INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

SPAIN

2005 Review

OECD

INTERNATIONAL ENERGY AGENCY

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

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

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

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

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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

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

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Disclaimer

This report is based on the visit to Spain by the IEA review team that took place in January 2005. It was drafted before some important policy documents and statements were published.

On 8 July 2005, the Spanish government published the 2005-2007 Plan of Action for the implementation of the Energy Saving and Efficiency Strategy E4. The plan foresees a total of EUR 7.9bn of public and private spending, and consists of 20 urgent measures, including the introduction of traffic plans in businesses with more than 200 employees, the equipping of 840 000 streetlamps with energy-efficient bulbs, and strict controls of speed limits on highways.

On 26 July 2005, a special commission published its White Paper on the reform of the Spanish electricity market. The criticism in the White Paper is similar to that in this report. Proposals to alleviate the problems include the introduction of virtual auctions, an improved design of the electricity pool, bringing electricity prices in line with production costs, and a harmonisation between the Spanish and Portuguese regulatory frameworks. These proposals will make the Spanish electricity market more open and competitive, through the reduction of market power of the incumbents.

These developments are in agreement with the suggestions made in this report.

On 15 July 2005, the Spanish government confirmed a pledge from the 2004 national elections, to significantly reduce the role of nuclear power in the Spanish generation mix.

ORGANISATION OF THE REVIEW

REVIEW TEAM

An IEA review team made up of energy specialists drawn from IEA member countries and the IEA visited Spain from 16 to 21 January 2005 to review the country's energy policies. The team met with representatives from government, the energy industry, trade associations, consumers and others. This report was drafted on the basis of information received during and prior to the visit, including views expressed by various parties during the visit.

The team greatly appreciated the co-operation and the openness demonstrated by the participants during this policy review process, and would in particular like to thank María Jesús Ónega, Luis Alonso Mijares and Luis Simó Moreno, without whose kind and generous help and extensive preparation the visit would not have been possible.

Members of the team were:

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Andreas Biermann managed the review and drafted the report in consultation with the team, with the exception of the electricity chapter which was written by Ulrik Stridbaek and the nuclear chapter which was written by Timo Haapalehto from the NEA. Monica Petit prepared the figures and Bertrand Sadin prepared the maps. Marilyn Ferris and Viviane Consoli provided editorial assistance.

ORGANISATIONS VISITED

The team held discussions with the following groups:

- AES Spain, an independent power producer
- AEGE, Association of Large Consumers
- AOP, the association of oil companies and its members
- APPA, the association of independent renewables producers
- BBE, an independent power producer
- CEOE representing the steel, glass, tile and ceramics industries
- CIEMAT, the government's environmental, energy and technological research centre
- CNE, the National Commission on Energy
- Cogen, the CHP Association
- CSN, the Nuclear Safety Council
- Electrabel Spain, an independent power producer
- Enagas, the operator of the gas network in Spain
- Gas Natural, the main gas supplier
- IDAE, the Institute for Energy Diversification and Saving
- Ministry of Industry, Tourism and Trade
- Ministry of the Environment
- Ministry of Transport
- Ministry of Housing
- OCU, the Association of Small Consumers
- OECC, the Spanish Office for Climate Change
- OMEL, the Spanish electricity market operator
- Red Eléctrica de España, the main Spanish electricity transmission system operator
- Sedigas, the association of the gas industry
- UNESA, the association of the electricity industry and its members
- WWF Spain

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The Spanish energy sector has undergone many positive changes since the last review. These include an increase in the use of natural gas and renewables in power generation leading to increased security of supply and reduced environmental impacts, further liberalisation of its markets ahead of EU directives and the entrance of new players into the energy market competing with the incumbents. The energy industry has coped very well in satisfying the rapidly increasing demand for energy. Notwithstanding all these positive developments, the energy sector in Spain and the Spanish government will face a number of challenges over the next years.

One of the most pressing issues is that Spain's demand for energy has grown rapidly and that this growth shows no sign of abating. Spain's indigenous energy resources are limited and unlikely to increase significantly, with the exception of some form of renewable energy production, in particular wind. Furthermore, weak cross-border gas and electricity interconnections and low electricity trade compared to total demand lead to a situation not dissimilar to that of an island. This carries risks for Spain's security of supply that will become greater with increasing demand for energy. Increasing interconnection capacity between Spain and the rest of Europe could not only reduce these risks, but also contribute to general European security of supply, because Spain could provide an additional entry point for non-Russian and non-Algerian gas to the European Union (EU) through its regasification terminals, and Spanish electricity generators could contribute to supply in neighbouring countries. The introduction of the Iberian Energy Market MIBEL will also help to create a stronger base for the Spanish energy markets when it happens, and should be commended. The decision to delay the introduction of the Iberian Electricity Market MIBEL appears sensible at this stage, however, because it will allow necessary improvements to be made to the market framework.

In the area of environmental protection, major efforts will be required by Spain to initially stabilise and subsequently reduce CO_2 emission levels to achieve its EU burden-sharing agreement to limit its GHG emissions at 15% above the 1990 level by 2008-2012. However, greenhouse gas (GHG) emissions in 2002 had already increased by 39% over the 1990 level. This trend creates a risk that, despite the efforts by the government to reduce CO_2 emissions, these might continue to grow further, thereby widening the compliance gap. Energy-related CO_2 emission increases have been exceptionally high in the transport

sector, in the residential, commercial and institutional sectors and in waste treatment. While some policies have been developed to deal with these problems, the concrete implementation measures required to realise significant improvements of energy intensity in Spain still have to be designed and agreed upon. There is no national climate change strategy in place that could support the implementation of measures aimed to reduce CO_2 emissions by providing an overarching conceptual and legislative framework. Furthermore, comprehensive cost-effectiveness analysis and monitoring/evaluation processes remain to be developed. Also, Spain is not sufficiently considering action on reducing non-CO_2 GHG emissions, despite these being responsible for almost 25% of all GHG emissions in the country. There is likely to be considerable potential for emissions reductions from these gases, as other countries have found.

While Spain has developed the E4 Energy Efficiency Strategy with sectoral targets, its implementation has been delayed and detailed measures to achieve the targets have not yet been developed. The government is advised to develop a concrete package of such policies and measures with appropriate funding and strong interministerial co-ordination without delay. The industry sector could potentially achieve further increases beyond the targets of the strategy in energy efficiency. It is recommended to evaluate the role of energy audits by the Insititute for Energy Diversification (IDAE) in this context. It is also a challenge to curb the growing energy demand in household and tertiary sectors owing to its diffuse nature. The transposition of the EU directive on the energy performance of buildings offers the Spanish government the opportunity to take significant steps towards increasing energy efficiency in these sectors. It should, therefore, implement it rapidly and ensure its vigorous enforcement. Improved enforcement of energy labelling for appliances and the extension of advanced metering should also be pursued. Transport is another sector in which demand growth continues unabated. The Spanish government will have to address this with a comprehensive set of measures for urban mobility, modal shifts and fleet rejuvenation. For example, the effect of the existing vehicle renovation programme PREVER would be enhanced by linking the reduction in taxation with the purchase of fuel-efficient replacement cars making use of the EU fuel efficiency label.

The Spanish government has had great success in fostering the fastest growing natural gas market within the EU, at the same time as liberalising it well ahead of EU directives. The government forecasts a growth rate of 17% for 2005, mostly driven by consumption at new combined-cycle gas turbine (CCGT) power stations that deliver increased security of electricity supply and reduced CO_2 emissions at the same time. This will require substantial investments in gas infrastructure such as gas transmission networks, LNG terminals and storage facilities. The government is mandating investment in the gas infrastructure and all consumers are shouldering their risks. While this has been instrumental in expanding the gas infrastructure, care should be taken that the guaranteed rates of return allow focusing investment on the most needed facilities.

The government could also encourage market-funded development of the infrastructure with which Spain is well provided. At the same time, as witnessed in the supply cuts in December 2004 and February 2005, it is necessary to determine transparent procedures to deal with disconnection of interruptible consumers in case of a major supply disruption. The government will also have to accelerate the development of underground storage to ensure security of gas supply. The access tariff to gas infrastructure is the same across the system, with Spain treated as one zone, a system which could hamper removal of bottlenecks. It is recommended to consider the introduction of locational signals in the gas market.

The gas market has been fully open since January 2003, and in 2004, 80% of the gas was delivered in the competitive market, where almost all industrial consumers are supplied. On the other hand, only 1.2% of residential consumers have moved into the competitive market. With a view to strengthening consumer confidence in the gas market, the standardisation of contracts and market supervision need to be enhanced. For maximising the benefit of competition, the still considerable market power of Gas Natural needs to be continuously supervised by the regulator and the independence of the transmission system operator (TSO) needs to be enhanced through the publication of a network code.

Spain's traditional indigenous fossil fuel resource is coal, in the form of both hard coal and lignite. Quality problems and cost of production make Spanish coal less competitive, compared to imported coal. It is unlikely that recent price increases for coal on the world markets will change that situation. As a consequence, Spanish coal production was further reduced between 2000 and 2004, and there was significant investment expended to attempt to economically restructure the areas affected. Because of the importance of coal mining in the already economically depressed production areas, the Spanish government sees coal primarily in terms of a social and regional issue.

Spain has ambitious targets for renewable energy, another indigenous resource, of increasing the share of renewable energy sources in TPES and electricity generation to 12% and 29.4% respectively by 2010. To achieve this target, Spain has set up the 1999-2010 Renewables Promotion Plan. A fixed feed-in tariff that is differentiated by technology has been the primary tool to promote renewable electricity in the past, and has delivered impressive growth rates for wind generation, putting Spain in third place worldwide for wind generating capacity. In an attempt to increase cost-efficiency, the government introduced a new regime for selling renewable electricity in 2004, whereby renewable energy producers can directly sell their power to the market receiving the average market price plus differentiated premiums based on the market price. This is to be commended as a first step to incorporate a market-based element. However, care should be taken by the Spanish government to ensure that the whole system to promote renewable energy is cost-effective in achieving its goals. The premium will be reviewed every four years and the

technology learning curve should be appropriately incorporated. Allowing renewable energy producers to switch between the old feed-in tariff system and the new premium scheme to maximise their profits could increase the overall cost to the economy. Guaranteeing prices without a time limit could also result in over-subsidisation. In the mid- to longer-term perspective, the government is advised to study the potential of a more market-oriented approach such as a quota obligation with a green certificates trading system to achieve the national target in a more cost-effective manner. Overcoming supply bottlenecks is essential for the introduction of biomass, which lags far behind the target.

Spain embarked on the liberalisation of its electricity sector in the mid-1990s, ahead of the timetable set by the European internal market directives. The liberalisation process was very comprehensive and led to the establishment of all the necessary regulatory and market institutions. Spain is now among the IEA member countries with the longest experience in electricity market reform. Spain is still in a transitional phase where commitments made by companies ahead of liberalisation have been addressed, and where one aim has been to protect consumers from the effects of the uncertainties liberalisation may bring. With the many other energy policy challenges that have also been met during the transition, the electricity market has, however, evolved with a continuously high level of regulation and political involvement. This regulation has served a purpose but has also created many distortions in the market. The Spanish electricity market is now at a stage where the regulation that was meant to ease the transition has become a hindrance for its further development. Spain has an opportunity to revise the role that the market is given in the Spanish electricity sector to meet the objective of higher efficiency for the long-term benefit of all electricity consumers in Spain. Political and regulatory involvement should then be focused on establishing a regulatory framework for the areas where transparent regulation is crucial to maintain market efficiency, such as system reliability, market design, competition, regulation of networks and public service obligations.

Successful liberalisation with the objective of increasing efficiency in the sector is achieved by introducing competition among market players. Success will depend on the market concentration of incumbent utilities and whether there is regulation in place to enable newcomers to build new plants and to easily trade the electricity in the market. In this context, the Spanish electricity market could benefit from reducing the concentration of large electricity companies by encouraging further new entry into the market and improving the regulation of the electricity pool. It is important to ease the access for newcomers to lower the entry costs into the market. The number of generating companies is increasing and an important share of new and expected investment in CCGT is made by the smaller and newer entrants. CCGT plants are likely to set the market price most of the time in the future, so this may prove a particularly important development for market efficiency and

competition. There are still some important pieces of information that are not published broadly. Information about the status of production plants, such as their availability and technical status, is not submitted to the market place. Information that is fundamental for analysing the demand/supply balance should be made public to all market players without delay.

The transmission grid and the operators of the Spanish electricity system seem to be able to meet the challenges from the increasing share of intermittent resources and other generating capacity. The few problems in the delivery of electricity to Spanish electricity consumers that were observed in recent years seem to derive primarily from problems in the distribution grid. This could indicate a need for a revision of the regulation of distribution activities. It should be considered whether local grid companies have the right incentives to make efficient investments. The introduction of regulation with an element of financial responsibility for the failure to deliver is commended. Since Spain covers a large geographic area, strong and transparent locational signals in price formation could improve the system efficiency. This will reduce the potential risk that congestion management is used by incumbents for market abuse. This is also crucial for the development of the interconnection capacity, in particular in the Iberian market with interconnection bottlenecks.

Enabling active participation by the demand side in the form of direct demand response to prices could provide efficiency gains. In particular, large industrial consumers have the potential to play an active role in balancing supply and demand when the system is constrained. So far, large industrial consumers have not had the incentive to participate in the liberalised market or even to change supplier. All consumers have the opportunity to be supplied through an integrated regulated tariff. The regulated tariff is based on a calculation of costs and the outcome of the calculation makes it difficult for suppliers to compete with an offer based on real market prices. In particular, the integrated regulated tariff offered to large industrial consumers and households seems to deprive these consumer groups of the incentive to go to the liberalised market.

Nuclear power is the most important indigenous energy source playing a vital role in terms of security of supply and GHG emissions reduction. The nuclear industry in Spain offers services and products that largely cover the needs of its nuclear power plant operators. Yet the current government has publicly expressed its willingness to phase out nuclear energy at least in the mid-term. This could hamper the stable and predictable operating of the market, further development of the regulatory environment and discourage further investment. Even though construction of new nuclear power plants may be difficult in the competitive market owing to economic reasons, the regulatory uncertainties caused by the government should be minimised. It should also be borne in mind that a nuclear phase-out could have significant implications for Spain's future energy security and climate mitigation policies. It is essential for the government to develop a reliable estimate of short-, mid- and long-term consequences of the phase-out.

Spain has a wide-ranging R&D programme that is reflecting well the country's energy supply mix. Spain has some very unique research programmes, and a well-skilled research base. Nevertheless, the Spanish energy R&D budget per thousand units of GDP is significantly lower than that of other European countries. Budgetary support for energy R&D should be continued and further strengthened to close this gap. Research activities funded by the government should attempt to bring in private partners, where appropriate, in order to enhance the cost-effectiveness of public research spending.

RECOMMENDATIONS

The government of Spain should:

General Energy Policy

- *Devote more attention to the demand side in energy policy-making.*
- *Improve energy forecasting outside the infrastructure planning process and beyond the current 2010-2012 time horizon.*
- *Reinforce security of supply and competition through enhanced interconnections by making them priority items within the energy infrastructure planning.*
- *Enable speedier decision-making and policy development by enhancing co-ordination of energy policy measures between different ministries and other layers of government.*
- *Strengthen the responsibility and independence of the regulator, the National Energy Commission (CNE), by investing it with more decision- and rule-making power.*

Energy and the Environment

- *Develop a comprehensive set of measures (National Climate Change Strategy) specifically directed at decoupling GDP growth from energy use and CO_2 emissions, by investigating, identifying and quantifying the many promising fields for cost-effective reduction of CO_2 emissions.*
- *Closely monitor and annually evaluate the results and cost-effectiveness of this strategy.*
- *Closely monitor the availability of international carbon credits from Joint Implementation (JI) and the Clean Development Mechanism (CDM) and prepare necessary actions in case they are not available as planned.*

- *Look into additional cost-effective GHG reduction options in the field of non-CO_2 GHGs.*

- *Increase the use of fiscal instruments to internalise the environmental externalities of energy use. In particular, examine fuel taxation in relation to environmental externalities.*

- *Strengthen the dialogue among the central government, Autonomous Communities and town councils to achieve more sustainable energy systems.*

Energy Efficiency

- *Develop concrete and effective policies and measures to implement the E4 Strategy and review it in the following years in order to more fully exploit the energy efficiency potential.*

- *Consider a shift of IDAE's budget to more investment in energy efficiency, and in particular strengthen IDAE's industrial energy efficiency activities.*

- *Implement and enforce significantly strengthened building codes. Regularly review and further strengthen these codes and support follow-up action in building certification. Train sufficient numbers of building inspectors to ensure successful implementation of the directive.*

- *Extend individual metering and billing of energy consumption in dwellings to existing buildings.*

- *Ensure that statistical information required for the planning and evaluation of energy efficiency policies is collected.*

- *Investigate the potential of smart metering for the reduction of energy use.*

- *Raise awareness of the benefits of energy efficiency through information campaigns and improved enforcement of energy labelling.*

- *Adopt measures to decouple transport demand growth from economic growth and encourage modal shifts towards more energy-efficient transport modes,* e.g. *the railways. The role of pricing should be investigated in this area.*

- *Use the PREVER system to improve car fuel efficiency by linking the registration tax reduction to EU fuel efficiency labels. Evaluate the experience of other EU countries in this respect.*

- *Encourage energy retailers and distributors to offer energy services and audits to their customers.*

- *Restrict support for combined heat and power (CHP) to plants that achieve energy efficiency gains.*

Oil

- *Closely observe the market for oil products, including liquefied petroleum gas (LPG), and promote further competition by, for example, encouraging new entrants, such as hypermarkets, and by removing planning obstacles.*
- *Co-operate with the local authorities to avoid delays in licensing new filling stations.*
- *Encourage the use of gasoline hybrid and alternative fuel vehicles, including converting bus operation to natural gas.*
- *Ensure continuous fulfilment of IEA emergency stock requirements.*

