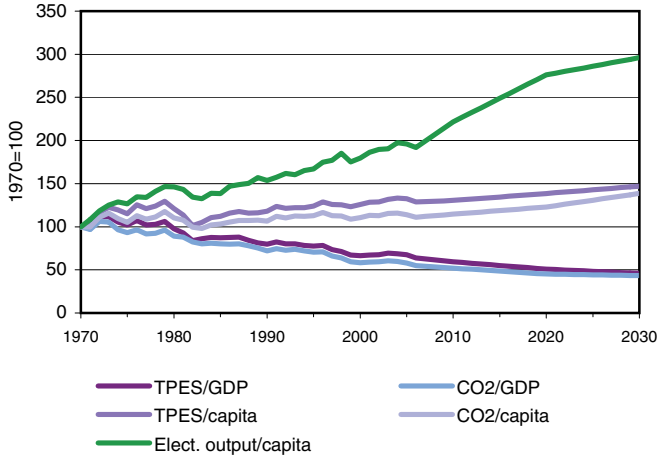


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

New Zealand

Figure 1. Energy production

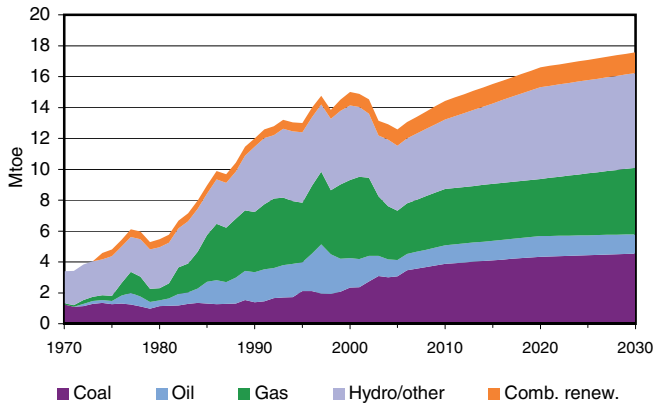


Figure 2. Total primary energy supply

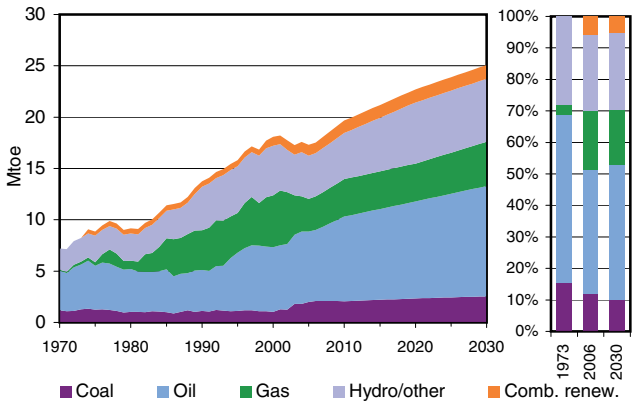


Figure 3. Energy self-sufficiency*

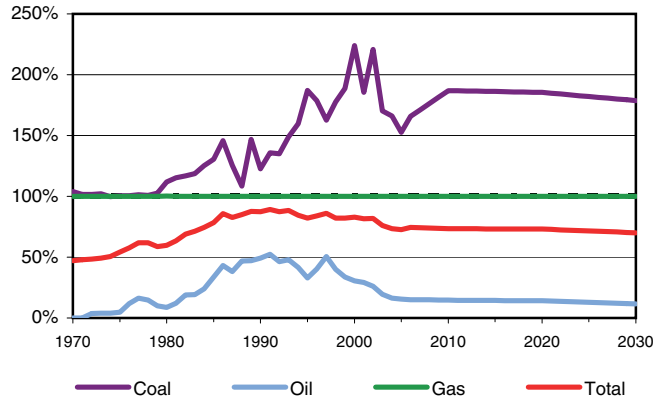


Figure 4. Electricity generation by fuel

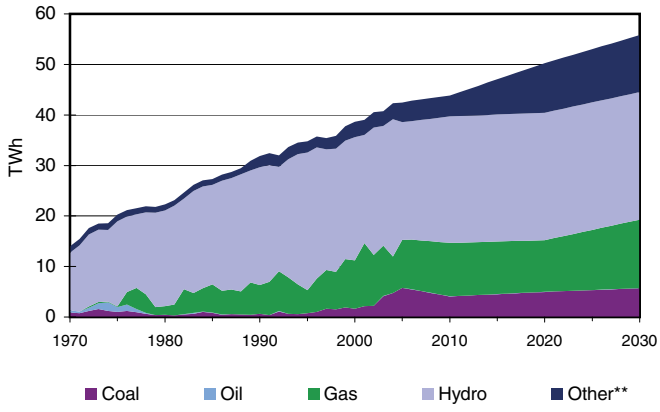


Figure 5. Breakdown of final consumption by sector and by source

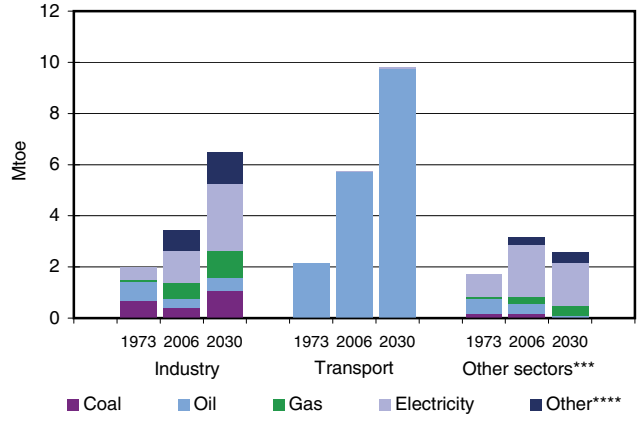
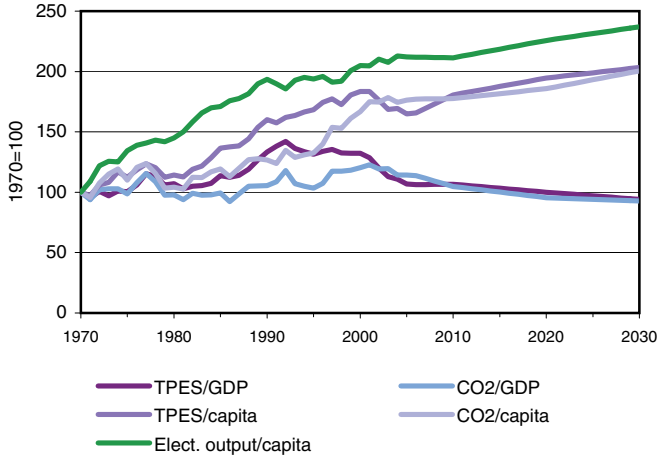