Natural Gas

- *Closely monitor and encourage the development of interconnections and liquefied natural gas (LNG) terminals, wherever possible by market-funded developments outside the system of guaranteed returns. Investigate whether especially new regasification capacity can be developed outside the regulated system.*
- *Create an environment in which the development of new storage facilities will be encouraged by allowing market fundamentals to be reflected in the price of gas; by reviewing the rate of return allowable for storage facilities relative to that for transportation; and by addressing siting, NIMBY and permitting issues to speed up the planning process.*
- *Set up an emergency plan in line with the EU directive on security of gas supply (2004/67, article 8).*
- *Monitor closely the development of the competitive market for natural gas and ensure that Gas Natural does not abuse its market power.*
- *Increase the transparency and independence of the transmission system operator (TSO) to avoid any risk of discriminatory behaviour.*
- *Review the access tariffs to the gas network with a view to introducing locational signals and correct pricing of congested assets.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Finalise and adopt a network code to ensure fair and standardised technical and commercial decisions for connection and access of third parties to the gas infrastructure.*
- *Promote and facilitate the development of the Spanish gas hub, and a liquid spot and balancing market.*

- *Review the policy on security of gas supply (particularly the 60% quota) in light of new developments in LNG and pipeline and move the focus towards the density of supply.*

- *Facilitate the timely transfer of market information to all participants.*

Coal

- *Continue to reduce the subsidy to the coal sector, and at the same time accelerate investment into the regeneration and economic change of regions affected by reductions in mining in order to reduce the welfare and regional impacts.*

Renewable Energy

- *Increase the transparency of the costs and benefits of the current renewables support system.*

- *Review the current scheme in order to assure cost-effectiveness while ensuring investor confidence with a view to reflecting the technology learning curve. Consider limiting the duration of the subsidy.*

- *Avoid hopping back and forth between old and new schemes.*

- *Eliminate possible double counting of carbon value between the European Union Emissions Trading Scheme (EU-ETS) and renewable energy promotion schemes.*

- *Consider and investigate more market-oriented mechanisms different from feed-in tariffs, taking into account other countries' experiences.*

- *Investigate the requirements of reliability and stability of the electricity network, given the significant increase of wind power on the grid.*

- *Identify the barriers to the increased use of biomass and address them in close co-operation with local governments and relevant ministries, in particular the Ministry of Agriculture. Due attention should also be paid to the potential available for the use of biofuels in transport.*

Electricity

- *Consider removing the capacity payment or, as a temporary measure, replace it with a more efficient instrument.*

- *Redesign the cost of transition to competition system (CTC system) to remove its distortionary effect on the formation of electricity prices as soon as possible.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Ensure that all market players have equal access to all information that is fundamental to the demand-supply balance, including the status of generating plants.*
- *Encourage participation of particularly large-scale consumers in the wholesale market,* e.g. *through load-shifting.*
- *Review the regulation of distribution grids to ensure that the right incentives are given to allow for efficient investment and operation.*
- *Consider the introduction of transparent locational signals in price formation and tariffs. This is particularly important with the development of the Iberian market.*
- *Reinforce efforts to establish the Iberian market by agreeing on common rules.*
- *Improve trade across the Spanish-French border.*
- *Ensure transparent licensing procedures for electricity-related infrastructure.*

Nuclear Energy

- *Ensure a stable and predictable operating and regulatory framework for nuclear.*
- *Assess the implication of extending the operating lives and increasing the capacity of existing nuclear plants on the national energy policy objectives, while ensuring high safety levels.*
- *Develop a clear vision about the future of nuclear backed by a quantitative assessment of the consequences of the nuclear phase-out on energy security, environmental protection and economic growth. Make such analysis publicly available and understood before taking a national decision.*
- *Ensure transparent and immediate disclosure of information on nuclear safety-related events and close monitoring of safety performance by the Nuclear Safety Council (CSN).*
- *Continue to develop high-level radioactive waste management solutions and take all the necessary steps to facilitate the decision-making by 2010 as planned.*

Energy Technology and R&D

- *Continue and further strengthen a sustained support to energy RD&D*
- *Ensure close co-ordination between the Ministry of Education and Science and the Ministry of Industry, Tourism and Trade in the implementation of the national energy RD&D programme.*
- *Further enhance public-private co-operation.*
- *Continue and deepen the evaluation of the performance of the energy R&D programme.*

Figure 1

Map of Spain

OVERVIEW

Spain is a country on the south-western edge of the European continent. Its total land mass is 505 000 km^2, making it the second-largest country in Europe. Spain has a low population density and the majority of the population lives in the major cities. The country's climate is quite varied, ranging from dry and hot in the central part with cold and dry winters, to mild and wet on the northern coast. Spain has extensive mountain ranges, and very long coastlines facing the Atlantic and the Mediterranean. Spain is directly bordered by France, Andorra and Portugal, and is only 30 kilometres from Morocco across the Gibraltar Straits. The two small enclaves of Ceuta and Melilla are held on the coast of North Africa, and the island groups of the Canaries in the Atlantic, and the Baleares in the Mediterranean also belong to Spain. The population in 2003 was estimated at 40.8 million, an increase of over 1% compared to 1998, with an estimated growth rate of 0.16% per annum, reflecting both a birth surplus and net immigration. A further revision in 2005 indicates that the actual population of Spain has reached 43.9 million, and this strong increase is probably mainly due to immigration.

Spain is a parliamentary monarchy on an autonomous basis, consisting of 17 Autonomous Regions (Communities) on the mainland and the islands, and two Autonomous Cities (Ceuta and Melilla), each with a local parliament. Autonomous Regions have acquired more powers in recent years. The Autonomous Regions are responsible for the authorisation of industrial installations, including power stations, and energy networks in their areas. They also have limited environmental taxation powers on transport fuels, although not all exercise these.

Following the national elections of March 2004, the government changed from the conservative Popular Party to a Socialist government. This change has brought about a reconsideration of some energy policy objectives that was ongoing at the time of writing, and has led to a move of energy policy from the Ministry of the Economy to the Ministry of Industry, Tourism and Trade.

Spain has enjoyed steady economic growth and low inflation for the last decade, with GDP growth in 2003 at 2.4%, and inflation at 3%. The unemployment rate has fallen rapidly over the last few years and in 2004 stood at 10.5%. Per capita income measured in purchasing power parity rose from USD 18 100 in 1999 to USD 22 000 in 2004. The difference compared

with other OECD countries has narrowed from 19% to 13% below average in the same time-frame. In 2004, productivity has only enjoyed a modest growth of 0.5%, and energy intensity is increasing in the Spanish economy. Spain is one of the main automobile manufacturing countries in the world, and it has an extensive tourism industry on the Mediterranean coast and the islands, and a large agricultural sector.

Spain has always enjoyed close and traditional links with South America and Spanish energy companies are active in South American markets. They have also, in recent years, become active in upstream developments in North Africa, where Spanish companies are taking a lead in developing natural gas fields in Egypt, and are the first foreign companies to be allowed to develop natural gas reserves in Algeria.

ENERGY MARKETS

PRIMARY ENERGY SUPPLY

In 2003, total primary energy supply (TPES) in Spain was 136.1 Mtoe. TPES has grown by almost 50% since 1990, or an average of 3.1% between 1990 and 2002 (see Figure 2), which is considerably more than the IEA average growth over that period. Domestic energy production (which is primarily coal, hydro and nuclear) expanded from 11 Mtoe to 34.7 Mtoe between 1973 and 1990, and has since been broadly stable, with recent increases coming from new renewable sources, primarily wind power. In 2003 it reached 33 Mtoe (see Figure 3). Because of the large share of hydroelectricity, there can be considerable year-on-year variations in Spanish energy production. Spain also has a small domestic gas and oil industry, contributing less than 1% to the domestic demand for each of these fuels. Spain is heavily import-dependent for its energy needs. In 2003, 75% of TPES was imported, or 87% if nuclear is counted as an imported fuel. The main domestic fuel resources are hydro, renewable biomass, wind and solar, together with the small oil and gas fields.

Spain has electricity and gas connections with all of its neighbouring countries, and has become a net electricity exporter to these countries in recent years. Spain currently has a total interconnector capacity of 5.3 GW (around 10% of total installed generating capacity), and is connected to France, Portugal and Morocco (see Chapter 10 on Electricity). The close proximity to Algeria has led to it becoming the main gas supplier for Spain through the Maghreb-Europe pipeline. An agreement to build another pipeline from Algeria by 2008 has been reached, but no investment decision has been made at this stage. Other gas imports are delivered in

the form of LNG to regasification terminals in Spain, and these originate in a number of countries.

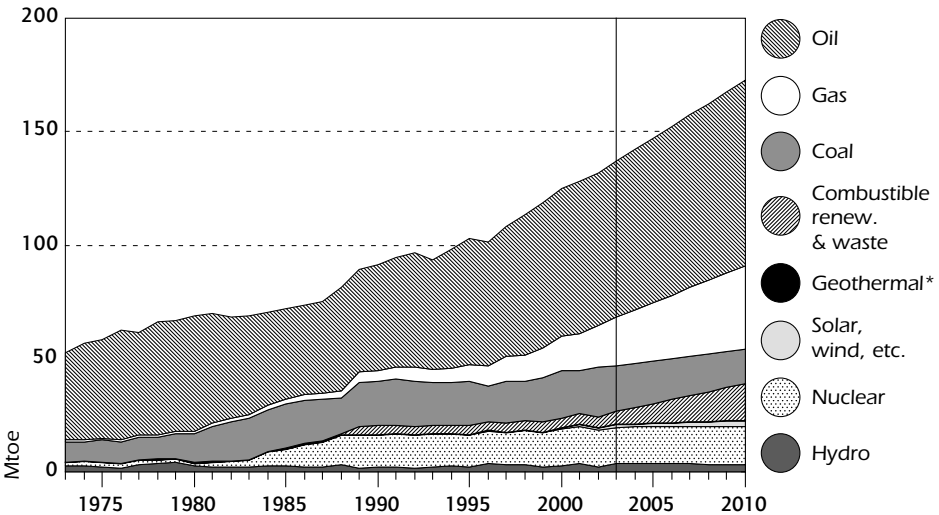
Spain is currently experiencing a significant shift in relative shares of TPES, with natural gas increasing in importance at the expense of coal and, to a lesser extent, oil and nuclear. There is also a strong increase in the share of renewable energy predicted over the coming years. Since 1973, oil's share of TPES in Spain has declined from 73.3% to 50.7 % in 2003, while that of coal has declined from 17.2% to 14.8%. Natural gas and renewables are primarily used for electricity generation, although Spain is also looking for significant increases in the use of liquid biofuels.

The generally mild Spanish climate reduces the need for space heating, and therefore the potential for district heating. Spanish summers are usually very hot and the increasing wealth of Spain has led to an increased demand for cooling services that is now affecting the energy system by creating a summer peak for electricity demand.

Coal use in Spain is primarily in the energy transformation sector for use in power stations, and as such varies year-on-year depending on the availability of Spanish hydro stations. Coal use in 2002 amounted to 30.2 million tonnes (Mt) of steam coal, 3.5 Mt of coking coal and 12.6 Mt of brown coal and lignite.

Figure 2

Total Primary Energy Supply, 1973 to 2010

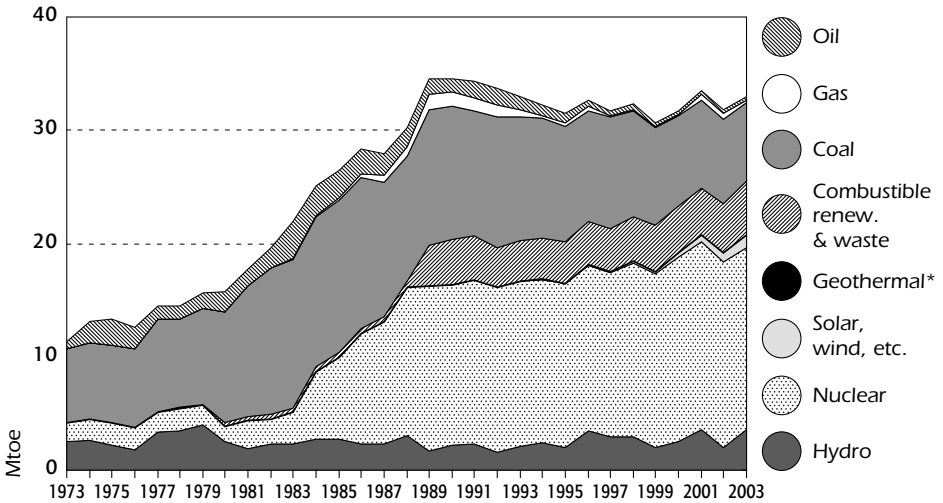


* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

Figure 3

Energy Production by Source, 1973 to 2003



* negligible.

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

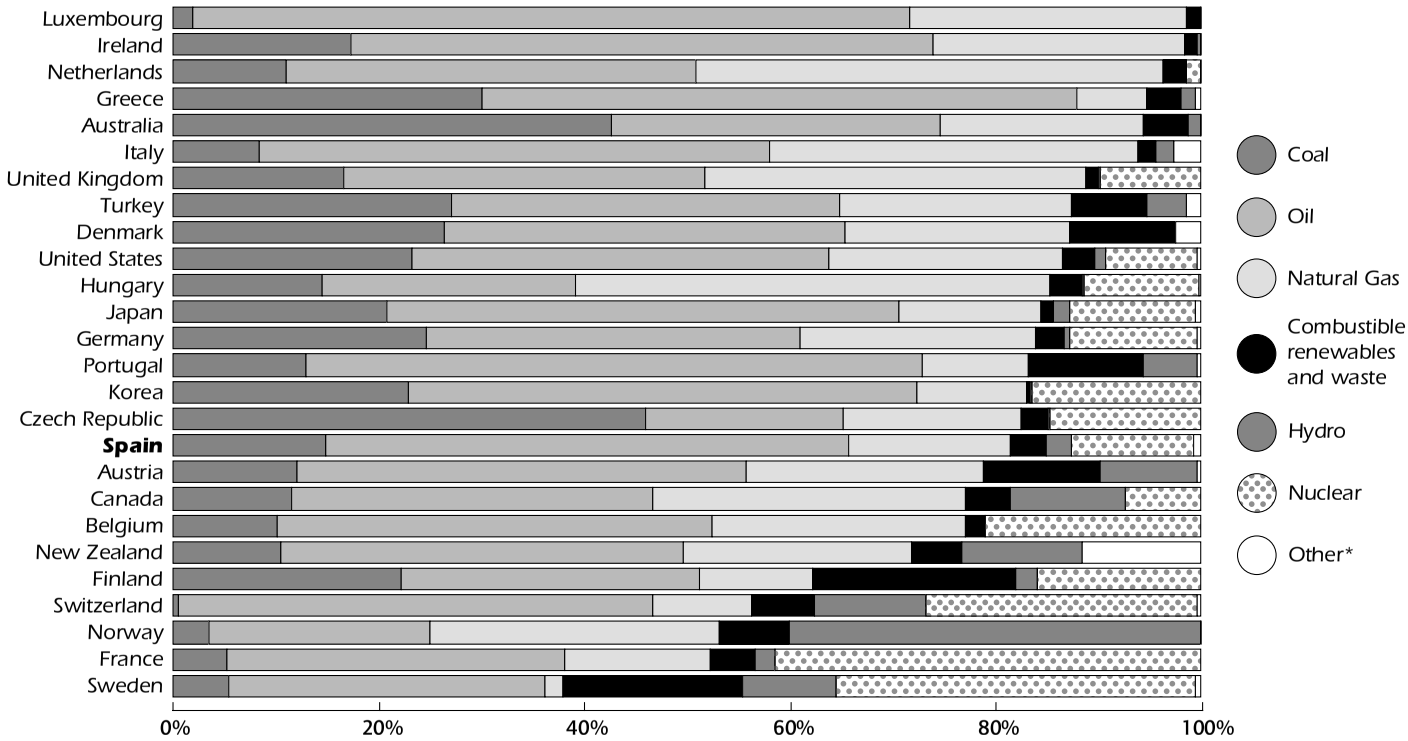
FINAL ENERGY CONSUMPTION

Total final consumption (TFC) was 100.2 million tonnes of oil equivalent (Mtoe) in 2003, which is an increase of 60.3% compared to 1990, when it was 62.5 Mtoe. In 2003, final energy consumption in the transport sector was 35.7 Mtoe (35.3%) a strong increase from 1990 when it stood at 22.8 Mtoe (36.5%). In industry, it reached 38.4 Mtoe (38.3%), again a strong increase over 1990 when it stood at 25.3 Mtoe (40.5%). In the other sectors (residential, service, agriculture), final consumption reached 24.2 Mtoe (24.2%), a significant increase of 9.8 Mtoe (+68%) over 1990 when it stood at 14.4 Mtoe (23%), indicating the rapid economic growth and development the Spanish economy experienced during the last decade (see Figure 4).

In 2003, oil accounted for 60% of TFC, dropping from 64% in 1990. This headline indicator does, however, mask considerable sectoral shifts. Oil consumption as a share of total consumption has decreased considerably in the industry sector from 44.6% to 39.1% of industry TFC (-12%). The strong increase in transport oil use from 22.8 Mtoe in 1990 to 37.6 Mtoe in 2003 (+65%) is counteracting these developments. Oil use in the power sector is variable but small and is driven primarily by the availability of hydro in any given year. The share of electricity in TFC has been relatively stable since 1990, at 18.7%; natural gas use is increasing considerably, and has more than

Figure 4

Total Primary Energy Supply in IEA Countries, 2003



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

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

doubled between 1990 and 2003, from 7.4% to 15.8%, but is still below the OECD average of gas use as a share of TFC. Further rapid increases in gas use, primarily in the power generation sector, are expected over the coming years, to a point where Spain will reach the OECD average of 21.8%. Coal accounts for 1.6% of TFC, a decrease from 5.2% in 1990, indicating a further decline of the already low coal use as a heating fuel both in the industrial and other sectors.

ENERGY FORECASTS

The Spanish government has presented an energy forecast as part of its E4 Energy Efficiency Strategy 2004–2012, divided into a baseline scenario and an efficiency scenario. The aim of the two scenarios is to allow a better understanding of the impact of the energy efficiency measures to be undertaken as part of the strategy. The base scenario is derived from the 2002 to 2011 national plan for the electricity and gas sectors, and assumes no significant changes to Spanish energy policy, but a change in the electricity generation mix with an increased share of CCGT and renewables. This is the latest available Spanish energy forecast.

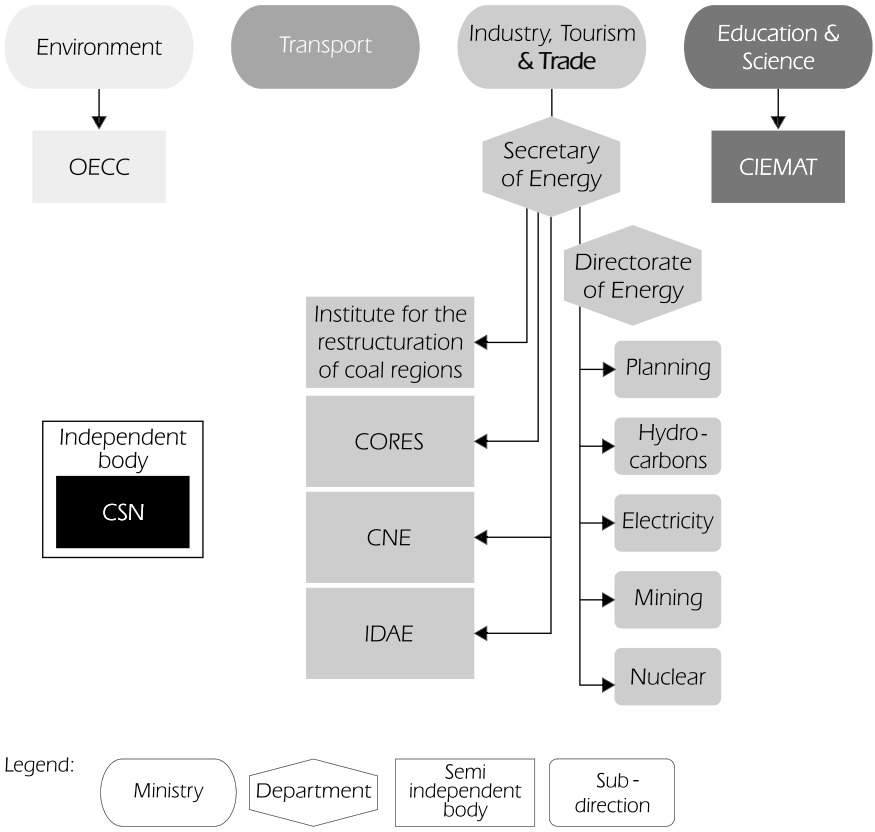
The official forecast in the 2004 E4 Energy Efficiency Strategy 2004–2012 assumes that TPES will grow to 181 Mtoe in 2012 if the strategy is not implemented, while under the efficiency scenario, growth will be restricted to 166 Mtoe. In the base scenario, TFC will increase to 136 Mtoe (+34.7%) by 2012, while in the efficiency scenario, the increase will be reduced to 126 Mtoe (–24.9%). The energy efficiency scenario assumes specific sectoral savings, with almost half of these coming from the transport sector. Across all sectors, the average annual growth would be restricted to a rate of 2.8% over the period 2004–2012. This compares to an average growth of 3.49% per annum between 2002 and 2011 in the national plan. The policies and measures by which these goals are to be achieved have not yet been formulated in detail, and it is therefore not possible to assess them at the time of writing.

ENERGY POLICY INSTITUTIONS

Spanish energy policy is directed by the central government in Madrid, where four ministries are directly involved. Further players are a range of semi-independent bodies attached to three ministries and the Autonomous Regions (see Figure 5). Within this chapter, all the bodies are briefly introduced; they are discussed in more detail within the relevant chapter.

Figure 5

Spanish Government Energy Policy Administration



Source: Country submission.

Ministry of Industry, Tourism and Trade: Secretary of Energy

Central responsibilities for energy policies fall under the Ministry of Industry, Tourism and Trade following the passage of Royal Decree 562/2004 on 19 April 2004. This decree shifted energy away from the responsibility of the Ministry of the Economy.

The Secretary of Energy within the ministry is the main authority for energy matters in Spain. Under the Secretary of Energy is the Directorate-General of Energy Policy and Mining. The ministry deals with the following responsibilities, among others:

- The drafting of energy and mining standards in line with the present legislation.

- The drafting of proposals on the regulation of the structure of rates, prices of energy products where these are regulated, and tolls for the use of energy infrastructure in line with the present legislation.
- The formulation of proposals for the conservation and saving of energy, promotion of renewable energies and development of new energy and mining technologies.
- The drafting and, if appropriate, application of measures aimed to ensure energy supply.
- The planning of infrastructure developments in the electricity and gas sectors that are carried out as regulated activities with full cost recovery.
- Regulation of the energy sector, advised by the CNE.
- The setting of administrative (regulated) prices.

The Secretary-General of Energy is the President of IDAE and of the Institute for the Restructuring of Coal Mining and Alternative Development of Mining Districts (see below).

The directorate is structured as follows:

- Sub-directorate of Energy Planning.
- Sub-directorate of Electrical Energy.
- Sub-directorate of Nuclear Energy.
- Sub-directorate of Hydrocarbons.
- Sub-directorate of Mining.

The directorate has extensive responsibilities as outlined above and is the central institution in Spanish energy policy. It co-ordinates energy policy with other ministries where necessary, for example with the Ministry of the Environment, which is responsible for climate change matters and the implementation of environmental legislation affecting the energy sector, such as the Integrated Pollution Prevention and Control Directive; the Ministry of Transport, which is responsible for transport policy; and the Ministry of Housing, responsible for the technical code on buildings. It also works on a bilateral basis with the Autonomous Regions on energy policy matters, but the competences on networks affecting more than one Autonomous Region belongs to the ministry.

The work of the ministry is supported by a number of semi-independent bodies attached to the Secretary of Energy. All of these bodies are led by political appointees and employ specialist staff to exercise their functions.

The Institute for the Restructuring of Coal Mining and Alternative Development of Mining Districts

This institute is responsible for the economic restructuring of coal mines in Spain, and as such oversaw a budget of EUR 214 million (m) in 2003 to support alternative economic development and early retirement in the areas affected by the reduction of mining activity. A national plan developed by the ministry is underlying this activity.

The Institute for Energy Diversification and Saving (IDAE)

The institute is responsible for the implementation of energy efficiency and renewables policies developed by the ministry. It took a lead role in developing the E4 Energy Efficiency Strategy and is directly investing in renewable developments. IDAE is supporting energy efficiency and renewable energy activities in all sectors of the Spanish economy, and is working both with the government, the Autonomous Regions and the European Commission. It is also internationally engaged by, for example, helping new members of the EU to implement energy efficiency and renewable energy provisions of the *Acquis Communautaire*. IDAE's budget in 2003 was EUR 23.6m, most of which was spent on supporting renewables.

National Energy Commission (CNE)

The National Energy Commission is attached to the Ministry of Industry, Tourism and Trade. The commission is responsible for advice to the ministry in the oil, gas and electricity sectors. The commission's regulatory role is to adjudicate commercial conflicts relating, for example, to infrastructure access, where both parties have referred the case to it. It mainly serves to advise the Secretary-General, as in the case of merger proposals in the energy industry, on competition issues and on the setting of the administrative prices. The commission serves some of the functions of an energy regulator, while many of the core functions are exercised directly by the Ministry of Industry in consultation with the commission. The commission is governed by a Board of Councellors. The chairman and the board members are appointed by a Royal Decree, based on suggestions by the responsible minister for industry after discussion in the Parliament, as nominations need to be accepted by the relevant parliamentary committee. The vice-chairman is appointed among the councellors based on the suggestion by the minister for industry. It is financed by fees on the energy industry and by a special tax on some hydrocarbon products sold on the Spanish mainland. In 2004 its budget was EUR 44m. CNE has 170 staff members who work on economic and engineering issues in the three areas it advises the ministry on.

Strategic Reserves Corporation (CORES)

The Department of Energy is responsible for the Strategic Reserves Corporation, a body set up to manage and maintain minimum security stocks of oil and petroleum products. CORES also has very recently become responsible for the security of supply in the gas industry and at the time of writing no rules had been issued.

Nuclear Safety Council (CSN)

The council is directly accountable to the Spanish Parliament, and formally independent from the administration. It is linked to the government via the Ministry of Industry, Tourism and Trade and is the competent body in matters of nuclear safety and radiation protection.

Other ministries and bodies involved in energy policy in Spain are described below:

The Ministry of Education and Science

This ministry is in charge of all basic research and development (R&D) carried out by the Spanish government. Attached to this ministry is a semi-independent body specialising in energy-related, technological and environmental research, CIEMAT:

Centre for Energy, Environmental and Technological Research (CIEMAT)

Its functions are researching and developing new energy technologies, together with participation in related international programmes. The centre has extensive research facilities, and is investing heavily in research into combustible renewables, nuclear technology and solar electricity technologies. It operates the world's most important concentrating solar facility in Almería.

Ministry of the Environment

This ministry is responsible for the regulation of environmental effects from energy production, such as the emission of air pollutants. It is also responsible for the implementation of energy-related EU directives, such as the Directive on Integrated Pollution Prevention and Control, into Spanish law. It was involved in the drafting of the E4 Strategy and the National Allocation Plan.

Spanish Office of Climate Change (OECC)

The OECC is under the responsibility of the General Secretary for Pollution Prevention and Climate Change. It is the secretariat for the National Climate Council, represents the ministry in the relevant international forums, and acts

as a co-ordinating body with other ministries and public or private entities in the area of climate change.

Ministry of Transport

This covers the development of transport infrastructure and has the responsibility for managing transport demand. The ministry has been closely involved in the drafting of the E4 Energy Efficiency Strategy.

Autonomous Communities

The Autonomous Communities have a variety of powers relating to energy, primarily in the area of authorising installations and tariffs where the tariff is only operated in one region. They also have limited taxation power over transport fuels.

ENERGY POLICY OBJECTIVES

The Spanish government has become progressively less intervening in the energy industry in recent years, and had abandoned national energy planning by the time of the last in-depth review in 2001. National planning is now undertaken for specific aspects of the energy system, such as renewables, energy efficiency and regulated infrastructure activities in transmission of electricity and gas.

The Spanish energy policy objectives are situated within the broader EU targets on energy and are compatible with the 3 Es (Energy security, Economic growth and Environmental sustainability) of the IEA's *Shared Goals*:

- By achieving sustainable development, Spain aims to grow in a sustainable manner. Its energy policy is trying to achieve the production and consumption of energy in a more sustainable manner.

- By ensuring security of energy supply, the economy will grow and become more competitive.

  Spain is still a country with a below-average per capita income in the OECD. It will need continued economic growth to achieve parity with other members, and this growth will need a secure and low-priced energy supply to support it. Spanish energy policy is aimed at providing the framework for the private energy companies to achieve this.

- A reduction of the impact of production, transformation and end-use of energy on the environment. The Spanish government realises that energy production and use have negative environmental consequences, and is trying to minimise these in its energy policy.

Spanish energy policy has been very much supply-side driven, and has seen its biggest successes in the supply sector, with the increase of power generation to meet growing demand, a shift to cleaner natural gas as a power generation fuel and, in particular, the significant success in deploying wind generation. As is shown in the trend of growing energy intensity, the demand side has not benefited from similar policy attention until recently. While the E4 Energy Efficiency Strategy has ambitious targets, concrete policies and measures to achieve them are still under preparation (see Chapter 5).

ENERGY MARKET STRUCTURE

The Spanish energy markets are in a transition phase from a fully regulated to a fully liberalised system. Spanish energy supply is provided by the private sector in all areas of oil, gas and electricity. Coal mining and the nuclear fuel cycle are the only areas left in which the government has a significant ownership stake. The government regulates the natural monopoly aspects of the energy system to ensure, for example, third-party access and transparency, but these activities are carried out by private companies. The markets are dominated by established Spanish players, many of which have taken up international operations in recent years. There is some foreign ownership in the market and some national subsidiaries of multinational oil companies are active in Spain.

In the period since the last review, merger attempts with an aim to create a "national champion" were undertaken, but not allowed by the government on the advice of CNE. The first attempt was to merge Iberdrola and Endesa, with the aim of creating a dominating integrated utility company, capable of competing against companies such as EDF or E.On on the European markets. The failure of these merger attempts has meant that the Spanish energy companies are of medium size compared to their counterparts in other European countries, and there are indications that the future may see renewed attempts at creating a national energy champion through mergers. Multinational energy companies have already entered the Spanish market: Hidrocantabrico is owned by the Portuguese electricity company EdP and the Italian Enel has entered the Spanish market through Viesgo.

The government experts determine the administrative prices (see Energy Taxes and Prices), and the infrastructure planning processes under national energy planning. In recent years, strong government support for electricity produced from renewable sources has led to considerable private investment in wind power, and the creation of a Spanish company, GAMESA, capable of competing in the world market for the manufacture and construction of wind-farm equipment and wind farms.

ENERGY SECURITY OF SUPPLY

Spain has insufficient energy resources of its own and depends on imports of all forms of energy resources from a variety of countries, while also exporting electricity and oil products. The coal resources of Spain are not of very high quality and large hydro resources are already considerably exploited. This means that future growth in energy demand will have to be met by increased imports, raising questions about the long-term security of such imports. Spain is already attempting to increase the exploitation of new renewable sources in order to reduce import dependence.

There is also no longer a moratorium on nuclear power, and the government is committed to phasing out nuclear power over the long term (see Chapter 11). Since any new nuclear power station would have to be built by private generation companies, it is unlikely that a proposal will be forthcoming without a change in government policy, given the economic risks associated with nuclear power stations owing to their long construction lead times and high capital cost.

This situation is exacerbated by the need to import growing quantities of natural gas, of which Spain does not have sufficient reserves after the adoption of measures to reduce the impact of Spanish energy consumption on climate change by replacing coal and oil-fired electricity generators with combined-cycle gas turbine (CCGT) plants. Increased liberalisation of the electricity market, which has led to a "dash for gas" among Spanish electricity generators, is also contributing to this effect. On the other hand, given a potential increase in the connection capacity of Spain to European gas and electricity networks, Spain could contribute to EU security of supply by reducing the dependence of other EU States on Russian gas. Spain has significant entry capacity through LNG regasification terminals that could be utilised to import gas from new suppliers into the EU, either as gas or electricity.

Spanish security of supply policy is pursuing a multi-pronged approach:

- Observing the developments in the market, and continuing legislative requirements on the origin of natural gas.
- Reducing energy demand by increased energy efficiency.
- Increasing the share of renewable energy in the supply mix.
- Establishing formal oversight of gas supply security within CORES.
- Fulfilling the IEA requirements for emergency stocks of oil.

The increasing interaction between the natural gas and electricity systems will provide new challenges about energy security to Spanish energy policy-makers in the future, because failures in gas supply have the potential to lead to

electricity blackouts when a significant share of electricity is produced from gas. Gas and electricity tend to have similar winter peaks and there has already been an occasion when CCGT plants had to be interrupted owing to a compressor failure on the Maghreb pipeline.

ENERGY TAXES AND PRICES

Energy taxes in Spain are set by the central government in the form of excise tax and value-added tax (VAT), with the exception of special taxes on petrol and diesel that can be set by Autonomous Regions to finance health care and environmental activities. Not all Autonomous Regions use this possibility to raise revenue, leading to a taxation differential between regions.

The taxation system for electricity included municipal taxes that were explicitly set at 1.5% for households until 1984. Since then, these taxes are priced into the administrative tariff for electricity, under which the majority of households are still supplied. They are not explicitly identified on the bill. Provincial taxes were abolished in 1986. The special tax has been set at 4.864% since 1998. For natural gas, a 1.5% municipal tax falling on domestic and commercial consumers is paid by the suppliers, and is also not explicitly identified on the bill.

Energy pricing is undertaken either by the markets, or by the government, under a system of so-called administrative prices. Spain has liberalised 100% of the electricity and gas markets in 2003. In both of these markets administrative prices are in effect based on full-cost calculations by the ministry. These prices are applied to all customers, although there is the possibility that the system of setting administrative prices will be phased out over the second part of the decade. Customers have to decide whether they want to freely choose their supplier, or whether they prefer to remain within the administrative system. If they return to the regulated market from the liberalised market, they are locked out into the administrative tariff system for a minimum of one year. Customers consuming over 100 GWh/year are locked out of the administrative system for three years if they choose to go to the market. Administrative prices are low and act as an effective ceiling on the market price. Because of the way they are calculated, there is little possibility to price below them.

The markets for petroleum and LPG are also liberalised, although in the market for LPG sold in cylinders (capacity over 8 kg) and by pipe, a *de facto* monopoly is exercised by RepsolYPF, and prices of LPG are set administratively while the price of bulk supplies (LPG transported by trucks to end-consumer stores) is not regulated.

Table 1

Energy Taxes in Spain, 2004

Sector/fuel	*Excise tax (EUR/unit)*	*VAT %*
Households/electricity	0.051[1]	16
Households/natural gas	0	16
Households/light fuel oil	84.71/1 000 litres	16
Households/coal	..[2]	16
Households/gasoline unleaded 95RON	0.396/litre	16
Households/gasoline leaded	0.427/litre	16
Households/diesel	0.294/litre	16
Liquefied petroleum gas in a 12.5 kg cylinder		16
Power generation/natural gas	0[3]	n/a (not applicable)
Industry/electricity	0.025[4]	n/a
Industry/natural gas	..	n/a
Industry/light fuel oil	84.71/1 000 litres	n/a
Industry/heavy fuel oil		
(taxation is equal for high and low sulphur HFO)	14.43/tonne	n/a
Industry/coal	..	n/a
Industry and commercial/diesel	0.294/litre	n/a

1. 2000 data.
2. Not available.
3. 2000 data.
4. 2002 price.