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Norway

Figure 1. Energy production

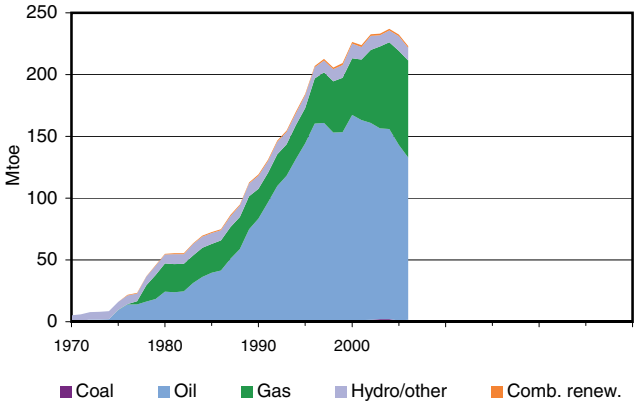


Figure 2. Total primary energy supply

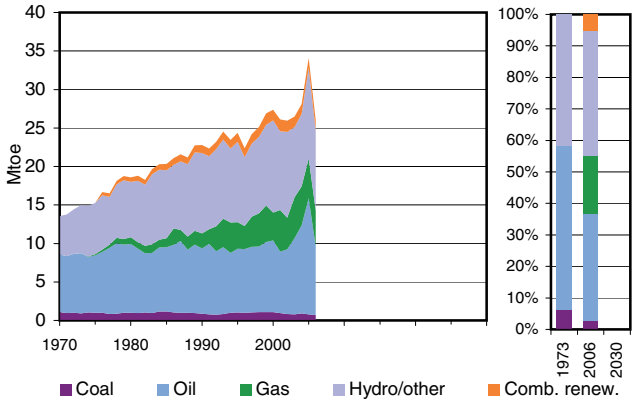


Figure 3. Energy self-sufficiency*

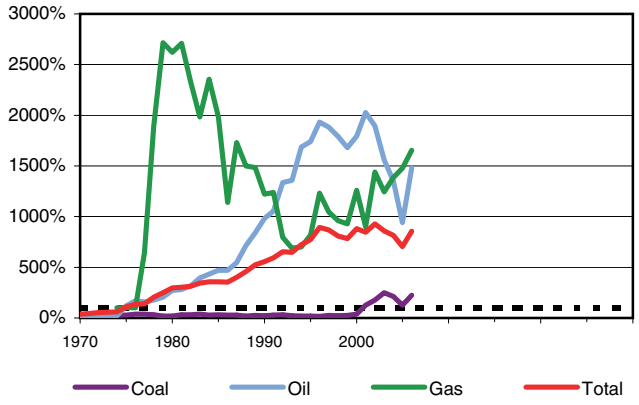


Figure 4. Electricity generation by fuel

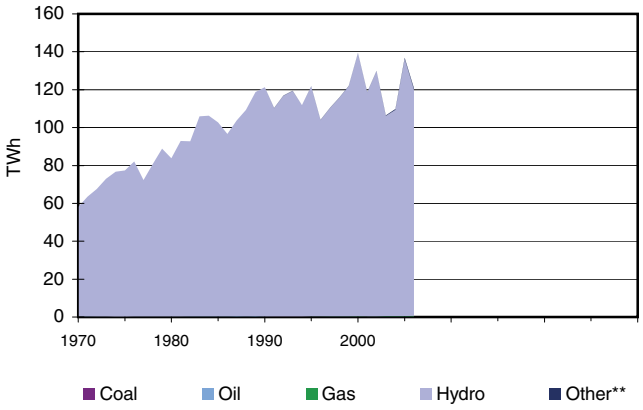


Figure 5. Breakdown of final consumption by sector and by source

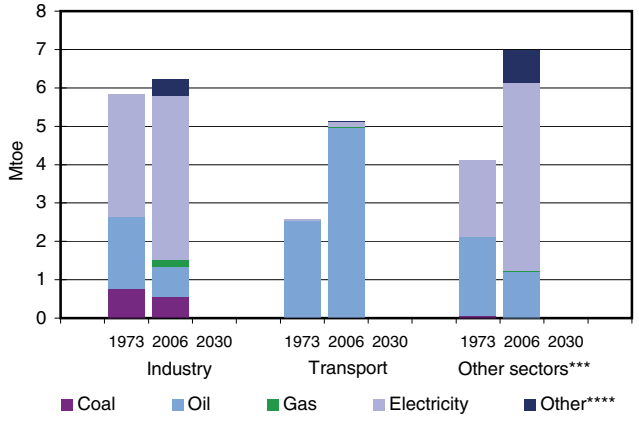
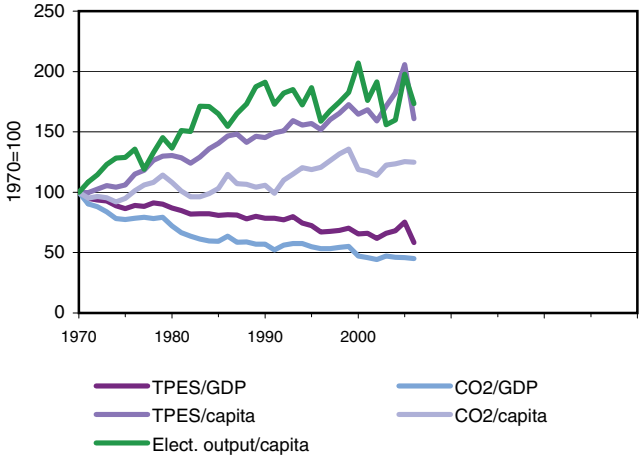


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Poland

Figure 1. Energy production

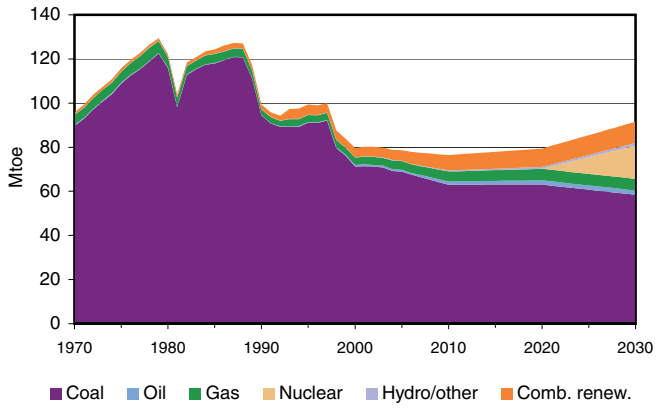


Figure 2. Total primary energy supply

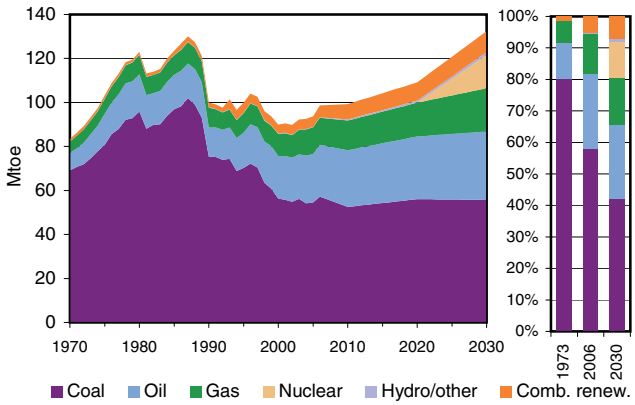


Figure 3. Energy self-sufficiency*

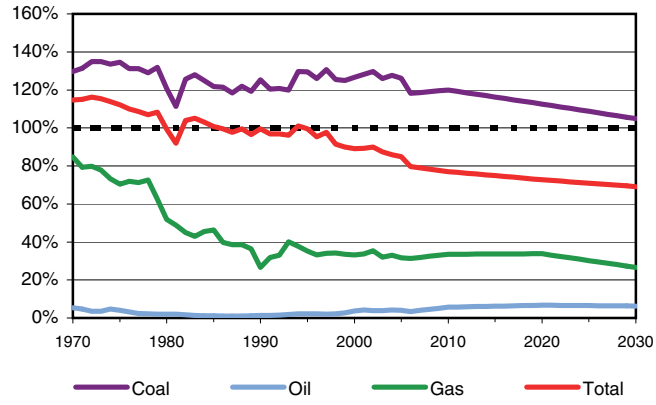


Figure 4. Electricity generation by fuel

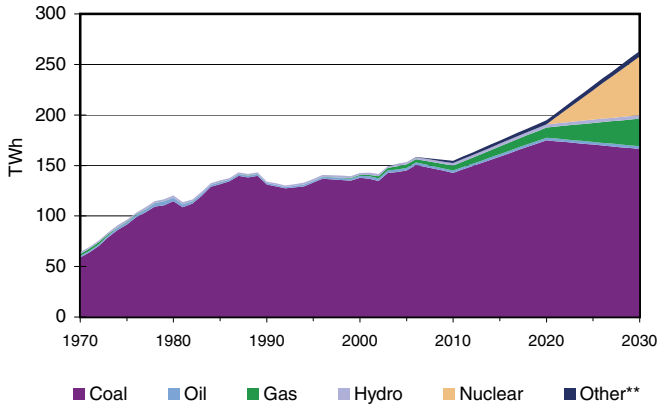


Figure 5. Breakdown of final consumption by sector and by source

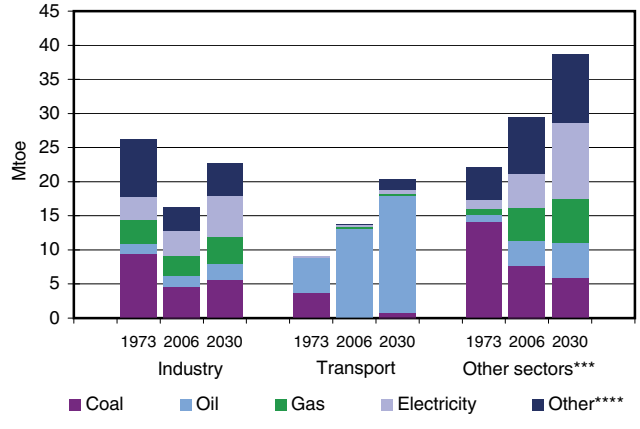
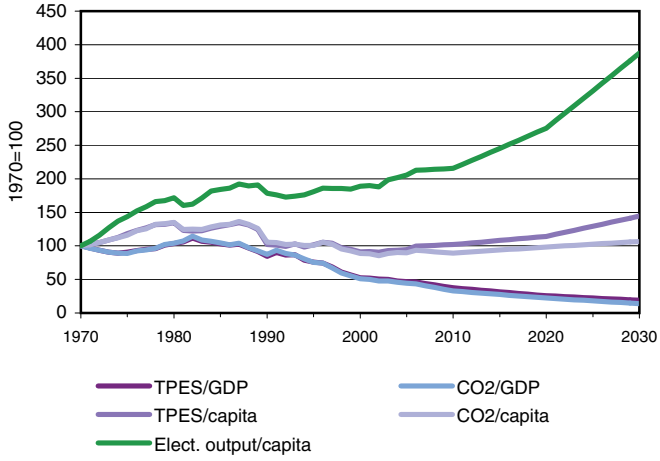


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Portugal

Figure 1. Energy production

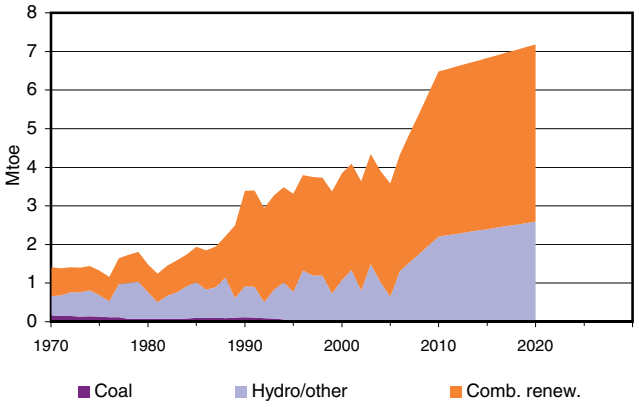


Figure 2. Total primary energy supply

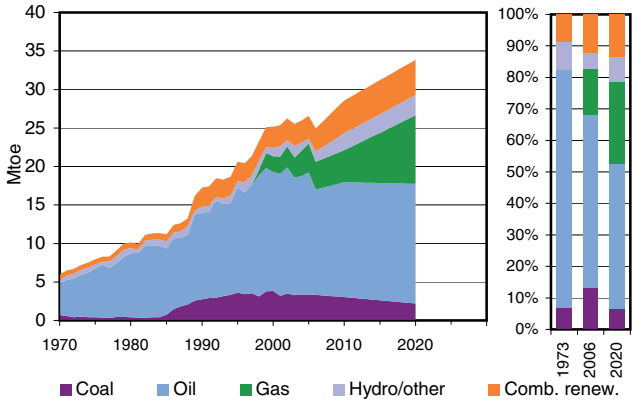


Figure 3. Energy self-sufficiency*

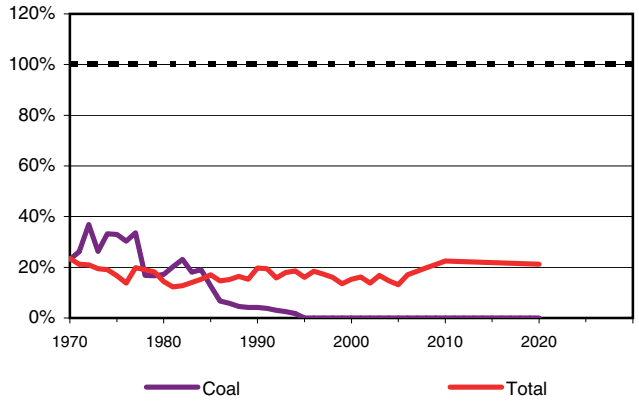


Figure 4. Electricity generation by fuel

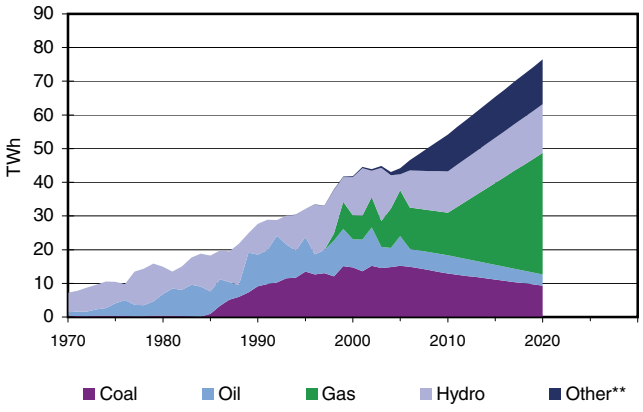


Figure 5. Breakdown of final consumption by sector and by source

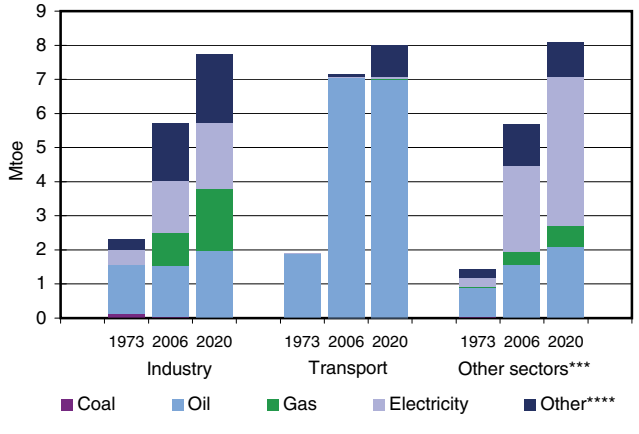
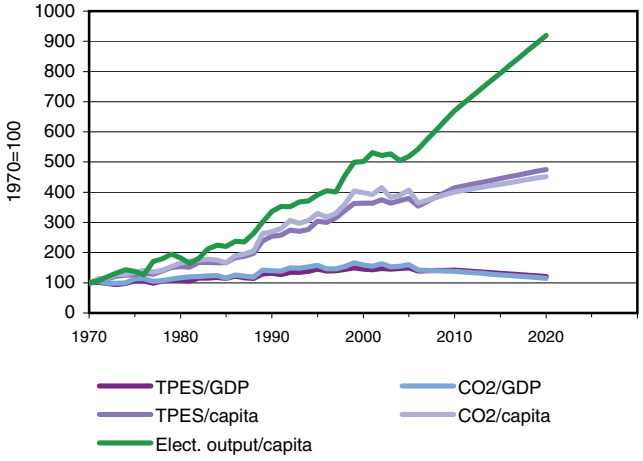