Sources: *Energy Prices and Taxes*, IEA/OECD Paris, 2005; Ministry of Industry.

CRITIQUE

The Spanish energy sector has undergone many positive changes since the last review, such as an increase in the use of gas or renewables in power generation, leading to increased security of supply, and further liberalisation and entrance of new players into the market. After being delayed twice, the Iberian market MIBEL is now scheduled to become a reality from 2005. At the same time, the energy industry has coped well with the rapidly increasing demand for energy in Spain, resulting from an increase in economic activity and population growth. Notwithstanding all these positive developments, the energy sector in Spain, and the Spanish government, will face a number of challenges over the next years.

Spanish energy policy is still very much supply-side driven, and has seen its biggest successes in the supply sector, with the increase of power generation to meet growing demand, the shift to cleaner natural gas as a power generation fuel and, in particular, the significant success in deploying wind generation. On the other hand, it does not appear that sufficient effort and resources are given to the implementation of demand-side policy instruments (in particular the implementation measures to achieve the E4 Strategy), which could lead to effectively curbing GHG emissions and demand for non-renewable fuels. Evaluation of the success of such measures that have been taken in the past should be undertaken, and new measures should be accompanied by evaluation from the start.

Spain's demand for energy is growing fast, while the indigenous energy resources are very limited and unlikely to increase significantly. Furthermore, weak cross-border gas and electricity interconnections and low electricity trade compared to total demand lead to a situation not dissimilar to that of an island (see Chapter 10). This carries risks for Spain's security of supply. Increasing interconnection capacity between Spain and the rest of Europe could not only alleviate this, but also contribute to general European security of supply by providing an entry point for Atlantic and Arabian gas to the EU through its regasification terminals.

Government energy forecasts beyond 2012 are lacking, making it difficult to address challenges such as the continuous growth of the population and the economy, climate change, or the need to replace existing nuclear plants in the longer term within the long-term investment framework required by the energy industry. The existence of such forecasts would also help to assess the untapped energy efficiency potential in all sectors of the economy. Many other countries are forecasting energy data up to 2020 and some even to 2030. Spanish policy development could benefit from moving to a longer forecasting period.

While different players exist in the energy scene, the Ministry of Industry, Tourism and Trade is the nexus of the energy policy administration. The ministry faces an important task in leading the response by the administration and the semi-independent bodies to the energy policy challenges as a whole. In particular, some measures are urgently required, involving all the policy-making bodies, such as the implementation measures for the E4 Strategy. Because energy policy challenges spread across such areas as climate change, energy efficiency, market reform and renewable energy, closer co-operation between different ministries and other layers of government is essential, as is the involvement of all stakeholders, including consumers, industry and non-governmental organisations (NGOs) in energy policy-making. Added to that, the Ministry of Industry, Tourism and Trade should be given the means to accelerate the development of policy responses, *e.g.* by receiving clear political guidance regarding the long-term aims of the Spanish energy and climate

change policies through a national strategy. This is particularly important for the success of market liberalisation, energy efficiency and climate change mitigation, where it has a major role to play, and where long-term policies are required.

Spain is still in a transition phase, going from a completely regulated to a liberalised market. In such an ongoing process of market reform, it is very important to ensure that efficient price signals are given to power generators, energy suppliers and consumers. The process of administratively determining integrated tariffs may undermine the power of price signals in all energy-related markets when these prices are set too low to enable competitive markets to emerge.

The Spanish energy regulator, the National Energy Commission (CNE), is well resourced and performs analysis and development which is crucial for the efficiency of the Spanish energy sector. The role of the regulator is, however, only consultative in most of the issues that it provides input for. Final regulation and decisions must be approved by the Ministry of Industry before they can take effect. Therefore, the strength of having an independent party to pass judgment, different from the rule-making and implementing authorities, may be lost.

Regulatory independence is an important indicator for investment certainty for new entrants into the energy markets of a country, and it could be argued to be almost a prerequisite for strong competition. The experience of other countries shows that those with strong regulators have benefited more from increased liberalisation, while those with less strong and independent regulators have lagged behind.

Despite the commitment by the Spanish government to further liberalisation of its energy markets, there is a perceived lack of transparency and investment certainty in its energy sector. The government should therefore consider ways to give the CNE powers to perform the actual regulation of these markets, to assure investors and new entrants. To achieve this, it may have to reconsider the procedures for the appointment of board members and executive staff at CNE, by, for example, the creation of an independent committee that has the task of selecting the chairman and board members.

RECOMMENDATIONS

The government of Spain should:

- *Devote more attention to the demand side in energy policy-making.*
- *Improve energy forecasting outside the infrastructure planning process and beyond the current time horizon of 2010-2012.*

- *Reinforce security of supply and competition through enhanced interconnections by making them priority items within the energy infrastructure planning.*
- *Enable speedier decision-making and policy development by enhancing co-ordination of energy policy measures between different ministries and other layers of government.*
- *Strengthen the responsibility and independence of the regulator, CNE, by investing it with more decision- and rule-making power.*

CLIMATE CHANGE

GREENHOUSE GAS EMISSIONS

Spain's total greenhouse gas (GHG) emissions reached 400 Mt CO^2-equivalent in 2002, a rise of 39% compared to 287 Mt CO^2-eq. in 1990 (see Table 2 below for the composition by type of GHG). Of these, 303 Mt CO^2-eq. (76%) are from fuel combustion from sectors included under the Kyoto Protocol, while another 30 Mt CO^2-eq. are from international maritime and aviation fuel combustion (see Table 3 below).

Table 2

Spanish GHG Emissions Inventory, 1990 and 2002 (in kt)

Greenhouse gas emissions	*1990*	*2002*	*Change*
CO_2 (net)	215 295.23	290 146.68	35%
CO_2 without LUCF[1]	*224 751.23*	*325 448.17*	*45%*
CH_4	30 244.07	41 136.13	36%
N_2O	26 273.22	28 755.38	9%
HFCs	4 645.44	3 896.11	-16%
PFCs	790.37	257.05	-67%
SF_6	93.58	238.69	155%
Total	277 341.91	364 430.03	31%
Total (without LUCF)	*286 797.91*	*399 731.53*	*39%*

1. Land use change and forestry.

Source: European Environment Agency.

Table 3

CO_2 from Fuel Combustion by Sector in Mt, 1990 and 2002

Year	*Energy transformation*	*Transport incl. maritime & aviation*	*Industry*	*Other incl. residential*	*Total*
1990	76.7	81.6	45.4	21.7	225.5
2002	116.5	128.0	58.1	30.8	333.4
Change	52%	57%	28%	42%	48%

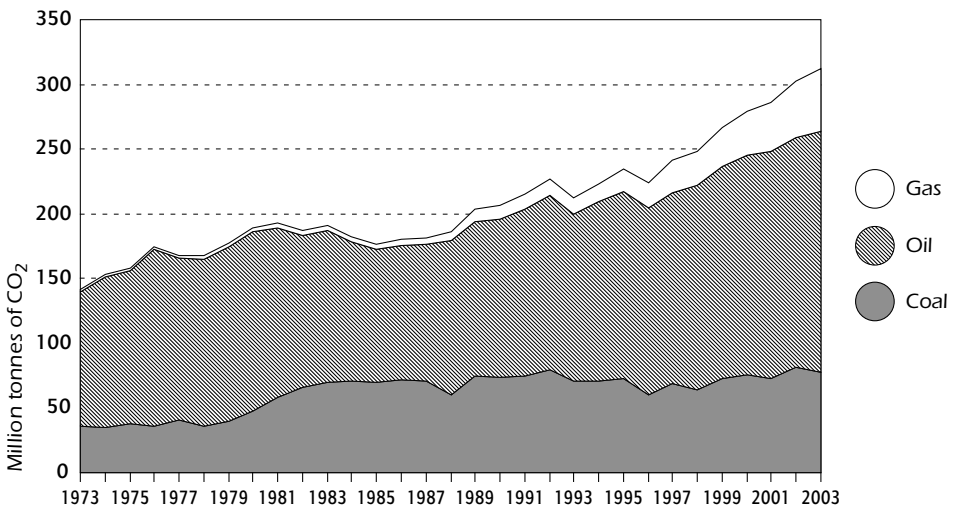
Source: *CO_2 Emissions from Fuel Combustion 1971-2002*, IEA/OECD Paris, 2004.

CO_2 EMISSIONS

Spanish per capita CO_2 emissions have reached 7.48 tCO_2 in 2002, close to the level of OECD Europe which stood at 7.53 tCO_2 in 2002. Contrary to the trend in OECD Europe where emissions have decreased by 5% from 7.93 tCO_2 in 1990, the current level in Spain represents an increase of 40.6% from the 5.32 tCO_2 emitted per capita in 1990. The main differences between Spain and OECD Europe emissions are in the transport and other sectors. Spain's per capita transport emissions stand at 2.42 tCO_2, 33% above OECD Europe's 1.82 tCO_2, owing to its reliance on air and sea transport to island communities, an inefficient railway system and relatively low taxation of vehicle fuels. The other sectors[1], which include residential, emit 0.76 tCO_2, 47% less than OECD Europe average of 1.44 tCO_2. This difference is probably coming from the lower heating requirements of Spanish homes compared to the European average.

Figure 6

CO_2 Emissions by Fuel*, 1973 to 2003



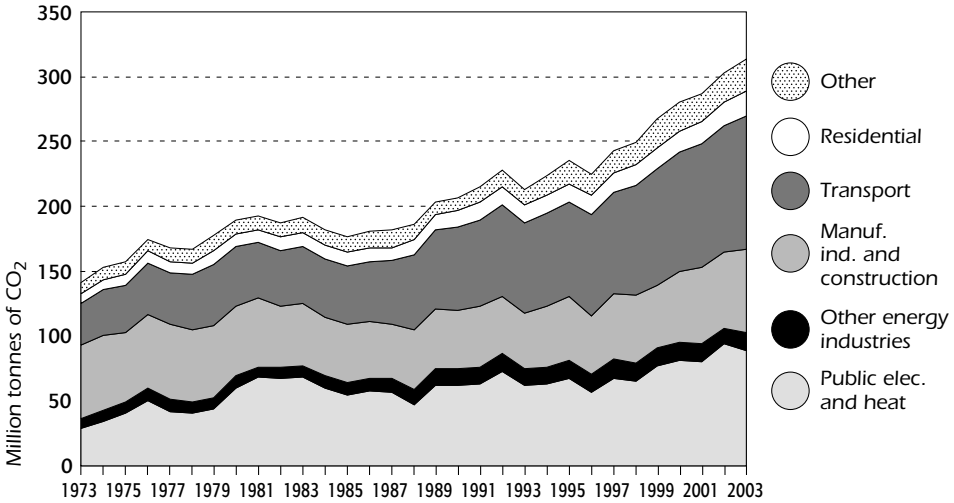
* estimated using the IPCC Sectoral Approach.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2005.

1. The "other" sectors include residential, commercial non-industrial, agriculture, and public services.

Figure 7

CO_2 Emissions by Sector*, 1973 to 2003



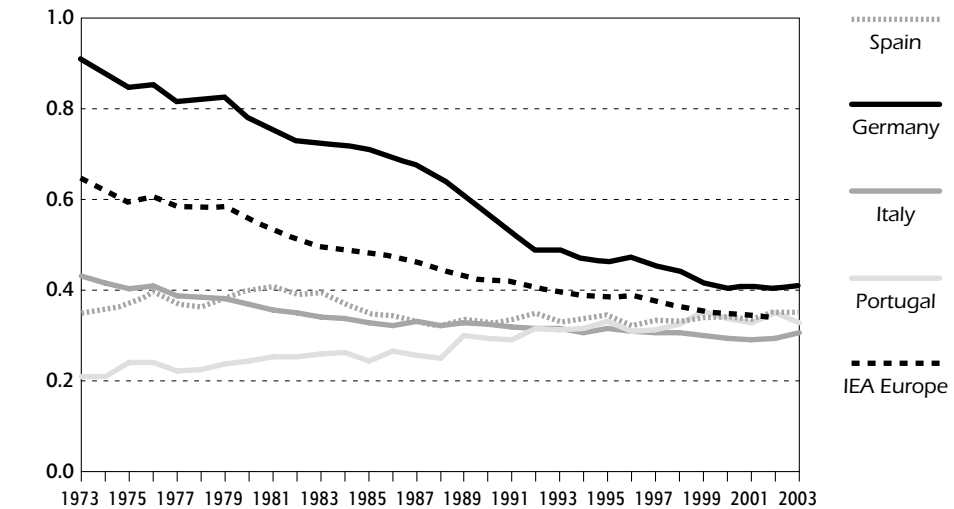
* estimated using the IPCC Sectoral Approach.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2005.

Figure 8

Energy-related CO_2 Emissions per GDP in Spain and in Other Selected IEA Countries, 1973 to 2003

(CO_2 emissions/GDP using 2000 prices and purchasing power parities)



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

SPAIN'S COMMITMENTS

Both Chambers of the Spanish Parliament ratified the Kyoto Protocol in May 2002. According to the EU burden-sharing agreement, Spain must limit the increase of average GHG emissions in the period 2008-2012 to no more than 15% above the 1990 base year level, while the overall EU commitment is for a reduction of 8% during the same period. Spain is however far from meeting its commitment. In 2002, the increase in emissions was already more than 39% above 1990 levels, with projections including measures already planned predicting further increases at or even above GDP growth.

In order to achieve the EU burden-sharing agreement in the period of 2008-2012, Spain has set a target to stabilise the CO_2 emissions during the period 2005-2007 at the average level of emissions of the last three years (2000-2002), at 401 Mt CO_2-eq.

The reduction effort is shared across the economy in order to maintain the current proportion in the national total of CO_2 or GHG emissions between the sectors covered by the European Emissions Trading Scheme discussed below (40.5%) and those not included (59.5%).

Measures are required for the sectors not included in the emissions trading scheme and these should lead to an additional reduction in CO_2 emissions of approximately 52 Mt CO_2 over the period 2005-2007. An action plan is being drawn up for 2005-2007 to identify which measures can contribute to achieve this aim. For Spanish emissions, this means an annual average objective of 398 Mt CO_2 for 2005-2007. This is a reduction of 0.4% compared to 2002 emissions of 401 Mt CO_2-eq., but still 39% above the 1990 level.

The additional reduction effort will take place in the period 2008-2012 so that Spanish GHG emissions would not exceed base-year emissions by more than 24% at the end of that period. Spain intends to achieve the target (+15%) under the EU burden-sharing agreement through carbon sinks (a maximum of 2%) and through the Kyoto Protocol mechanisms (7%).

POLICIES AND MEASURES

Spain's domestic policies to mitigate climate change are mainly focused on the introduction of CCGT to cover additional electricity demand, a reduction of energy intensity and an increase in renewable energy production. The Spanish government considers that policies to promote energy efficiency and renewables contribute not only to reducing CO_2 emissions, but also to reducing other emissions like SO_2, NO_X or particles and to enhancing its energy security. These policies cover all sectors of the economy, but some of

them are less well developed than others in terms of their implementation, for example energy efficiency policy is considerably less advanced than renewables policy. Spain does not have an overarching climate change strategy which could ensure that individual measures are working in conjunction with each other and are implemented according to an orchestrated schedule. There is also a strong potential to reduce non-CO_2 GHGs, which is not exploited at the moment. The existing measures are listed below:

- **Planning of the Electricity and Gas Sectors. Development of the Energy Transport Network 2002-2011**

The planning framework gives priority to the installation of transmission lines for electricity generation from renewable energy sources and to the building of gas pipelines which cover the increasing demand for gas both from CHP and CCGT power stations (see Chapter 10 for more details).

- **Plan to Promote Renewable Energy**

The plan was approved in 1999 with extended objectives in order to achieve a share of at least 12% of primary energy supply in 2011 with renewable sources (see Chapter 9 for more details).

- **Energy Efficiency Strategy in Spain (E4)**

The strategy, which covers demand-side measures to reduce energy consumption in all sectors of the economy, is expected to contribute significantly to the reduction of emissions in the end-consumer sectors. The Spanish government views private transport and the residential sector as fields with great opportunities for increased energy efficiency. It intends to promote the necessary instruments in the form of incentives, legal improvements and through information and awareness-raising campaigns, to ensure the participation of all Spanish citizens in the common objective of limiting Spain's energy consumption and complying with its international commitments. However, the strategy lacks an implementation programme and has fallen behind schedule, putting the delivery of its targets at risk (see Chapter 5 for more details). It is estimated that the strategy will lead to 42 Mt CO_2 emissions reductions from 2012.

- **Use of Flexible Mechanisms (CDM, Emissions Trading)**

Spain plans to use both emissions trading within the European Trading System and credits worth 100 Mt CO_2 over the period 2008-2012 from the Kyoto Protocol mechanisms to achieve its Kyoto target. The section below gives details on both.

Kyoto Protocol Mechanisms: Clean Development Mechanism (CDM) and Joint Implementation (JI)

Spain decided that it will use the Kyoto Protocol mechanisms as they are especially promising for the country to achieve compliance with its commitments under the Kyoto Protocol. In order to ensure credits on the level required, the Spanish government is conscious of the necessity for a number of steps to be taken and has started working on the areas mentioned below.

On institutional arrangements, Spain has designated its national authority for Kyoto project-based mechanisms under the Royal Decree 1/2005, which transposed the EU Directive 2003/78/CE into national legislation. In this law, an interministerial commission is established in order to act as national authority for Kyoto mechanism credits based on projects. The commission has, among others, the following functions:

- Submit reports on voluntary participation in Clean Development Mechanism (CDM) and Joint Implementation (JI) project activities in accordance with international and community legislation.
- Propose to the Council of Ministers the recognition of Emissions Reduction Units (ERUs) and Carbon Emissions Reduction Certificates (CERs) as valid allowances for emissions trading within the EU.
- Act as the focal point in the relationship with other countries' designated national authorities, to promote CDM and JI.