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Slovak Republic

Figure 1. Energy production

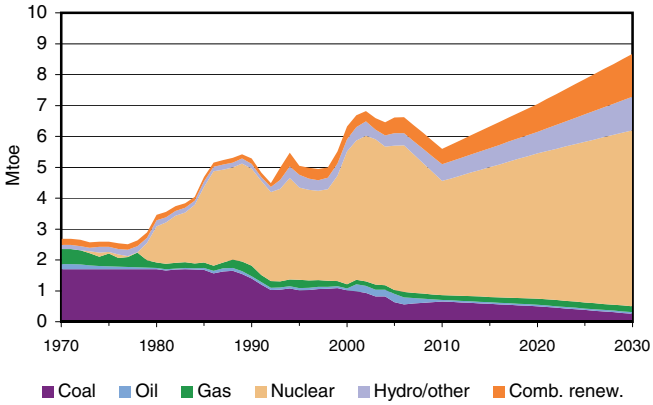


Figure 2. Total primary energy supply

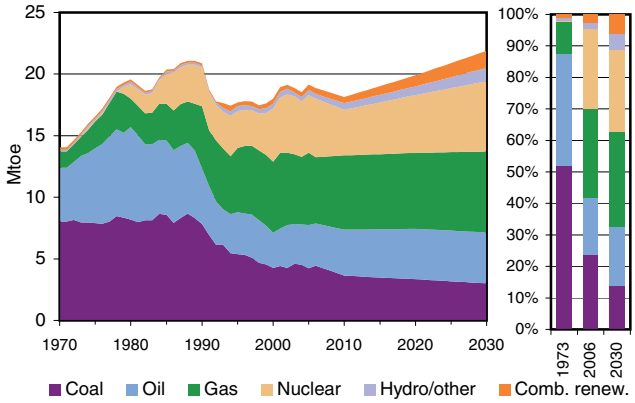


Figure 3. Energy self-sufficiency*

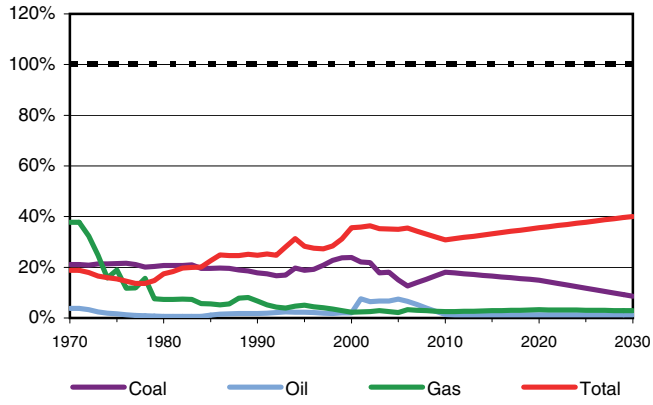


Figure 4. Electricity generation by fuel

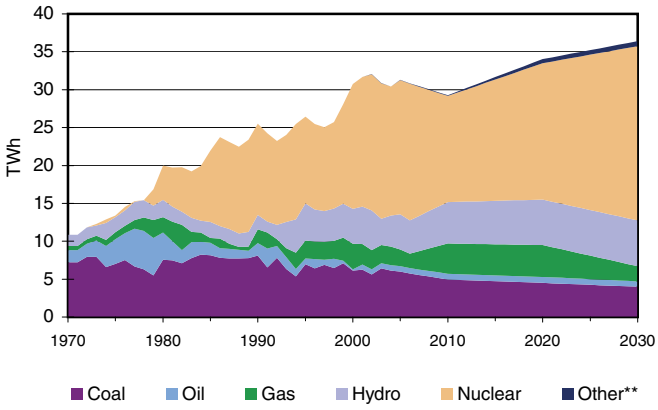


Figure 5. Breakdown of final consumption by sector and by source

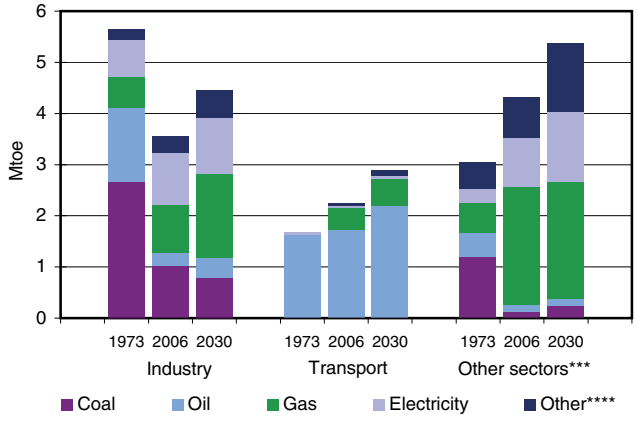
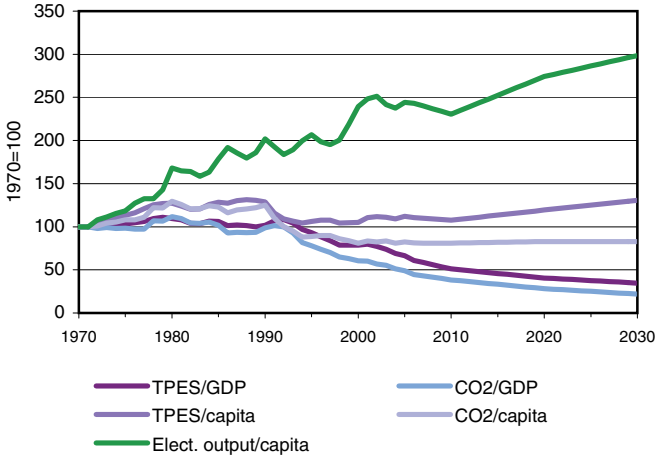


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Spain

Figure 1. Energy production

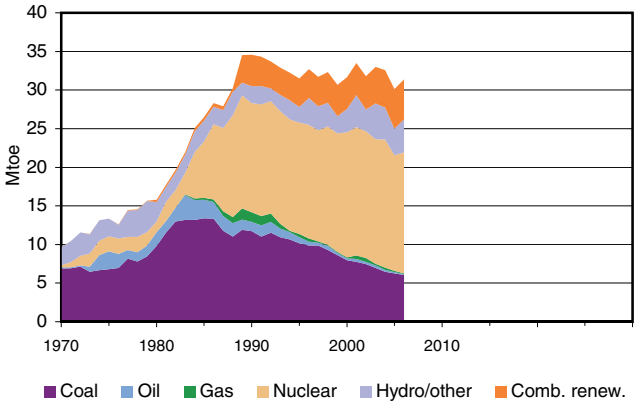


Figure 2. Total primary energy supply

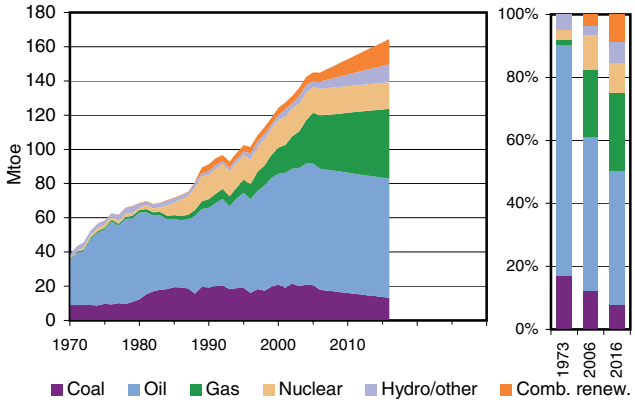


Figure 3. Energy self-sufficiency*

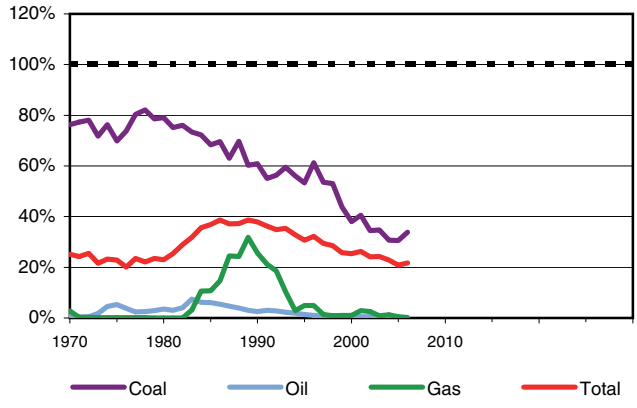


Figure 4. Electricity generation by fuel

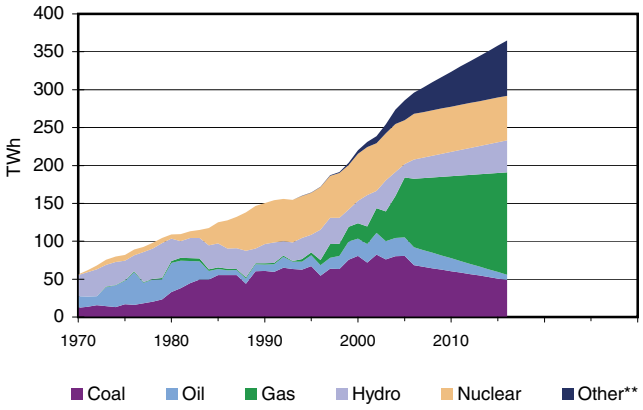


Figure 5. Breakdown of final consumption by sector and by source

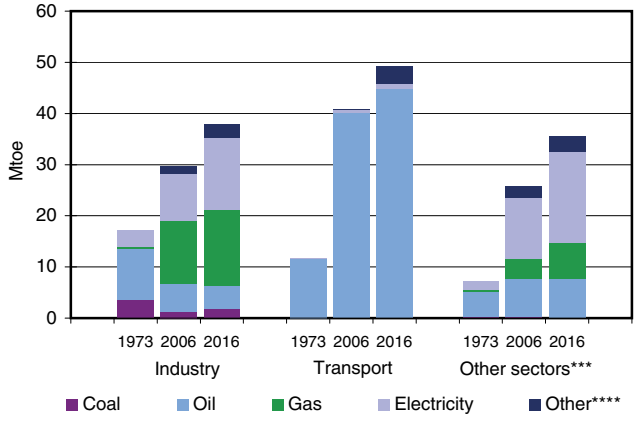
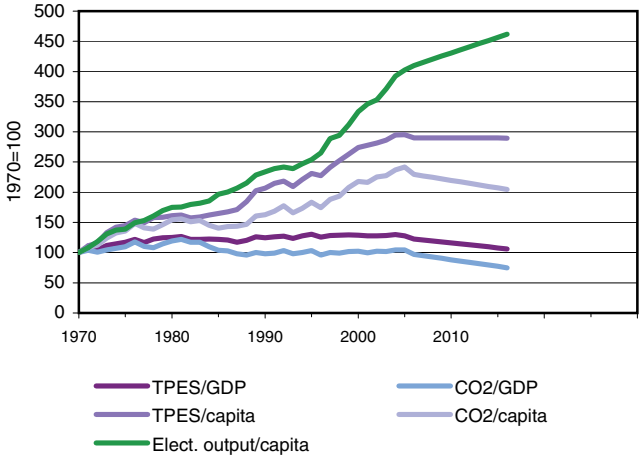


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Sweden

Figure 1. Energy production

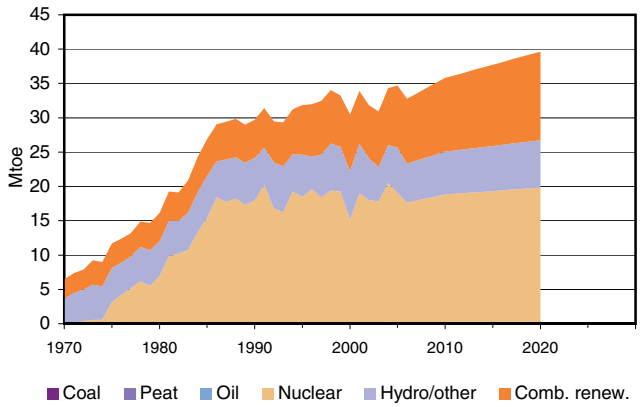


Figure 2. Total primary energy supply

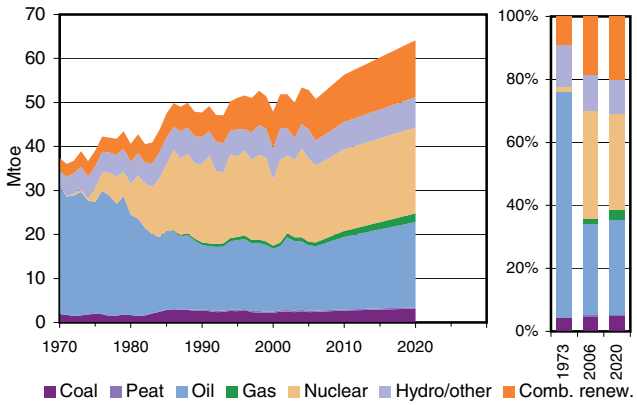


Figure 3. Energy self-sufficiency*

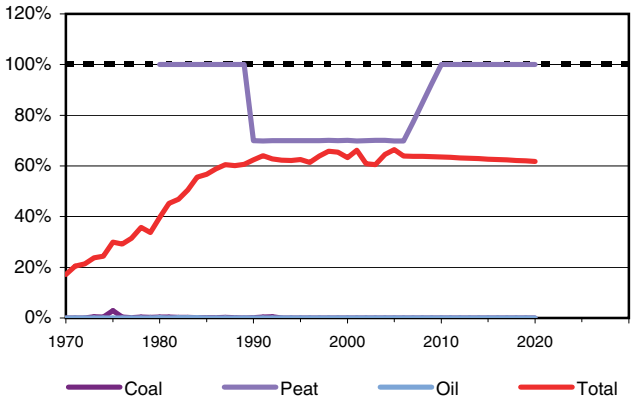


Figure 4. Electricity generation by fuel

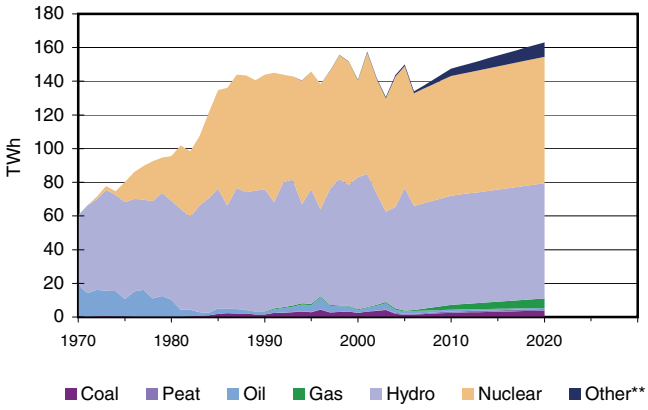


Figure 5. Breakdown of final consumption by sector and by source

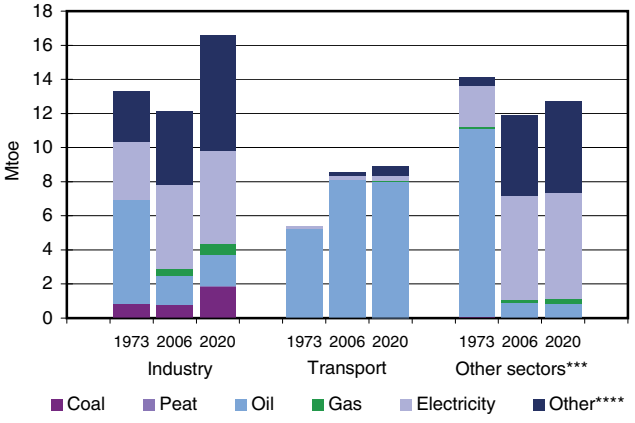
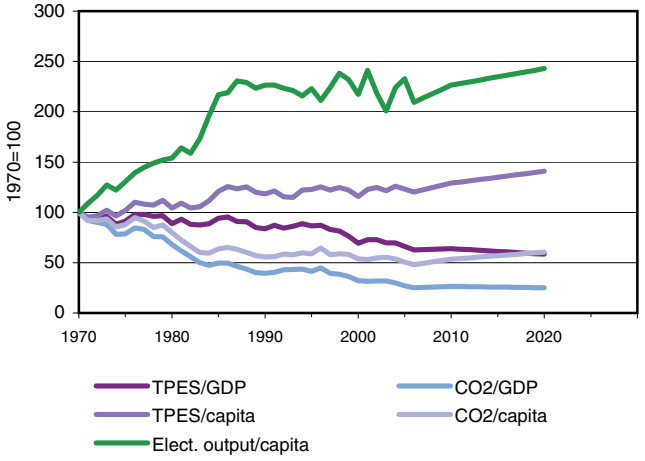