This national authority has the possibility of establishing agreements with Autonomous Communities in order to promote the implementation of CDM and JI projects.

Latin America

As a consequence of the relationship between Spain and Latin American countries, Spain took the initiative to establish a "Latin American Climate Change Units Network", with the participation of Climate Change Departments from Portugal, Spain and Latin American countries, including the private sector of both regions. Under this initiative, Spain has signed a memorandum of understanding (MOU) with six countries of the Latin America region for co-operation on CDM activities.

Latin America is one region with a considerable potential for emissions reduction through the CDM, and Spain has strong historical and cultural links to Latin America. Many major Spanish companies, including energy suppliers, are currently active on the American continent. Because of the presence of such diplomatic and commercial links, CDM could become an important area

of co-operation between Spain and Latin America over the coming years, simultaneously contributing to the clean development of the host countries and to the achievement of Spain's Kyoto commitments. For Spanish industry, this possibility provides greater flexibility and may reduce the cost it incurs in the discharging of its obligations.

In parallel with actions abroad, Spain has been working at national level. The Spanish administration has been co-operating with different companies in order to facilitate progress in this process. The Ministry of the Environment created a working group on the Kyoto Protocol project-based mechanisms, with the participation of other ministries and private companies. This group was created with a double objective: on the one hand, to promote CDM/JI projects and facilitate their registration, and on the other hand, to identify the administrative structure and to implement a pilot programme in a learning-by-doing exercise.

EU Community Level

An EU directive has been passed on 27 October 2004 linking the flexible mechanisms to the Emissions Trading Scheme by accepting the use of emissions reduction credits within the community scheme (from 2005 for CDM and from 2008 for JI). Spain has already transposed this through Law 1/2005 of 9 March in order to give certainty to the installations with commitments under the National Allocation Plan (NAP).

The total volume of credits required by Spain to achieve its target under the Kyoto Protocol that would result from the use of flexible mechanisms is estimated in the National Allocation Plan 2005-2007 at a total of 100 Mt CO_2 for the period 2008-2012, equivalent to about 7% of 1990 emissions. The government will encourage the acquisition of credits to cover the excess emissions in sectors not covered by trading, especially in transport and the residential sector. To achieve this aim, an agreement with the World Bank has been signed to obtain 40 Mt CO_2 out of the 100 Mt CO_2. In order to achieve the remaining 60 Mt, there are various alternative approaches being considered to support the delivery of the projects required to achieve the savings, including participation in other international funds, or the setting up of one or more Spanish carbon funds.

EMISSIONS TRADING

EU Directive 87/2003/CE created the EU Emissions Trading Scheme (ETS), a mandatory instrument and a means of preparing and providing flexibility to companies in terms of compliance with the commitments flowing from the Protocol. Spain aims for an effective and flexible application of the directive to provide market-based instruments to encourage efficiency. The main instrument to achieve this is the national allocation process which works in two stages, the first covering the period 2005-2007 and the second 2008-2012.

The Spanish government viewed the preservation of competitiveness and employment in the Spanish economy as a key feature of the National Allocation Plan (NAP), while it was aiming to achieve a significant step towards compliance with the Kyoto commitment by its formulation. This meant identifying the most efficient opportunities for reduction in industry and setting out a course of emissions reductions by industry that will further intensify in 2008-2012, thereby enabling them to plan ahead with certainty. Dialogue with the affected industries was seen as essential in order to produce a well-balanced NAP with the lowest possible cost for the economy, taking into account aspects such as technological innovation in the field of emissions reduction, and the continuing internationalisation of the industry sectors covered by the NAP. The Spanish government also intends to pursue a dialogue with trade unions about the possibilities to minimise adverse effects from complying with the Kyoto Protocol.

For the sectors included in the directive, the proposal is for the distribution of 157.3 Mt CO_2 as an annual average for the 2005-2007 period, plus an additional reserve of 1.9% of this for new entrants and enlargements, resulting in a total allocation of 160 Mt CO_2/year. This gives a total allocation in annual average terms of 160 Mt CO_2, a reduction of 2.5% compared to 2002 emissions of 164 Mt CO_2. Added to this are 14 Mt CO_2/year and 0.36 Mt CO_2/year reserve for CHP installations in sectors not covered by the EU-ETS.

The power production sector allocation is broken down by company in Table 4 below, and the other industrial sectors allocation scenario is set out in Table 5. For power production, the average emissions forecast is 94 Mt CO_2/year in the period 2005-2007. The NAP allocates 86.4 Mt CO_2/a (92% of the forecast emissions) to the electricity generation sector in the period 2005-2007. This amount includes the reserve for incoming operators in the sector.

Table 4

NAP Energy Sector Allocations in Mt CO_2 for Large Generators in Spain

Company	*Allocation*[1]	*Percentage of total*
Endesa	40	46%
Iberdrola	12.8	15%
Union Fenosa	13.3	15%
Gas Natural	4.6	5%
Others	14.7	17%
Future reserve	1.0	1%
Total	86.4	100%

1. Average annual allocation over the period 2005-2007.

Source: Ministry of Industry.

Table 5

Forecast CO_2 Emissions, Non-energy Sector, and the Spanish NAP

Sector	*1990*	*2000*	*2001*	*2002*	*Avg. 2000-2002*	*Increase avg/ 1990*	*Sectoral request for 2006*	*Average annual assignment 2005-2007*			*Coverage of requests*
	Mt CO_2	*Mt CO_2*	*Mt CO_2*	*Mt CO_2*	*Mt CO_2*	*%*	*Mt CO_2*	*Without reserve*	*Reserve*	*Total provision*	*%*
Oil refining	12.64	15.25	14.99	14.86	15.03	18.93	16.78	15.25	1.99	17.24	103
Steel working*	13.83	10.79	10.74	10.85	10.79	-21.96	12.3	11.23	0.00	11.23	91
Cement and lime	22.72	27.08	27.76	28.78	27.87	22.68	32.23	29.99	0.00	29.99	93
Glass and ceramics industry	6.09	8.58	9.06	9.37	9.00	47.84	No application	8.55	0.00	8.55	Not applicable
Paper, paper paste and cardboard	2.29	3.64	4.33	4.52	4.16	81.80	5.6	5.29	0.00	5.29	94
Mixed installations Annex I								1.581	0.00	1.58	Not applicable
Total industrial	57.57	65.34	66.88	68.38	66.87	16.15		71.89	1.99	73.88	
Mixed installations not Annex I								1.68		1.68	Not applicable
Co-generation not Annex I		8.62		10.2				12.238	0.36	12.60	Not applicable
Total not Annex I								13.92	0.36	14.28	Not applicable
Total Spanish emissions (MT CO_2-eq)	285.69	368.68	385.05	401.34	391.02	36.87		26.16	0.73	26.89	Not applicable

(*) Projections adding blast furnace gases.

NB: Sectorial estimates include nearly all increases in capacity forecast.

Emissions allocations were significantly more restrictive for coal plant. Coal power plants will receive declining allowance volumes at an average of 80% of historical emissions (2000-2002), with highs for the most efficient hard coal plants of around 95% and a minimum of 55% for inefficient lignite-fired plants. This special formula is aiming to ensure that the oldest and least efficient coal plants will close first in order to reduce CO_2 emissions, although it remains to be seen if this goal is achieved. There is also a strong possibility of interaction between the CO_2 emissions reduction and further reductions of other pollutants mandated under EU regulations. Operators of CCGT plants have been given a higher share of requested emission rights. CCGT plants will receive the full allocation for forecasted yearly production on the basis of a CO_2 benchmark derived from state-of-the-art CCGT technology emitting 365 kg CO_2 per MWh generated.

For the industrial sectors, the following allocations were undertaken (see Table 5 for details). A free reserve will be set up for incoming operators under the EU-ETS, equivalent to 3.2% of emissions of the reference scenario in the industrial sectors. 50% of the reserve will be allocated preferentially to CHP facilities. Distribution will be on a first come, first served basis while reserves last. Any surplus will be auctioned off.

- 72 Mt CO_2 for all the industrial sectors, including the increases in production capacity of existing operators.
- 3 Mt CO_2 reserve for incoming operators, shared out between sectors in line with the estimated increase in emissions between 2002 and the forecasts for 2006.
- 0.43 Mt CO_2 of reserve emission rights not shared out by sectors which will provide a stock for non-identified future entrants.
- In the allocation of rights to the steel sector, an additional 1.6 Mt CO_2 has been allocated, and this corresponds to the emissions from producing electricity with blast furnace gas.

Banking, *i.e.* carrying over rights from the first allocation period (2005-2007) to the second one (2008-2012), will not be permitted under the Spanish NAP. Rights allocated to facilities that close during the period will automatically pass to the reserve for incoming operators. Grouping of facilities will be partially accepted. The voluntary pooling that is allowed under the NAP should maintain competition in emissions trading while giving some flexibility to industry by making it possible to reduce transaction costs for smaller companies/sectors. It will enable these companies to increase their negotiating capacity in the CO_2 market without altering the overall integrity of the system. In the case of the electricity generation sector, the current market structure in Spain could mean that the setting-up of one or more pools would prevent the NAP from providing an effective incentive for the introduction of less polluting technologies. For this reason, pools are not allowed by the NAP in electricity generation.

A national registry of emission rights was created in late February 2005. The Ministry of the Environment is responsible for the registry.

AIR POLLUTION

Royal Decree 653/2003 transposes European Directive 2000/76/CE on waste incineration into Spanish legislation. It establishes a series of conditions and requirements, including emission pollution limit values, for the adequate working of waste incineration and co-incineration facilities.

In order to comply with the requirements of European Directive 2001/81/CE for National Emission Ceilings (NEC Directive), the Ministry of the Environment issued a resolution in 2003 approving the national programme for the progressive reduction of national emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_X), volatile organic compounds (VOCs) and ammonia (NH_3). The programme will be reviewed annually up to 2006, and then every two years.

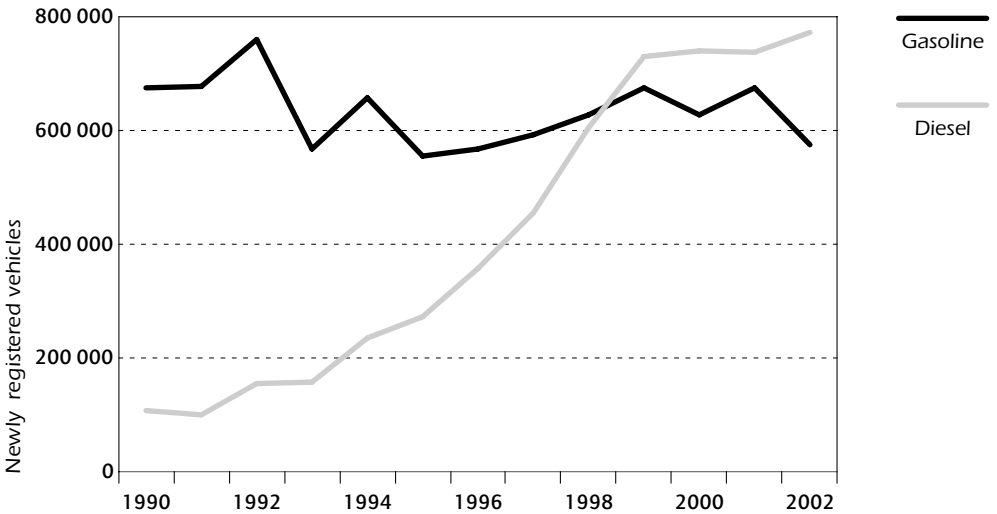
The Royal Decree 430/2004 transposes the stricter emission limits for SO_2, NO_X and particles of the European Directive 2001/80/CE about the Limitation of Emissions of Certain Pollutants into the Air from Large Combustion Plants (LCP Directive) into Spanish legislation. It covers emissions from large combustion facilities with a thermal capacity of at least 50 MW, as well as emissions of these pollutants from oil refineries and other sectors' facilities. Emission Limit Values (ELV) have been set for every facility on the basis of their thermal capacity and the fuel used. The elaboration of a National Emissions Reduction Plan (NERP) for large combustion plants previous to 1987 is being finished, in order to accomplish the LCP Directive in a cost-effective way. Facility coverage was expanded compared to the previous decree from 1991 by including CCGT plant and biomass installations. The implementation of these emission limits may lead to requirements for desulphurisation units on coal plants, further reducing their fuel efficiency and increasing CO_2 emissions from these plants.

Spanish vehicle fuel taxation is favourable to diesel. Spain has the sixth-lowest (after VAT) gasoline taxes, the third-lowest diesel taxes in the EU15 countries and there is a strong effect on the vehicle fleet caused by the differential taxation between gasoline and diesel fuel, with gasoline being taxed 38% higher than diesel (after VAT). While gasoline engine vehicles have increased by 7.5% between 1993 and 2002, the number of diesel engine vehicles has increased by 274% in the same time. Since 1999, new vehicle registrations for diesel vehicles are the majority of new registrations

in any year, and in 2002 were more than two-thirds of newly registered cars. Consequently, consumption of gasoline has stayed roughly equal between 1994 and 1999 (these are the latest available figures), while that of diesel rose by over 60% in the same time-frame, and doubled since 1988. This has no doubt contributed to urban air pollution concerns, especially in the Madrid area, even though increased use of diesel is reducing CO_2 emissions from transport overall. From 2005 onwards, diesel vehicles will need to meet EURO IV standards and will likely be much cleaner, but all the vehicles sold in the past 15 years do not have to meet such stringent standards.

Figure 9

Development of New Vehicle Registrations by Fuel, 1990 to 2002



Source: Ministry of Public Works (Ministerio de Fomento), AOP.

Royal Decree 1700/2003 outlines the technical specifications of gasolines, gas oils, fuel oils and liquefied petroleum gases in line with EU Directive 2033/17/CE, bringing the specifications previously found in different national regulations into a single provision. It also sets out the maximum percentages for mixtures of biofuels with gasoline and gas oils.

The specifications for the sulphur content of gasoline, diesel, and diesel used in special applications were revised by Royal Decree since the last review, as set out in Table 6.

Table 6

Sulphur Content Reductions in Fuel Use in Spain, 2005–2009

Fuel	*Sulphur content prior to 1.1.05*	*Sulphur content from 1.1.05*	*Sulphur content from 1.1.09*	*Reduction 1.1.05 to pre 1.1.05*
Gasoline	150	50	10	67%
Diesel	350	50	10	86%
Special use				
Diesel used in shipping			1 000 ppm from 1.1.08	
Diesel in agriculture/residential use	2 000 ppm			

ppm: parts per million.

Source: Country submission.

CRITIQUE

Spanish energy policy is seeing the move towards a more sustainable energy future as one of its key aims. Spain has accepted a challenging CO_2 emissions reduction target and will have to undertake significant efforts to meet it. The government has implemented the relevant EU directives on non-CO_2 emissions control from large combustion plants since the last review and is looking to significantly increase renewable use in electricity generation and transport.

Under the EU burden-sharing agreement, Spain is allowed to increase GHG emissions by 15% above 1990 levels for 2008-2012. By 2002, GHG emissions have already risen by 39%. Energy consumption still rose at or above current GDP growth rates, meaning that Spain´s energy intensity increased, contrary to trends in other OECD countries. The difficulty of burden-sharing compliance is not alleviated by the fact that Spanish CO_2 emissions per capita are still lower than they are in the EU15 average. In the past, Spain has not been successful in developing, implementing and monitoring comprehensive strategies to combat these trends. At the same time, despite efforts by the government, CO_2 emissions might continue to grow further, widening this compliance gap.

Major efforts will be required by Spain to initially stabilise and subsequently reduce emission levels. While Spain has individual measures to promote CCGT, renewable energies and energy efficiency, there is no comprehensive national climate change strategy in place that could support the delivery of individual measures by providing an overarching conceptual and legislative framework with a clear layout of responsibilities and requirements for co-operation. Furthermore, Spain has not conducted a comprehensive analysis of cost-effectiveness of each policy and measure through quantifying its expected

impact on CO_2 emissions reduction. Developing such a comprehensive strategy and monitoring/evaluation process will be essential to achieve the domestic reductions necessary to meet Spain's CO_2 emissions target. The more challenging it will be for Spain to stabilise and reduce its emissions level, the more attentive to cost-effectiveness it needs to be in implementing various policies and measures.

The government envisages covering some 20 Mt CO_2/year, *i.e.* 7 percentage points of the current compliance gap of 24 percentage points, with CDM project credits primarily from Latin America. The government and the industry are actively exploring possibilities of CDM projects in Latin America. The government is also considering signing MOUs with the host countries. This is a sensible approach to reduce overall cost for climate change mitigation. However, it also needs to be noted that the authorisation procedure of CDM projects at the CDM Executive Board has been very slow and only four projects have been approved as of writing this report despite the fact that CDM projects can be pursued since 2000. Therefore, it is not necessarily clear if the CDM will deliver sufficient projects in time to achieve this level of emissions reductions. The government may need to develop a contingency plan in case the CDM credits do not become available as planned.

Spain has presented a National Allocation Plan (NAP) for the EU Emissions Trading Scheme (ETS), and this has been accepted by the EC. In this plan, the government makes a respectable effort at balancing "significant steps towards compliance" with Kyoto obligations, with the preservation of "competitiveness and employment levels within the Spanish economy". Consequently the NAP's objectives are first to stabilise CO_2 emissions in the period 2005-2007 before reducing them in the 2008-2012 period. The NAP also aims to hold constant the 40.5% share that energy and energy-intensive industry sectors have as part of total national emissions, and to secure the competitive position of Spanish industry by fully allocating on the basis of historical emissions (2000-2002) with an allowance reserve for new entrants.

The electricity sector's annual allocation in 2005-2007 is fixed at 86.4 Mt CO_2 while its emissions reference forecast is 94 Mt CO_2. The government's energy sector strategy focus on expanding the shares of CCGT plants and renewables will almost certainly be successful in bringing down specific emissions in the electricity sector. Whether this will be sufficient in the context of rapidly rising demand for electricity remains to be seen. Nevertheless, the available options are not limited to CCGT and renewables, and other options, such as high-efficiency coal plant or the reduction of non-CO_2 GHGs, should be considered.