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Switzerland

Figure 1. Energy production

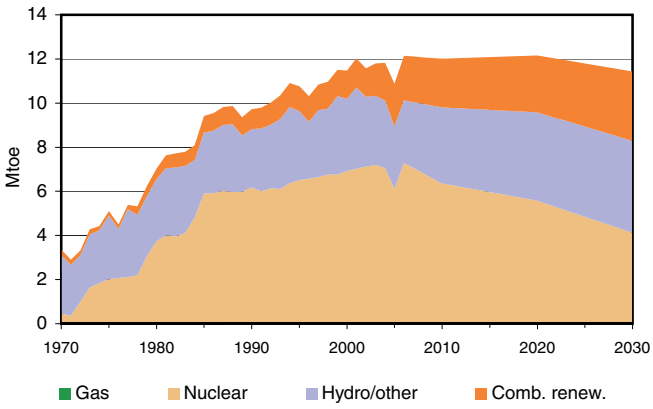


Figure 2. Total primary energy supply

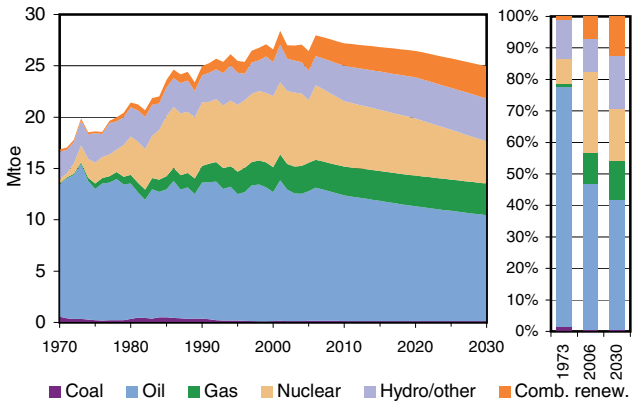


Figure 3. Energy self-sufficiency*

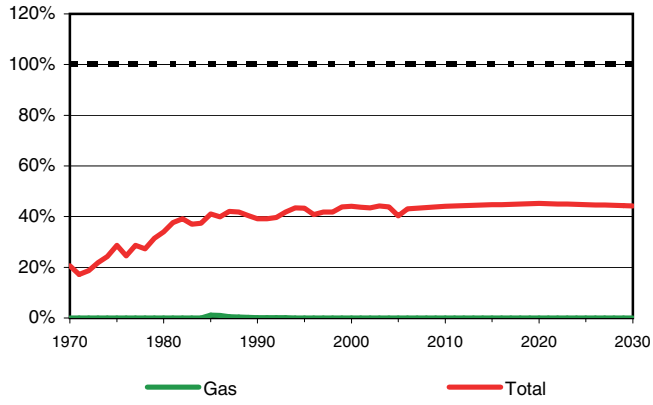


Figure 4. Electricity generation by fuel

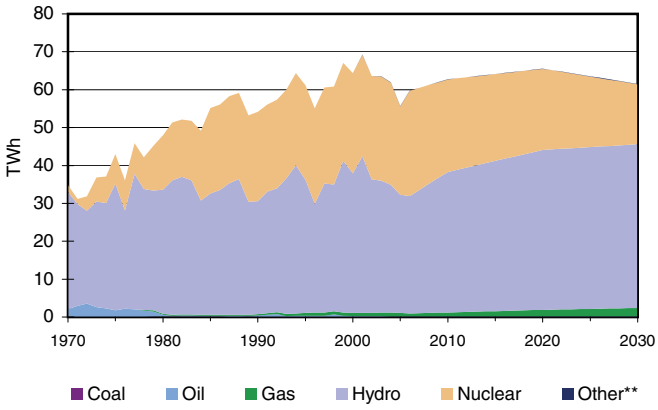


Figure 5. Breakdown of final consumption by sector and by source

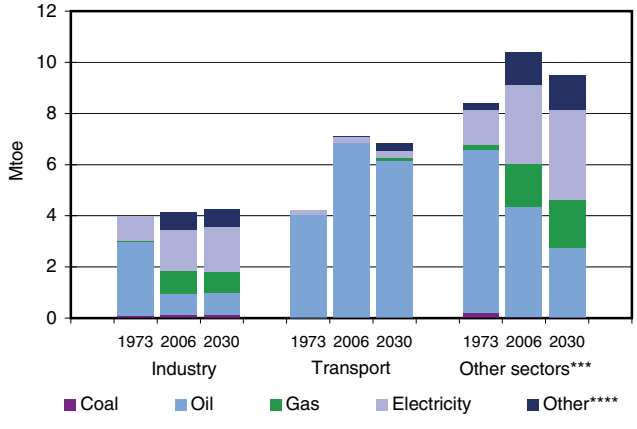
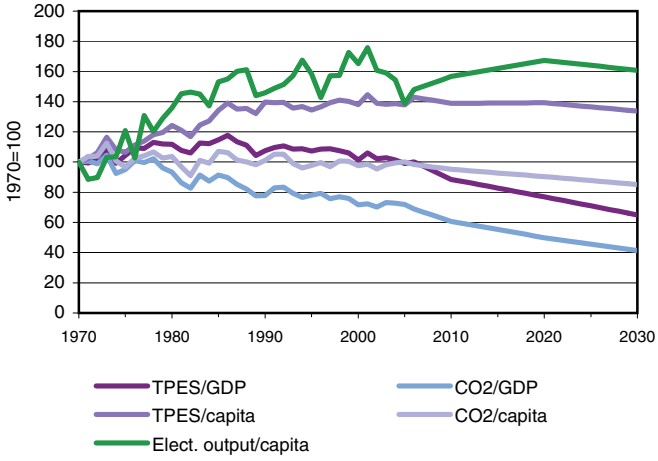


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Turkey

Figure 1. Energy production

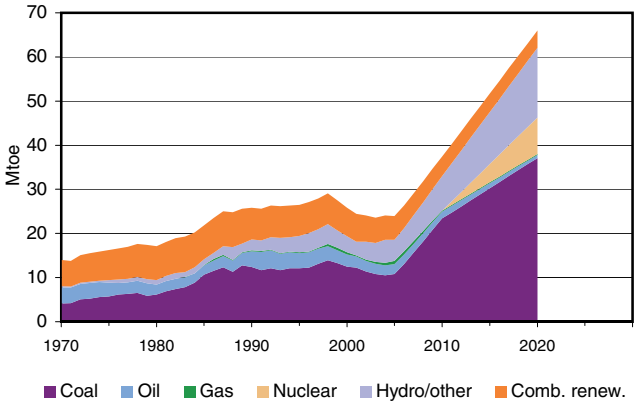


Figure 2. Total primary energy supply

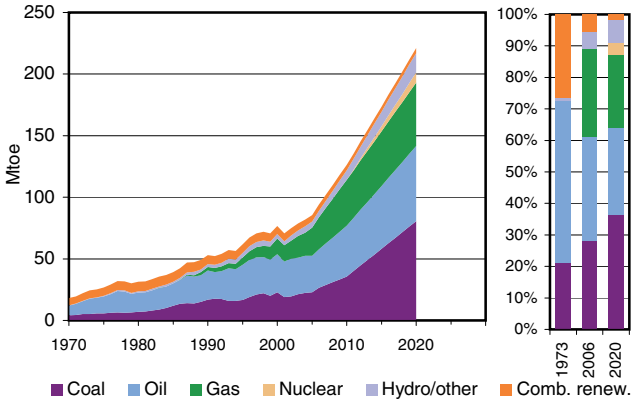


Figure 3. Energy self-sufficiency*

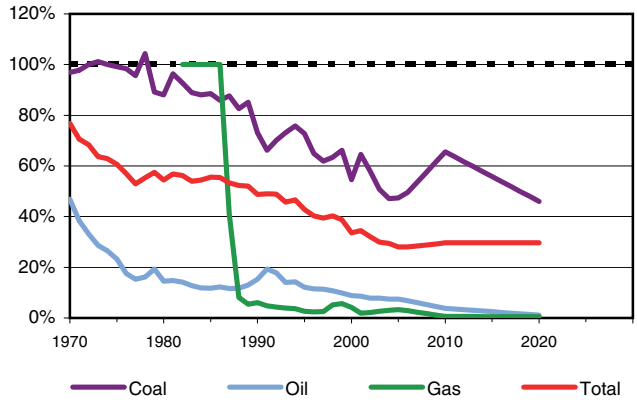


Figure 4. Electricity generation by fuel

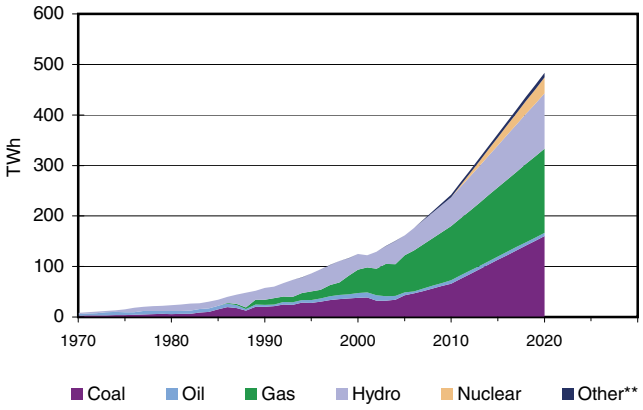


Figure 5. Breakdown of final consumption by sector and by source

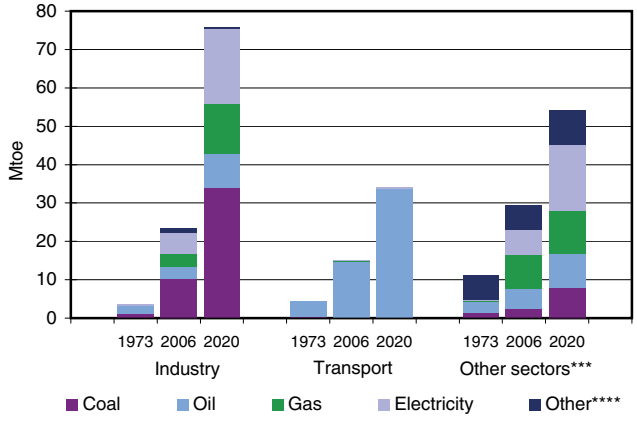
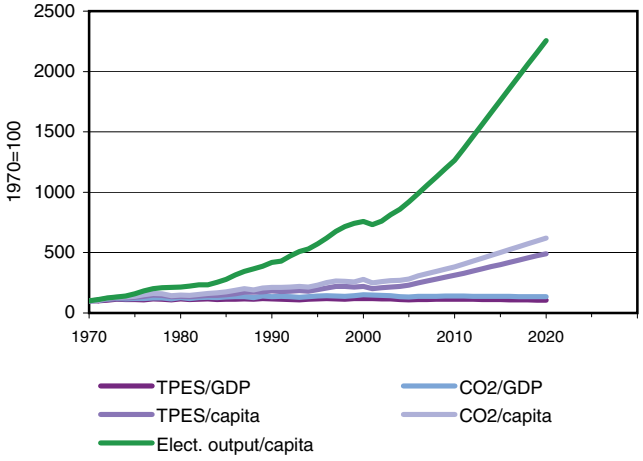


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

United Kingdom

Figure 1. Energy production

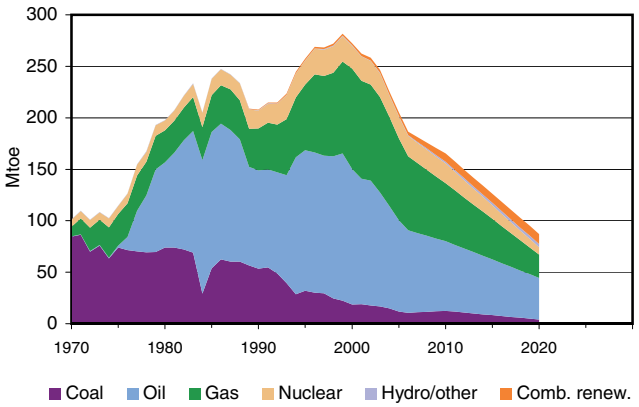


Figure 2. Total primary energy supply

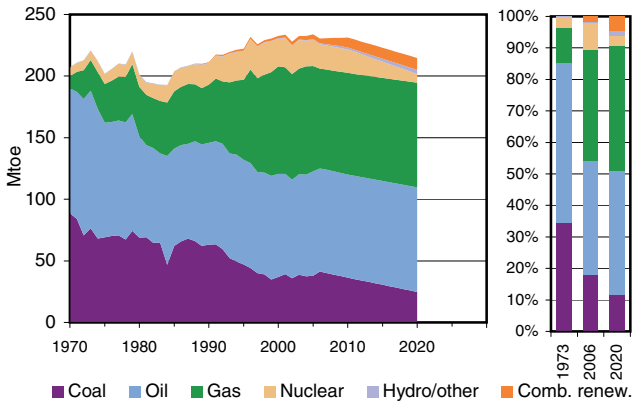


Figure 3. Energy self-sufficiency*

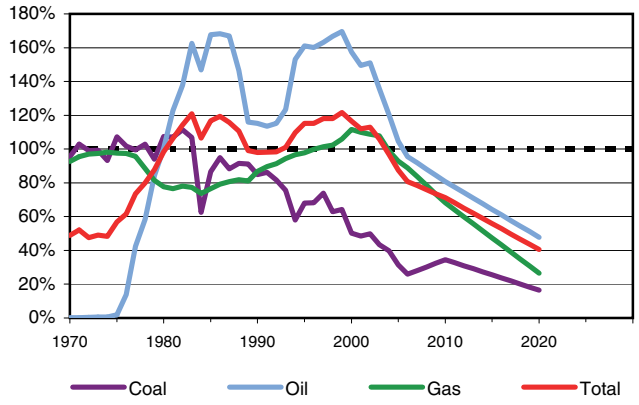


Figure 4. Electricity generation by fuel

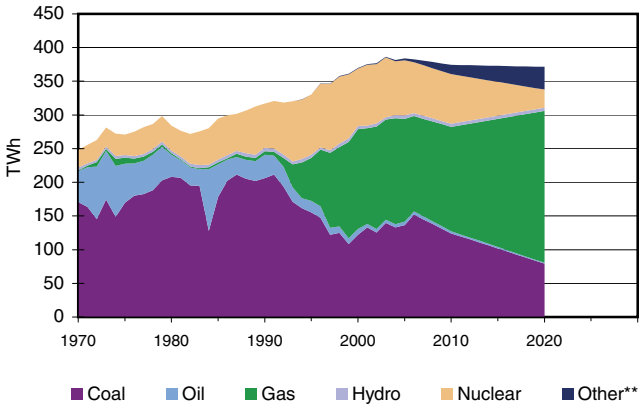


Figure 5. Breakdown of final consumption by sector and by source

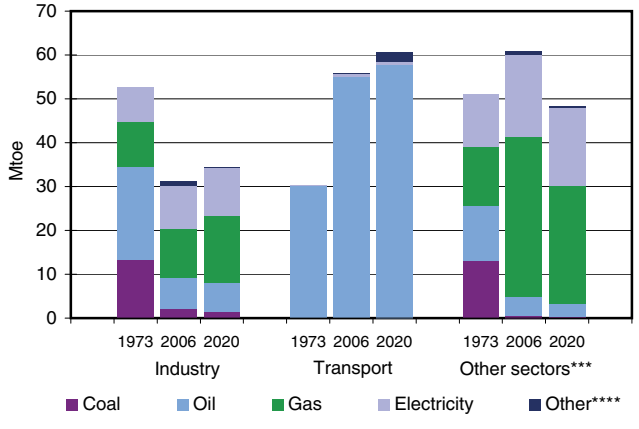
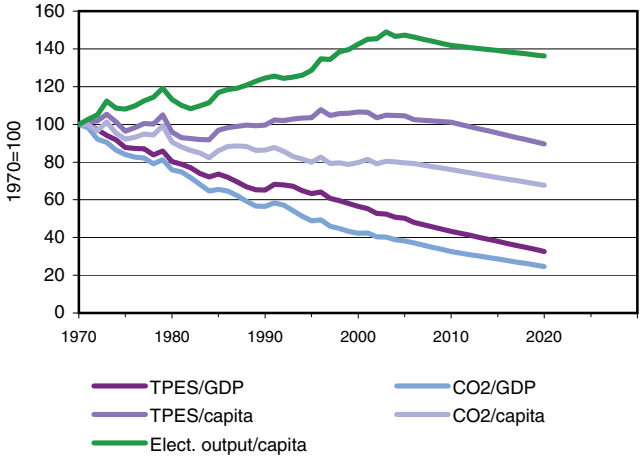


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

United States

Figure 1. Energy production

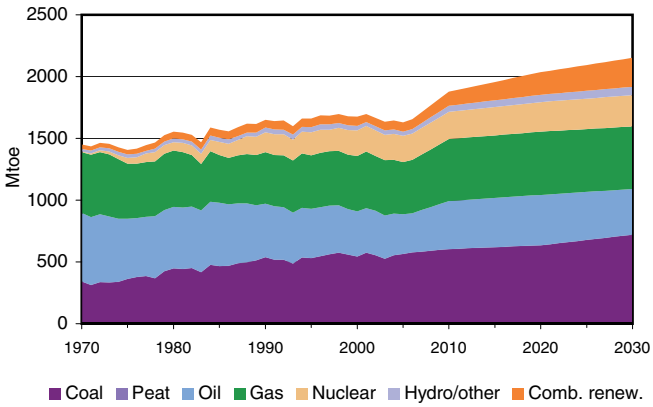


Figure 2. Total primary energy supply

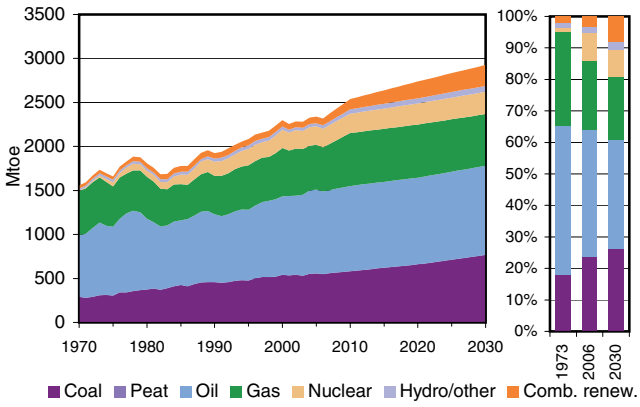


Figure 3. Energy self-sufficiency*

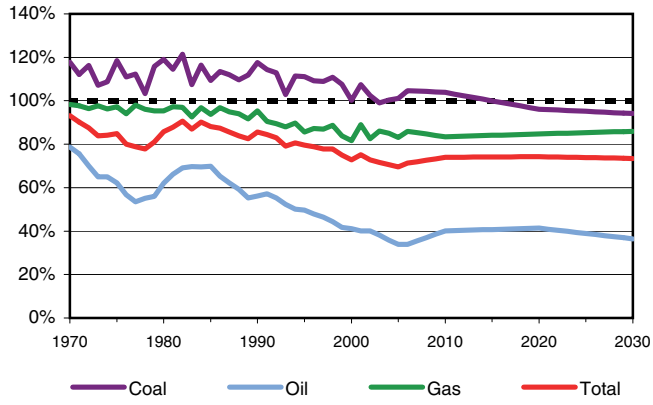


Figure 4. Electricity generation by fuel

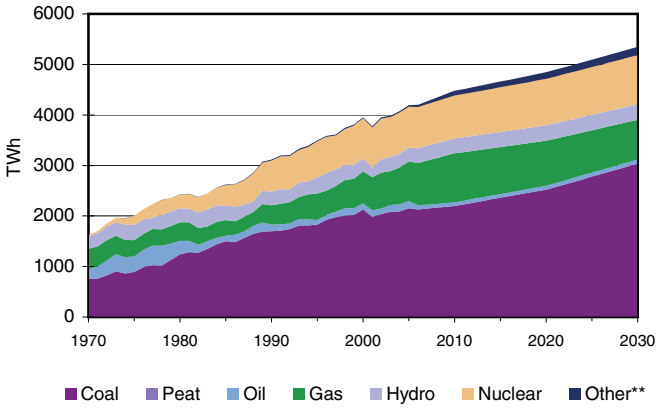


Figure 5. Breakdown of final consumption by sector and by source

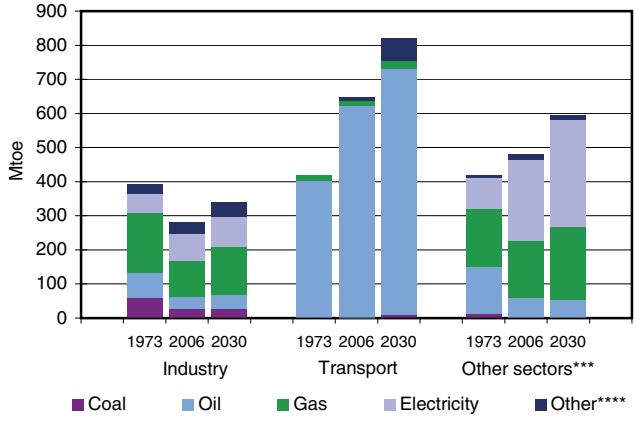
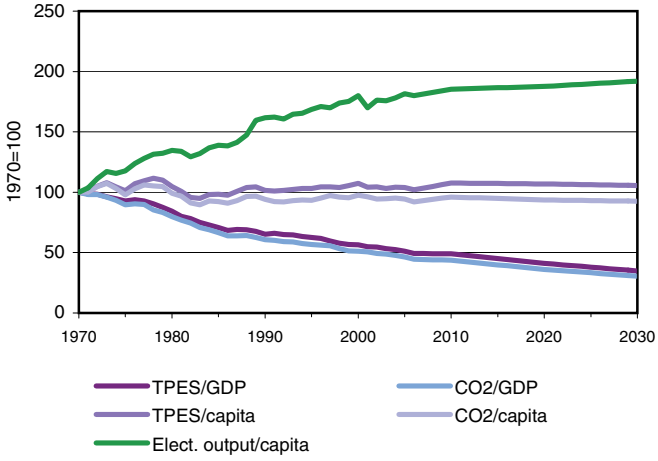


Figure 6. Selected indicators



* Self-sufficiency is measured as production divided by TPES.