Coal power plants will receive declining allowance volumes at an average of 80% of historical emissions (2000-2002), with highs for the most efficient hard coal plants of around 95% and a minimum of 55% for inefficient lignite-fired plants. However, while being in line with the government's objective to

see coal-based electricity generation largely replaced by CCGT plants in the medium term, this method is clearly not designed to include modernisation incentives for existing coal-fired plants. The allocation in the next period would have to be significantly less to incentivise the operators of coal plants (primarily Endesa and Union Fenosa) to undertake modernisation of their plant leading to higher efficiencies. In a growing electricity market, it is therefore possible that coal power plants will remain in operation without investment in fuel efficiency and desulphurisation for just as long as CO_2 allowance prices remain below the fuel price difference and compliance with clean air legislation is still achievable. While the intention of the NAP should be commended, the government should closely monitor the plans by Spanish electricity companies regarding their old coal stations, and develop the next stage of emissions allocations as soon as possible to provide sufficient visibility to the market.

Outside the emissions trading system, energy-related CO_2 emission increases have been exceptionally high in the transport sector (+40% from 1990), in the residential, commercial and institutional sectors (+35%) and in waste treatment (+66%). This is due to a considerable increase in Spanish energy use in recent years as a consequence of the rapid increase of Spain's GDP. In particular, transport energy demand is rising rapidly and this is not just contributing to climate change, but also creates local air quality problems in urban locations. Spain's recent economic development has taken place with little change to its energy intensity. In other European countries, energy intensity has decreased significantly during the same period, and has almost halved in IEA Europe since 1973. Despite the development of the Energy Efficiency Strategy E4, Spain has seen a prolonged delay in the preparation of an implementation plan. This delay puts the demand-side plank of the government's strategy at serious risk (see Chapter 5 for more detail). The Spanish government is currently deciding on a Plan for Action on E4.

Spain does not seem to have fully exploited the potential of non-CO_2 GHG emissions reduction, which may reduce the total cost of climate change mitigation. Non-CO_2 GHG emissions reduction may provide a more cost-effective option in achieving the national target. In particular, policies attempting to address methane (CH_4) emissions from abandoned or current mining operations may be worth investigating in this context.

Increased use of fiscal instruments could be effective in addressing sectors not covered by the EU-ETS and air pollution issues. For example, currently low taxation of transport fuels contributes to a rise in demand for these fuels, and therefore to a rise in CO_2 and other emissions.

Transport fuel taxation has contributed to a shift from gasoline to diesel as the fuel choice for private vehicles, with the majority of vehicles today being diesel-fuelled. Diesel engines are more efficient than gasoline engines of the

same size and comparable to hybrid engines, but the move towards larger diesel engines counteracts efficiency improvements to some degree. A further shift from gasoline to diesel could create problems in the efficiency of the refining processes upstream, and lead to higher CO_2 emissions at refineries, as well as a growing imbalance between the production of Spanish refineries and the demand for fuel in Spain (see Chapter 6). Furthermore, in the existing car fleet, diesel engines emit more harmful pollutants such as particles and non-methane VOCs, although the availability of new, cleaner diesel technologies and tightening emissions standards will, over time, reduce the externalities of diesel. On the other hand, the increased number of diesel vehicles is helping to reduce overall fuel consumption and CO_2 emissions from the Spanish transport sector, owing to the lower CO_2 emissions from diesel vehicles that achieve a better mileage than gasoline engine vehicles. Taking these factors into account, the sustainability of fuel taxation favouring diesel, in terms of both air pollution and climate change, should be examined. One possibility to address this conflict without increasing CO_2 emissions from transport might be to introduce gasoline hybrid or alternative fuel vehicles into the market, for example by converting city bus operations to natural gas. This would also have positive effects on local air quality. Readjusting the gasoline and diesel tax rates to bring them into better alignment may also be an important strategy.

Because of the way legal and regulatory power is distributed in Spain, many policies relating to energy use are the responsibility of the Autonomous Communities and the town councils. Policies where this is the case include those affecting urban mobility and public transport, building regulations, and industrial (including power generation) and environmental permitting. Barcelona has, for example, enacted regulations requiring solar installations in new and refurbished buildings well ahead of national regulation, where these are only discussed now. The government sectors can also take a lead in procuring more environment-friendly technologies (equipment, vehicles, etc.). Because of this decentralisation of power, the Spanish government will have to engage in an extensive institutional dialogue to concentrate the efforts of the three levels of administration on achieving the goal of a more sustainable energy system.

RECOMMENDATIONS

The government of Spain should:

- *Develop a comprehensive set of measures (National Climate Change Strategy) specifically directed at decoupling GDP growth from energy use and CO_2 emissions, by investigating, identifying and quantifying the many promising fields for cost-effective reduction of CO_2 emissions.*

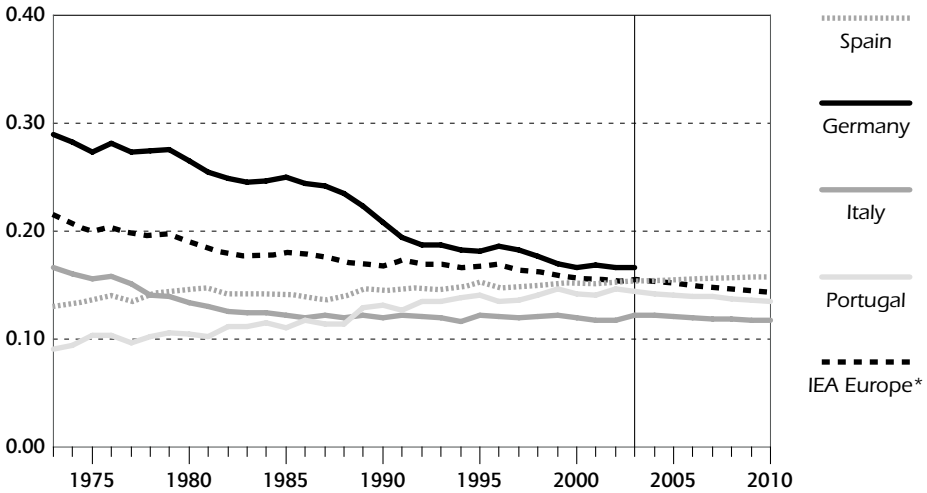
- *Closely monitor and annually evaluate the results and cost-effectiveness of this strategy.*
- *Closely monitor the availability of international carbon credits from JI and CDM and prepare necessary actions in case they are not available as planned.*
- *Look into additional cost-effective GHG reduction options in the field of non-CO_2 GHGs.*
- *Increase the use of fiscal instruments to internalise the environmental externalities of energy use. In particular, examine fuel taxation in relation to environmental externalities.*
- *Strengthen the dialogue among the central government, Autonomous Communities and town councils to achieve more sustainable energy systems.*

Major changes have occurred in Spain's energy consumption since 1973, both in quantitative and qualitative terms. Spain's total primary energy supply has risen by 160% from 52.4 Mtoe in 1973 to 136.1 Mtoe in 2003. Its total final consumption now stands at 150% more than it did in 1973, a rise from 39.9 Mtoe to 100.2 Mtoe. This is a consequence of the significant economic and social development that has occurred since the mid-1970s, a development that has accelerated since Spain joined the EU in 1985. Economic growth has brought with it an increase in car ownership and households have increased and diversified the use of domestic appliances. Spain has also built up a significant industrial base over this period, for example, becoming the sixth-largest car manufacturing country in the world by volume.

Figure 10

Energy Intensity in Spain and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand USD at 2000 prices and purchasing power parities)



* excluding Finland, Germany, Greece, Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

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

Spain's GDP has increased by an average of 2.7% between 1990 and 2002, while total primary energy supply has increased from 91.1 Mtoe/year to 136.1 Mtoe/year, by 3.1% during the same period. Spanish energy intensity

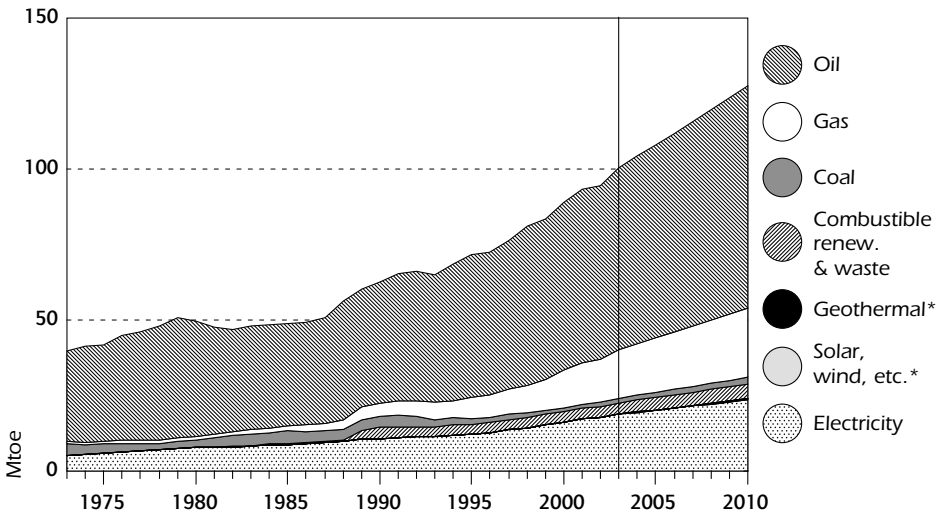
has, therefore, increased since 1990 from 0.14 to 0.15 units of TPES per unit of GDP in 2000 USD/PPP (see Figure 10) in 2003. It is expected to increase further to 0.23 by 2010, against the trend in other IEA member countries. Increasing GDP growth in Spain has not been accompanied by a reduction in energy intensity, as has been the case in other countries.

Final energy consumption in Spain in 2003 reached 100.2 Mtoe, an increase of 5.9% over the 2002 figure of 94.6 Mtoe. This high rate of year-on-year increase was driven by increased economic activity and more extreme weather conditions both during the summer months and in the last few months of the year. Spain still has a slightly lower energy consumption of 2.46 toe/capita than the EU15 average of 2.77 toe/capita, but over the last few years economic growth has led to a rise in living standards resulting in a narrowing of the gap. Increasing demands for comfort and mobility by the Spanish citizens are leading to increases in energy consumption.

Energy consumption increased most strongly in the other[2] sectors between 1990 and 2003, from 14.4 Mtoe to 24.2 Mtoe. In the transport sector, consumption rose from 22.8 Mtoe to 37.6 Mtoe, and in industry from 25.3 Mtoe to 38.4 Mtoe. Consumption is predicted to continue to grow in all sectors, reaching 127.7 Mtoe in the business-as-usual (BAU) scenario by 2010.

Figure 11

Total Final Consumption by Source, 1973 to 2010



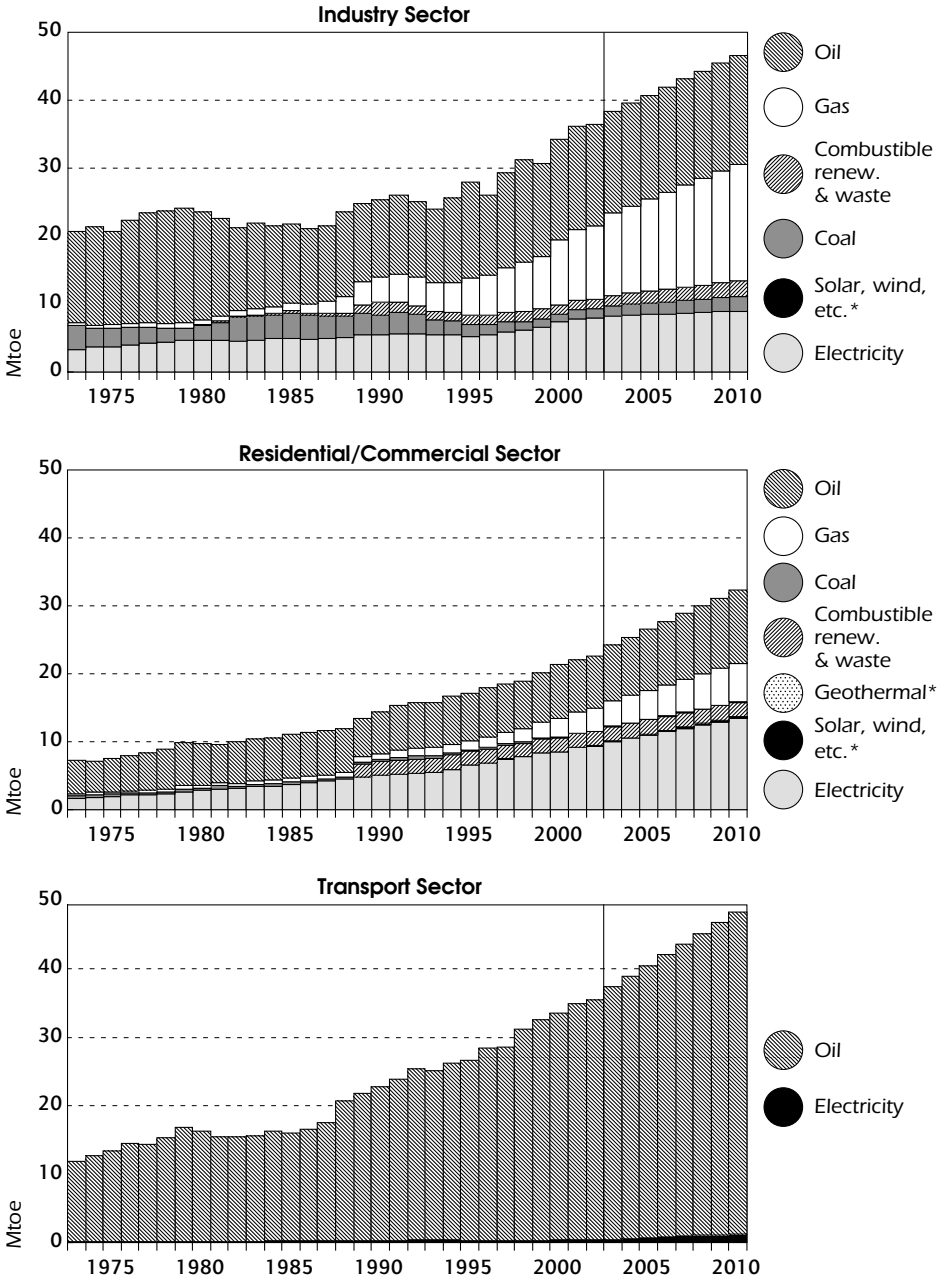
* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

2. The "other" sectors include residential, commercial non-industrial, public services, and agriculture.

Figure 12

Total Final Consumption by Sector and by Source, 1973 to 2010



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

Transport fuel use is the main cause for the rapid growth in oil use and one of the most important drivers for increased CO_2 emissions in the Spanish economy: 55% of Spain's total oil supply is consumed in the transport sector of which 78% for the road sector, 15% for air transport, 4% for maritime transport and 3% for rail transport. Within road transport, 46% of fuel is used by passenger cars, 34% by trucks, 17% by vans and 3% by buses. Table 7 below shows the development of passenger kilometres by mode. The development is similar in the freight sector, as shown in Table 8. In both cases, road transport increased significantly and increased its share at the same time. This development is more pronounced in the freight sector. Reversing modal shifts away from the road may be especially difficult in the freight sector.

With increasing prosperity and changing lifestyles, car ownership has increased significantly, while the size of cars has also increased. The private vehicle park has increased from 13.44 m private vehicles to 18.73 m between 1993 and 2002. The number of Spanish private vehicles (*turismo*) has increased from 344 vehicles/1 000 inhabitants in 1990 to 461 vehicles/1 000 inhabitants in 2002, an increase of 34%. Between 1992 and 2002 the registration of new cars with engines over 1 999 ccm in size rose by 102%, from 69 547 to 141 508. The registration of small cars with an engine size of less then 1 199 ccm dropped from 167 823 to 93 494, a decrease of 44% in the same period. In total, 832 768 newly registered cars in 2002 (62%) had an engine size above 1 600 ccm. While the average fuel use for gasoline vehicles has remained about the same since 1995, the available data indicate that the fuel use of diesel vehicles has increased slightly between 1995 and 2000, coinciding with a move towards larger diesel engines and use of diesel in luxury cars. These factors are all contributing to the rapid growth of energy demand in road transport, despite the overall move towards more efficient diesel engines instead of gasoline engines.

Table 7

Passenger Kilometres in Spain, 1990 and 2002

(in million km)

Mode	*1990*	*2002*	*Difference 1990 – 2002*	*Share 1990*	*Share 2002*
Road	207.8	387.6	179.8	89.3%	90.7%
Rail	16.7	21.2	4.5	7.2%	5.0%
Air	7.1	17.4	10.3	3.1%	4.1%
Maritime	1.1	1.3	0.2	0.5%	0.3%
Total	**232.7**	**427.5**	**194.8**	**100.0%**	**100.0%**

Source: Ministry of Public Works (Ministerio de Fomento).

Table 8

Freight Tonnage Kilometres in Spain, 1990 and 2002

(in Mt-km)

Mode	*1990*	*2002*	*Difference 1990 – 2002*	*Share 1990*	*Share 2002*
Road	151	342.2	191.2	74.8%	85.0%
Rail	33	37.9	4.9	16.3%	9.4%
Air	11.6	12.2	0.6	5.7%	3.0%
Maritime	6.4	10.4	4	3.2%	2.6%
Total	**202**	**402.7**	**200.7**	**100.0%**	**100.0%**

Source: Ministry of Public Works (Ministerio de Fomento).

Electricity use is increasing rapidly in Spain, mainly driven by consumption in the non-industrial sectors, which almost doubled from 5.1 Mtoe in 1990 to 10 Mtoe in 2000, and is predicted to rise to 13.4 Mtoe by 2010. The main reason for this increase in electricity consumption is almost certainly a strong rise in air-conditioning demand. While no detailed study has been undertaken to confirm this, the summer peak in electricity use in recent years is normally associated with air-conditioning demand. This peak increased considerably in 2004 and reached 36.6 GW, 97% of the winter peak in 2004. Industrial electricity use by comparison rose much more slowly, from 5.4 Mtoe to 8.3 Mtoe in the same period. Oil use increased by 20.3 Mtoe, 14.8 Mtoe of which are attributable to the transport sector alone. Oil has lost importance in the "other" and industrial sectors, where gas has increased in importance. A significant share of the increase in final consumption is served by gas, which rose from 4.6 Mtoe in 1990 to 15.8 Mtoe by 2003. Gas alone, therefore, accounted for 11.2 Mtoe of the 37.7 Mtoe rise in consumption between 1990 and 2003.

ENERGY EFFICIENCY POLICY

The Spanish government views energy efficiency policy as important, recognising the increasing environmental pressure on the energy sector, the liberalisation of energy markets and threats to the security of energy supply coming from rapidly increasing demand. Energy efficiency has a significant potential in Spain, and can contribute to achieving all the aims of the government in energy policy-making.

A reduction in energy intensity in the Spanish economy will lead to the achievement of three essential goals of EU and Spanish energy policy:

- Guaranteeing the supply of energy in Spain despite a high degree of external energy dependence.

- Improving competitiveness through the more efficient use of energy resources. This will contribute to increasing productivity, further convergence with the economically more developed countries of the EU and more employment.

- Promoting environmental protection by reducing emissions from energy use.

THE ENERGY EFFICIENCY STRATEGY E4 2000 TO 2012

The Framework for the E4 Energy Efficiency Strategy

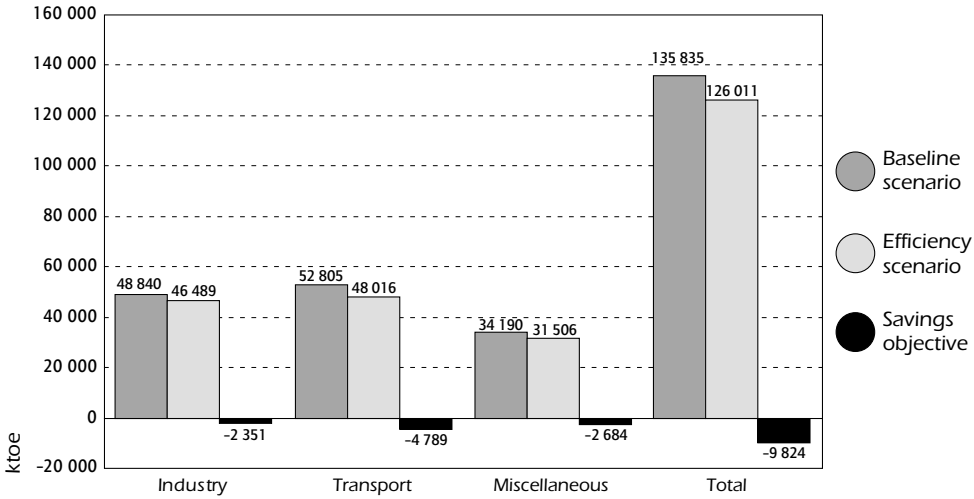
In November 2003, the Spanish Council of Ministers approved the *Energy Saving and Efficiency Strategy in Spain 2004-2012*, also called E4. Energy efficiency is an essential element of national and EU energy policy objectives, and the E4 Strategy provides it with a new framework in Spain. The strategy was developed through a co-operative process, by setting up interministerial working groups made up of the different ministerial departments with responsibilities for specific sectors of the economy. IDAE (see Chapter 3) was heavily involved in the development of the strategy. These working groups then consulted with different public bodies, Autonomous Communities, town councils via the Spanish Federation of Municipalities and Provinces, social groups and private associations, and were also supported by technical consultants. The groups made an assessment of the potential for improving energy efficiency in Spain and which measures would have to be taken in order to achieve this. Following that process the strategy was discussed with public and private groups in order to reach a consensus and ensure commitment to its success when it was put into practice.

The strategy is based on a comparison of two scenarios, one baseline and one efficiency scenario. In the baseline scenario, business-as-usual is assumed, while the efficiency scenario is assuming a range of measures are undertaken in all sectors of the economy. The baseline scenario is based on the Spanish government's document *Planning of the Electricity and Gas Sectors*, which covers the forecast development of energy infrastructure during the period 2002 to 2011. Therefore, the improvements in efficiency in electricity production through the introduction of additional renewables and CCGTs are already taken into account in the baseline scenario.

Figure 13 shows the sectoral results for final consumption of energy envisaged for 2012 in the two scenarios, as well as the savings objectives. The savings objective for final energy consumption in 2012 stands at 9.8 Mtoe annual savings achieved by 2012, compared to the baseline scenario.

Figure 13

Total Final Consumption under BAU and E4 Scenarios, 2012



Note: includes consumption for non-energy use.
Source: Country submission.

OBJECTIVES OF THE E4 STRATEGY

Sectoral Efficiency Targets

Industry

Industry has the lowest savings objective because it was assumed that many efficiency measures had already been taken. The envisaged savings of the sector are at 2.3 Mtoe. The strategy covers industrial sectors that are also included under the EU-ETS, and there may be a reinforcing effect in generating energy savings. IDAE is offering energy audits and energy service contracts to industrial energy users in order to increase the energy efficiency of industrial processes. Information about the projects is made available on IDAE's website (www.idae.es).

Transport

The transport sector is the most important in the E4 Strategy, and is expected to contribute almost half the total savings, 4.8 Mtoe/year out of 9.8 Mtoe/year. The largest reduction is expected to come from modal shifts, with an annual reduction of 2 Mtoe by 2012 out of a total 4.8 Mtoe expected from the transport sector for the period 2004-2012. This is followed by improvements to vehicle efficiency, with savings of 1.45 Mtoe and more efficient use of transport modes with 1.34 Mtoe. But even with these reductions, energy consumption in the transport sector will rise to 48 Mtoe by 2012, 28% above the level of 37.6 Mtoe reached in 2003.

Concrete policies to achieve modal shifts include urban and company mobility plans, the improvement of the public transport system to increase its attractiveness compared to private transport, an increase in the share of rail transport following the extension of the high-speed rail network and an increase in sea shipping for freight transport.

Spain operates a vehicle renovation programme (PREVER) under which purchasers of a new car receive a grant if they destroy their old car at the time of purchase. The aim of the programme is to contribute to the renovation of the Spanish vehicle fleet. Despite the existence of PREVER, 52% of gasoline-fuelled cars are older than 10 years, while only 16% of diesel-fuelled cars are older than 10 years, reflecting the significant increase in the registration of diesel vehicles in recent years. Average fuel consumption of newly registered vehicles fell by 25% between 1980 and 2000. It is too early at this stage to analyse the effect of the EU vehicle label which was introduced following the voluntary agreement on EU levels of fuel consumption of new vehicles in Spain. The label has been introduced, but is currently not linked to either taxation, or, for example, the PREVER programme. There are no data available on compliance with the labelling legislation.

The Spanish government recognises that additional measures are required and realises that incremental technological solutions to individual vehicles are not sufficient in an environment with rapid demand growth in the sector. It is, therefore, particularly looking at modal shifts beyond those already planned for, and at improved road traffic management.

Other Sectors

The other sectors, including residential, are expected to contribute 2.7 Mtoe/year to the savings objective. Savings here are expected to come from a much more stringent approach to building regulations, which are currently being revised, and from increased efficiency of home and office appliances. Owing to the diffuse make-up of the other sectors, a focus on information and awareness-raising campaigns is planned as part of the strategy. Spain is currently in the process of revising its building regulations which date from 1980, and will likely include requirements for renewables in new buildings and at the time of major refurbishment. The revision is in line with the EU directive on the energy performance of buildings. Some municipalities in Spain already require the installation of solar water heating in new constructions, and this has been judged as a successful approach to increasing the renewables share in building energy supply. A drawback in encouraging efficient energy use is the low share of A-rated appliance sales in Spain. In 2003, Spain had the lowest share of A-rated appliances of any kind being sold among the major EU countries[3]. Further

3. For example, in 1st quarter 2003 A-rated cold appliances had a share of 20.4% in Spain, while the next lowest share in a major EU country was 40.7%, and the highest 59.1%. The same set of figures for freezers is 16.3%, 22.8% and 60.4%.

liberalisation of the Spanish energy markets could become a driver for improved metering facilities that could support energy management and easy switching of suppliers if these were required by the regulator.

Expected Results from the Demand Sectors

Table 9 below illustrates the development of final consumption by sector over the period 2000 to 2012. Most of the expected savings compared to the business-as-usual scenario will be generated in the second half of the period, which means that the effects of delays in the implementation may be recovered by vigorous action now, taking into account lags between policy measures and their effects. In 2012, final energy consumption in Spain will stand at 126 Mtoe if the targets are achieved, equalling an average growth rate of 2.8% per annum from 2000 onwards. This can be broken into a high growth period of an average 3.4%/year between 2000 and 2006, and a lower growth period of 2.3%/year between 2006 and 2012. In this scenario, the biggest increase by sectors, as well as the highest savings, are coming from transport, with an average annual growth rate of 3.4% between 2000 and 2012. Nevertheless, that growth is again expected to slow down significantly in the second half of the period, presumably because by then the infrastructure measures, such as the construction of new rail lines, will start to have an effect.

Table 9

TFC by Sector under the E4 Strategy, 2000 to 2012

(in kilotonnes)

							Annual growth rate (%)		
Sector	*2000*	*Share*	*2006*	*Share*	*2012*	*Share*	*2006/ 2000*	*2012/ 2006*	*2012/ 2000*
Industry	34 340	38.04%	40 432	36.70%	46 489	36.89%	2.8	2.4	2.6
Transport	32 272	35.75%	41 313	37.50%	48 016	38.10%	4.2	2.5	3.4
Other sectors	23 654	26.20%	28 413	25.79%	31 506	25.00%	3.1	1.7	2.4
TFC	90 266	100%	110 158	100%	126 011	100%	3.4	2.3	2.8

Source: Country submission.

Supply Side Measures

The E4 Strategy is also considering supply-side measures within the energy system, for example in electricity generation or CHP and refining, and accounts for indirect savings from reduced losses in energy transformation. The savings objective foreseen for 2012 from the measures in the transforming sectors stands at 1.5 Mtoe, 577 ktoe or 39% of which will come from the refining sector (see textbox below). In addition to the efficiency improvements in the supply sector, the expected lower demand for electricity and other energy products will feed through in reduced transformation losses, totalling 4.3 Mtoe. The total annual saving in primary energy at the end of the E4 Strategy is therefore

reaching 15.6 Mtoe, 9.8 Mtoe or 63% of which are saved in energy demand and 5.6 Mtoe or 37% of which are saved directly and indirectly on the supply side. TPES in 2012 is expected to stand at *circa* 165 Mtoe if these targets are achieved, growing at an average rate of 2.3% a year between 2000 and 2012, with a period of lower growth of 2% after 2006.

E4 Induced Energy Efficiency Improvements in the Spanish Oil Refining Sector

Spanish oil refineries have identified a range of measures to improve energy efficiency as a result of participating in the development of the E4 Strategy. These should lead to estimated savings of 577 ktoe/year after implementation, 25% of the total savings target for industry. From estimations by the Association of Oil Producers in Spain, these measures are estimated to have a total cost of EUR 149m, which indicates that they will generate a positive payback comparable to commercial projects for the refineries undertaking them.

The Spanish refining industry has already invested in efficiency improvements in the past, yet has still been able to identify a range of financially viable projects for further improvements.

Table 10

Projected Energy Saving by Sector from the E4 Strategy by 2012

Sector	*Total saving objective 2012*	
	ktoe	*%*
TFC		
Industry	2 351	15%
Transport	4 789	31%
Buildings	1 773	11%
Residential & office equipment	409	3%
Public services	154	1%
Agriculture and fishing	348	2%
TFC	**9 824**	**63%**
Energy transformation		
Direct savings as a result of sectoral actions	1 494	10%
Savings in TPES from savings in TFC	4 257	27%
Total energy transformation	**5 751**	**37%**
TPES saving	**15 575**	**100%**

Source: Country submission.

Table 11

Projected Energy Supply by Fuel under E4, 2000 to 2012

Fuel	*2000*	*Share*	*2006*	*Share*	*2012*	*Share*	*Annual growth rate (%)* *2006/ 2000*	*2012/ 2006*	*2012/ 2000*
Coal	21 635	17.3%	17 653	12.1%	11 691	7.1%	-3.3	-6.6	-5
Oil	64 663	51.7%	73 365	50.1%	75 958	46.0%	2.1	0.6	1.4
Natural gas	15 223	12.2%	26 261	17.9%	39 027	23.6%	9.5	6.8	8.2
Nuclear	16 211	13.0%	16,570	11.3%	16 602	10.1%	0.4	0	0.2
Renewable energy	7 061	5.6%	12 190	8.3%	21 436	13.0%	9.5	9.9	9.7
Electricial balance (imp - exp)	382	0.3%	385	0.3%	385	0.2%	0.1	0	0.1
TPES	**125 175**	**100%**	**146 424**	**100%**	**165 099**	**100%**	**2.6**	**2**	**2.3**

Source: Country submission.

Table 12

Projected CO_2 Emissions Avoided by the E4 in 2012

	Million tonnes CO_2 per year
Final consumption:	
Industry	5
Transport	16
Other sectors	4
Total final consumption	**25**
Energy transformation:	
Total energy transformation	**17**
Total CO_2 avoided in energy terms	42

Source: Country submission.

Reduction in Energy Intensity

The strategy aims at a reduction in energy intensity of 7.2% from 2003 to 2012, equivalent to an annual reduction of 0.83%. It covers a range of measures involving rules, regulations, research and technological development and promotion, information and communication which should make it possible to achieve annual savings of 15.6 Mtoe from 2012 when all the measures have been implemented. This level of energy saving would equate to an emissions reduction of 42 Mt CO_2/year from 2012 onwards, assuming all the measures contained in the strategy have been put into practice and all the targets reached.

The strategy envisages a total investment of EUR 24.1 billion (bn), of which EUR 2 bn will come from public support over the period 2004-2012. The measures to implement the strategy are not yet elaborated in detail but will need to be in the future, as part of an implementation strategy through the Action Plan.

COMBINED HEAT AND POWER (CHP)

Spain has a significant number of CHP plants in operation, and is supporting CHP through preferential treatment of CHP-generated electricity by including it under the Special Regime of the electricity market (see Chapters 9 and 10). Support is, however, not tied to minimum efficiency requirements, meaning that old CHP plants that are less efficient than a modern boiler and grid-average efficiency electricity generation will still receive a subsidy.

At the beginning of 2002, 800 CHP plants were in operation and located principally in industrial centres (50% of these related to building materials, and agricultural and food sectors). The installed capacity reached 5.6 GW in 2001, almost half the capacity installed in the entire special regime and around 10% of the total capacity in the national electricity system (see Figure 14). The estimated electricity production of CHP plants is around 30.2 TWh/year, of which 16.6 TWh were supplied to the national grid in 2001. The primary use of CHP in Spain is in industrial installations and refineries. The residential sector in Spain does not provide the heat load to operate CHP in a district heating scheme profitably, owing to the climate in Spain. IDAE is studying the potential for district cooling, however, and should technological development make this feasible, applications may be developed in the Spanish cooling market.

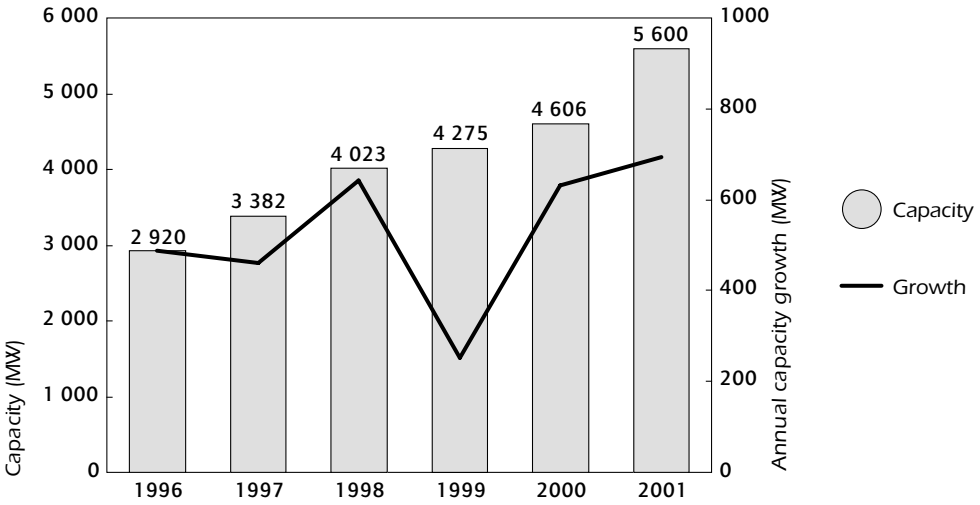
In terms of the technologies used, reciprocating engines are used in 75% of the plants, whilst the remainder use turbines. The primary fuel used is natural gas which is used in 72% of the plants, while the remainder use mostly fuel oil. Energy consumption of CHP plants in 2000 reached 8.2 Mtoe, of which 55.3% was delivered in the form of natural gas and 20.1% in the form of fuel oil.

CHP installations are predominantly found in building materials and agricultural and food sectors, followed by textiles, chemicals, and the pulp and paper sectors. The most important sectors by installed capacity are: agricultural food, chemicals, pulp and paper, oil refining, building materials and textiles (see Figure 15).

Over the last few years, CHP plants have had to change their operating conditions, introducing running criteria that are driven by the market rather than by the desire to achieve the highest overall efficiency. This means that generation is switched off during off-peak hours and loads are reduced in medium-load periods. This form of operation has an impact on the CHP plant's overall efficiency, especially if gas turbines are used, as these are very sensitive to partial loads.