** Includes geothermal, solar, wind, combustible renewables and waste, etc.

*** Includes residential, commercial and public services, agriculture/forestry, fishing and non-specified.

**** Includes combustible renewables and waste, direct use of geothermal/solar thermal and heat produced in CHP/heat plants.

Estimated IEA* government energy RD&D expenditure

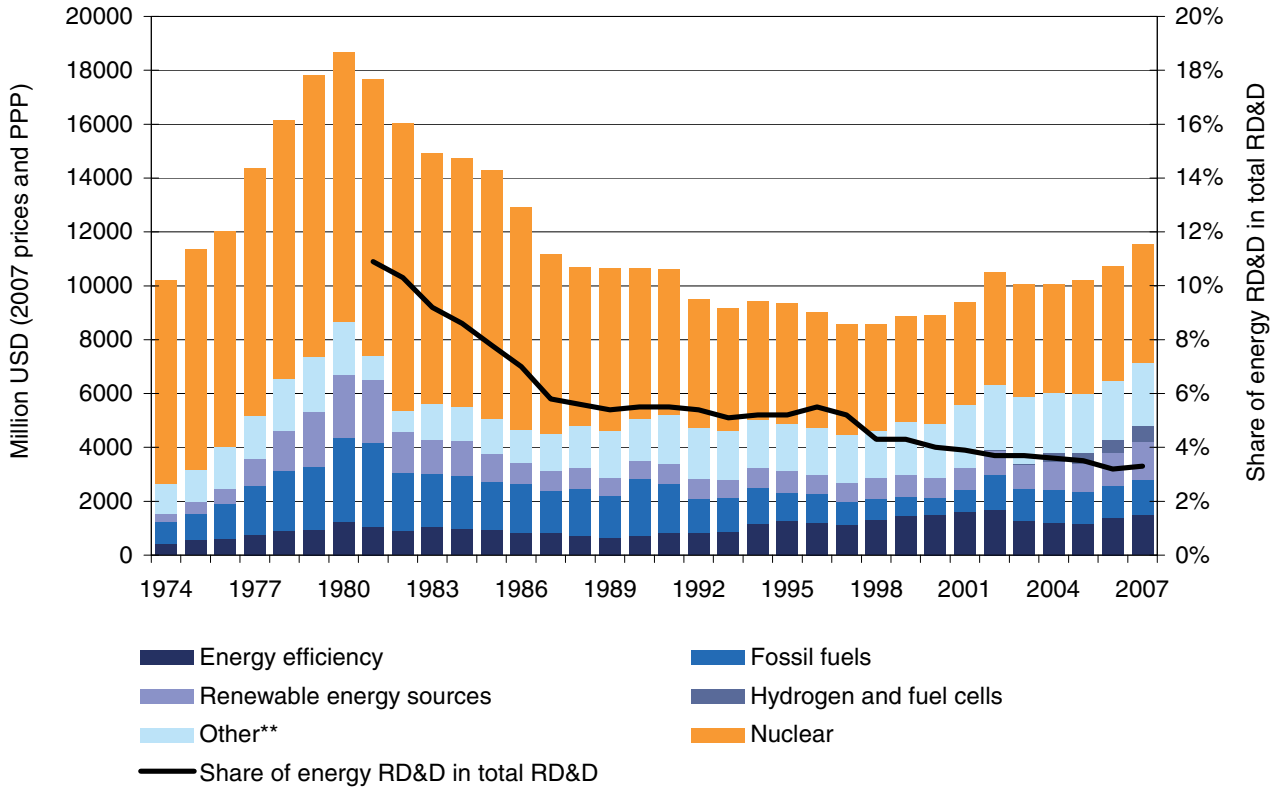
Table 1: Expenditure in USD million at 2007 prices and exchange rates

	1974	1980	1990	2000	2002	2003	2004	2005	2006	2007
Energy efficiency	445	1342	779	1564	1769	1352	1260	1262	1466	1599
Fossil fuels	939	3288	2225	689	1395	1302	1323	1258	1332	1397
Renewable energy sources	307	2479	787	852	1015	996	1163	1166	1306	1551
Nuclear fission and fusion	8493	10951	6038	4356	4478	4475	4258	4462	4481	4624
Hydrogen and fuel cells	0	0	0	0	32	38	341	405	541	662
Other power and storage techs.	269	611	346	628	591	589	465	380	549	490
Cross-cutting technologies/research	892	1446	1313	1439	1916	2011	1862	1921	1733	1950
Total Energy RD&D	11345	20117	11488	9528	11196	10763	10672	10854	11408	12273

Table 2: Expenditure in USD million at 2007 prices and PPP

	1974	1980	1990	2000	2002	2003	2004	2005	2006	2007
Energy efficiency	401	1238	696	1488	1671	1268	1183	1189	1383	1512
Fossil fuels	850	3114	2118	631	1293	1202	1225	1157	1220	1281
Renewable energy sources	285	2352	703	774	916	896	1068	1070	1188	1425
Nuclear fission and fusion	7558	10019	5584	4037	4178	4188	4034	4219	4241	4392
Hydrogen and fuel cells	0	0	0	0	26	32	321	375	504	608
Other power and storage techs.	250	573	316	577	540	540	433	348	512	458
Cross-cutting technologies/research	869	1393	1217	1392	1871	1941	1797	1861	1670	1879
Total Energy RD&D	10213	18689	10634	8899	10495	10067	10061	10219	10718	11555

Figure 1: Public sector energy RD&D in IEA countries



* IEA totals include estimates where data are not available. The Czech Republic, Poland and the Slovak Republic have not been included due to lack of data.

** Other includes other power and storage technologies and cross-cutting technologies and research.

Annex B. International Energy Agency "Shared Goals"

The 28 member countries* of the International Energy Agency (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 hydropower, make a substantial 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 achievement 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 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 costeffective manner. There are significant 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 realize 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.

* The 28 member countries of the IEA 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, Poland (since November 2008), Portugal, the Slovak Republic (since November 2007), Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

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.)

Annex C. Glossary and List of Abbreviations

3Es	Energy security, Economic growth and Environmental sustainability
AEEG	Regulatory Authority for Electricity and Gas, Italy
ANRE	Agency for Natural Resources and Energy, Japan
APEC	Asia-Pacific Economic Cooperation
APP	Asia-Pacific Partnership
CBCC	Interministerial Co-ordination Board on Climate Change
CCS	carbon capture and storage
CH_4	methane
CO_2	carbon dioxide
CRE	Commission for the Regulation of Energy, France
DG	Directorate-General for the EU Commission
E&P	exploration and production
EU15	the 15 first member states to join the European Union
EU-ETS	European Union's Emissions Trading Scheme
FERC	Federal Energy Regulatory Commission, the United States
GHG	greenhouse gas
IEF	International Energy Forum
IPCC	Intergovernmental Panel on Climate Change
JOGMEC	Japan Oil, Gas and Metals Corporation
LNG	liquefied natural gas
MDGs	Millennium Development Goals
MEPS	Minimum Energy Performance Standards
METI	Ministry of Economy, Trade and Industry, Japan
Mt	megatonne
N_2O	nitrous oxide
NEB	National Energy Board, Canada
NIMBY	"not in my backyard"
NUTEK	Board of Industrial and Technical Development
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OFGEM	Office of Gas and Electricity Markets
OPEC	Organization of Petroleum Exporting Countries
OPITO	Oil & Gas Academy, the United Kingdom
PESSE	emergency procedure for residential electricity, Italy
PIP	Long-Term Indicative Investment Planning programme, France (gas)
PPI	Long-term Programme on Investment, France (electricity)
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well
RD&D	research, development and deployment, especially in energy technology

SEA	Swedish Energy Agency
SEPA	Swedish Environmental Protection Agency
SPR	Strategic Petroleum Reserve
TPES	total primary energy supply
UNFCCC	United Nations Framework Convention on Climate Change
VROM	Ministry of Housing, Spatial Planning and the Environment, the Netherlands
WEO	*World Energy Outlook*, IEA yearly publication