Figure 14

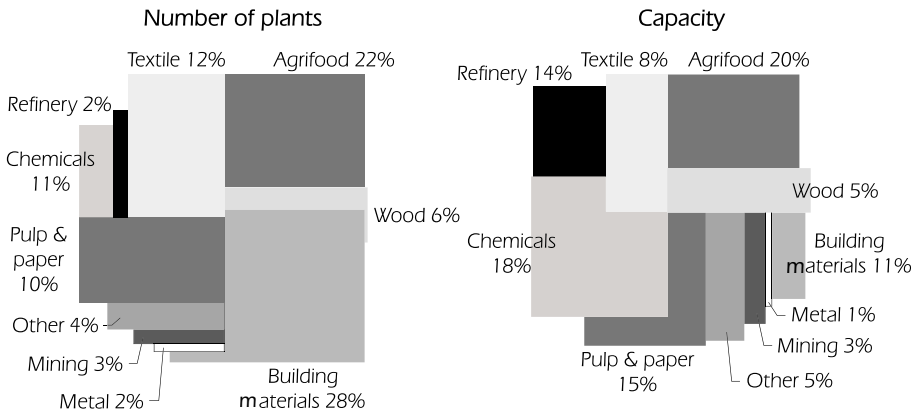
CHP in Spain - Development of Annual Growth and Accumulated Capacity, 1996 to 2001



Source: IDAE.

Figure 15

Distribution of CHP Plants and CHP Capacity Installed by Industrial Sector in Spain, 2002



Source: IDAE.

The E4 Energy Efficiency Strategy has studied the potential for improvement in CHP technologies based on increased efficiency in existing plants through renovation of plant, motors, turbines and recovery plants. Energy audits will

be held in order to achieve this, with a plan for the modernisation of these facilities, especially in the industrial sector which has the oldest facilities. The saving envisaged by the strategy in CHP is 150 ktoe a year in 2012, with investment throughout the period 2004-2012 of EUR 213m and public support of EUR 28m.

CRITIQUE

Energy intensity has grown quickly in Spain in recent years and has already surpassed the OECD average. It is forecast to grow further, while in most other IEA member countries there is a trend towards decreasing energy intensity. In the energy efficiency scenario underpinning the E4 Energy Efficiency Strategy there is an energy intensity improvement of 0.8%/year from 2003 to 2012. Even with this improvement in energy intensity, final energy consumption in 2012 will still grow by 40% over the 2000 level with an increase of TPES of 32% over the same period. However, the implementation of the E4 Strategy has already encountered delays owing to questions relating to financing and co-ordination, even though the strategy was supposed to take effect in 2004. Furthermore, the policies and measures to realise such energy intensity improvements have still to be designed, agreed upon, implemented and monitored. A concrete package of policies and measures to implement the E4 Strategy under appropriate funding and strong interministerial co-ordination should be developed without delay.

Given the challenge implicit in meeting the Spanish GHG emission target agreed upon in the Kyoto Protocol and the EU burden-sharing agreement, the government should consider a review of the E4 Energy Efficiency Strategy within a short time after its implementation, particularly to check whether it is adequate in terms of its environmental and overall economic efficiency objectives and how the delay in its implementation may affect the achievement of the goals. The rapidly growing Spanish economy should offer a considerable potential for achieving energy intensity improvements by ensuring that new investment in all sectors is focused towards energy-efficient solutions. The E4 Strategy may be underestimating the possibilities for energy efficiency improvements by not reflecting this potential in its current form.

IDAE is expected to play an important role in the implementation of the E4 Strategy. However, IDAE's budget is heavily supply-side focused on support for renewables and co-generation. Seeing that these technologies are already receiving significant support from the Special Regime of the electricity market, and the challenges faced in energy efficiency in Spain, the government should consider whether IDAE's focus is appropriate.

The industry sector has the lowest saving objective under the E4 Strategy on the ground that many efficiency measures have already been taken. However,

this assumption may be too conservative. Large industrial users in Spain benefit from low prices for electricity and gas if they are on interruptible contracts, so they may not have had a strong incentive to become more efficient in the past. Industrial consumers can benefit from the provision of energy audits that are quickly followed up by actual efficiency improvement. IDAE 's activity in this context should be evaluated with a view to a possible strengthening and further development. Stronger energy audits could lead to the creation of a strong energy service sector which could increase the contribution to E4 savings from the industry sector. EU-ETS that commenced in January 2005 will be a strong driving force of energy efficiency in large emitters in the industrial sector. In addressing energy efficiency improvement in the industrial sector, synergies with EU-ETS should be ensured.

Energy consumption is rapidly increasing in the household and tertiary sectors. Achieving the saving objective of 2.7 Mtoe/year under the E4 Strategy will be challenging because of the diffuse nature of this sector compared with industry. The transposition of the Directive on the Energy Performance of Buildings offers the Spanish government the opportunity to take significant steps towards increased energy efficiency. Once the directive has been transposed, vigorous enforcement of the new building codes will be essential for them to achieve their desired effect. Training of building inspectors will be required to help with putting the requirements of the directive into practice. Rising demand for air-conditioning can be addressed through building design that exploits passive cooling techniques in new buildings, while the introduction of high efficiency standards for cooling equipment can alleviate cooling energy demand in retrofit situations.

For existing buildings, building certification followed by action to improve the energy performance of the building will help to realise at least parts of the efficiency potential present in the current housing stock. Effective implementation of the requirements for inspections of boilers and air-conditioning devices would also help to increase energy efficiency in the building sector.

Many Spanish residences lack adequate metering facilities, depriving their occupants of the information needed to take decisions about energy use. The extension of individual metering and billing of energy consumption in dwellings can support behavioural change for better efficiency. Liberalisation of the energy markets can be a driver for advanced metering if this is required by the regulator. In order to achieve the desired results in both the newly built and refurbishment sectors, detailed statistical information about building energy loads acquired through monitoring programmes will be required.

Changes with a view to an improved uptake of energy efficiency can also be realised through enforcement of labelling requirements as well as measures aimed to ensure that the labels are understood by sellers and buyers of

appliances. Spain is lagging behind in the market share of A-rated appliances, and awareness-raising campaigns could support such energy efficiency measures and help to realise the government´s energy efficiency objectives. Other IEA members have significant experience with promotional campaigns, and Spain could study the experience from these.

Unlike industry, where single investments in processes can generate significant savings, targeting the road transport sector is much more difficult, and the achievement of the ambitious savings target in this sector is, therefore, dependent on continued efforts by the government and the local authorities. Rising transport energy demand stems from the strong link between growth of economic activity and demand for passenger and freight transport in Spain. Moreover, there is a strong concentration of transport activity in the less efficient modes such as road and aviation, where the demand has shifted towards these in the past. Finally, the limited improvements in fuel efficiency in private cars contribute to rising energy demand in transport.

To decouple transport demand growth from economic growth, strong measures, both regulatory and fiscal, need to be developed in fields such as traffic management, logistics, teleworking and infrastructure charging. This should be supplemented by a policy approach that encourages modal shifts towards more energy-efficient modes of transport, *e.g.* railways. Noting that the fuel efficiency of newly registered vehicles has improved in the past 20 years, successful and rapid phasing-out of older vehicles could bring a significant reduction in transport energy demand, or at least slow further growth. Despite the existence of the vehicle renovation programme PREVER, more than half of gasoline-fuelled cars are older than 10 years. This indicates that PREVER may not be successful in actually retiring older vehicles. One of the reasons could be that the current vehicle registration tax is only linked with engine size not with fuel efficiency. The PREVER system should be reviewed through, for example, linking the registration tax reduction to the EU fuel efficiency level so that it encourages more rapid retirement of old vehicles, while encouraging the purchase of fuel-efficient replacement cars through differentiated registration tax reductions.

Given current levels of awareness for energy efficiency and the rather high transaction costs involved in finding energy-efficient solutions, final energy providers are well placed to offer energy services and energy audits to their customers. Pursuing energy-efficient solutions for providing energy services (*e.g.* lighting, indoor thermal comfort) at the customer's site would harness the professional expertise and financial capabilities of the energy company which can then be remunerated via the fuel savings through better energy efficiency. Such an approach would benefit from supportive policies by the government.

Significant industrial CHP capacity is installed in Spain. Efficient co-generation has the potential to save energy and reduce emissions, as well as to contribute

to the security of supply of the operator of the CHP. All this is dependent on the useful demand for heat, technology features, operation and the choice of fuel. The Spanish government is not setting minimum efficiency requirements for CHP to benefit from favourable treatment in the energy market. It could be more cost-effective to target the support of high efficiency CHP as a means of achieving energy efficiency and environmental objectives.

RECOMMENDATIONS

The government of Spain should:

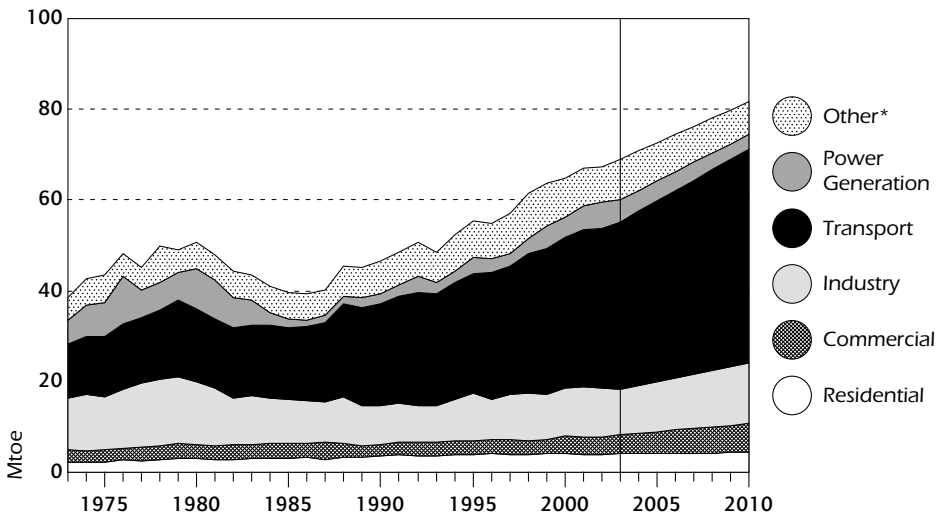
- *Develop concrete and effective policies and measures to implement the E4 Strategy and review it in the following years in order to more fully exploit the energy efficiency potential.*
- *Consider a shift of IDAE's budget to more investment in energy efficiency, and in particular strengthen IDAE's industrial energy efficiency activities.*
- *Implement and enforce significantly strengthened building codes. Regularly review and further strengthen these codes and support follow-up action in building certification. Train sufficient numbers of building inspectors to ensure successful implementation of the directive.*
- *Extend individual metering and billing of energy consumption in dwellings to existing buildings.*
- *Ensure that statistical information required for the planning and evaluation of energy efficiency policies is collected.*
- *Investigate the potential of smart metering for the reduction of energy use.*
- *Raise awareness of the benefits of energy efficiency through information campaigns and improved enforcement of energy labelling.*
- *Adopt measures to decouple transport demand growth from economic growth and encourage modal shifts towards more energy-efficient transport modes,* e.g. *the railways. The role of pricing should be investigated in this area.*
- *Use the PREVER system to improve car fuel efficiency by linking the registration tax reduction to an EU fuel efficiency label. Evaluate the experience of other EU countries in this respect.*
- *Encourage energy retailers and distributors to offer energy services and audits to their customers.*
- *Restrict support for CHP to plants that achieve energy efficiency gains.*

OBSERVATIONS

In 2003, oil accounted for 50.7% of TPES and 60.2% of TFC in Spain. The share of oil in TPES is stable compared to 1990, while in TFC this share represents a reduction of 6% compared to the 1990 level of 63.9%. In absolute terms, however, oil consumption has increased considerably over the same period by 51%, from 39.9 Mtoe in 1990 to 60.2 Mtoe in 2003, excluding bunker fuels and own use at refineries and terminals. This also represents a 4% increase over 2002's TFC of 57.7 Mtoe. The rate of consumption growth has increased in recent years, primarily driven by a strong demand from the transport sector. In the residential and tertiary sector, demand fell as a result of climatic variations and the ongoing replacement of oil by natural gas as a heating fuel.

Figure 16

Supply of Oil by Sector, 1973 to 2010



* includes other transformation and energy consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

DOMESTIC CRUDE OIL PRODUCTION

Spain is importing almost 100% of its oil requirements, apart from a very small domestic production. In 2003, the internal production of crude oil stood

at 0.32 Mtoe (or 2.4 million barrels), about 0.5% of Spanish consumption, reaching similar levels as in previous years. The producing oil fields are Lora, Casablanca, Rodaballo, Chipirón and Boquerón, the first of which is located in the region of Burgos and the other four in the Mediterranean opposite the coast of the Province of Tarragona. It is estimated that there are 21 Mt (154 mbbl) of total reserves of crude and condensed products. RepsolYPF has received additional exploration licences from the Spanish government, but no large-scale discoveries are expected at this time. The most promising area for exploration in the sea off the Canary Islands is difficult to access owing to environmental concerns by the Autonomous Region.

EXTERNAL TRADE

In 2003 Spanish net imports of oil products reached 68.7 Mtoe, which represents a slight increase of 1% compared to net imports in 2002, but is significantly above the 1990 level of 45.9 Mtoe, an increase of 50%. By geographical areas, the origin of crude imports in October 2004 was as follows: Africa, including North Africa 27%, with Nigeria and Libya the main suppliers; the Middle East 26%, with Saudi Arabia, Iraq and Iran as the main suppliers; Latin America 13 %, with Mexico as the main supplier and Europe 20%, the main supplier being Russia; 14% of imports originated from other countries. Overall, Spanish imports are well diversified.

Because of the high demand for the middle range distillates, diesel and kerosene, Spanish refineries have to amend their production schedule to focus more on this range of output. As a consequence, surplus production gasoline is exported to the United States, and middle distillates are imported from there. It is estimated that in 2004, over one million tonnes of gasoline were produced above domestic consumption, while for diesel, kerosene and fuel oil the domestic production deficit reached a combined 14.5 million tonnes. The import of diesel has risen by 421% from 2 384 thousand tonnes (kt) in 1994 to an estimated 12 350 kt in 2004.

DEMAND DEVELOPMENT

Spanish oil demand is increasing in total, but there is significant variation between individual product ranges. In terms of particular products, Spain continues to observe a strong growth in the demand for diesel fuel for cars. This is due to the increased activity in the cargo transport sector and the unabated growth in the number of diesel-fuelled cars. There was also a strong increase in kerosene consumption, with air traffic increasing again after the slow-down recorded over the last two years following the terrorist attacks of 11 September 2001 in the USA.

Table 13

Spanish Oil Product Demand, 2001 to 2003

(in kt)

Product	*2001*	*2002*	*2003*	*Product share 2003*	*Change 2003-2001*
Gasoline	8 406	8 147	8 052	11.2%	–4.2%
Gas oil	27 901	28 767	31 019	43.3%	11.2%
Kerosene	4 424	4 172	4 389	6.1%	–0.8%
Fuel oil	12 643	13 846	13 129	18.3%	3.8%
Others[1]	12 638	13 200	12 815	17.9%	1.4%
LPG	2 330	2 350		3.2%	–1.6%
Total	**68 342**	**70 482**	**71 696**	**100.0%**	**4.9%**

1. Includes base oils, bitumen, petroleum coke, etc.

Source: AOP.

Demand for gasoline continued to fall owing to diesel engines being preferred in new cars as a result of taxation differential between diesel and gasoline. This led to a year-on-year fall of 2.1% in gasoline demand in 2003. The available data on the registration of new cars in Spain indicate that in 2003 there was continuing growth of 7.7% in diesel registrations, while registrations of new petrol vehicles fell again.

In the energy transformation sector, there was a significant year-on-year fall in the demand for fuel oils for electricity generation on the Spanish mainland. This was due to the better availability of hydro generating stations in 2003 compared to 2002. Demand growth for fuel oil held steady in the island regions off the Spanish mainland. Overall, oil is not a key fuel in Spanish electricity generation, providing only around 10% of total electricity generation, and most of that on the islands. Recent proposals to introduce gas-fired generators on the islands will lead to a further reduction of oil use in power generation.

The total estimated consumption of fuel oils, excluding bunker fuels and own consumption of refineries, was 6.8 Mt, a fall of 8.4% compared to 2002 driven by the reduction of oil burn in electricity generation and in end-use. There was a 9.8% increase in the consumption of oil coke in end-uses and also in electricity generation. The consumption of naphtha as a raw material fell by 22.7%.

COMPETITION AND PRICES

Retailing

The Spanish market for oil product retailing can be divided into direct sales and sales through filling stations: 64% of oil products in the vehicle, heating and agricultural/fishing markets are sold through the filling stations, with the

remainder being direct bulk sales. There are indications that the direct sales markets are very competitive, with a high number of companies competing and margins for these companies being very tight compared to other large European countries. Average margins for sales of motor gasoline (diesel) in 2001-2003 were EUR 0.051/litre (EUR 0.05) in Spain, compared to EUR 0.041/l (EUR 0.057) in the United Kingdom, EUR 0.062/l (EUR 0.063) in Germany and EUR 0.086/l (EUR 0.086) in Italy.

The situation is different in the filling station market, where margins for the dealers are high, compared to other European countries, with Spain reaching EUR 0.051/l in 2001, compared to EUR 0.021/l in Germany and EUR 0.04/l in Italy. One reason for this could be that Spain has a relatively low density of filling stations compared to some other countries in Europe, with Spain having 8 700 filling stations compared to *ca.* 12 000 in the UK, and *ca.* 26 000 in Italy, where population numbers are similar. Local planning restrictions are among the reasons blamed for this. The number of filling stations has increased considerably during the 1990s, but there has been very little increase in the total number of stations since. Spanish filling stations serve *ca.* 4 700 people and *ca.* 2 600 vehicles per station. This compares to *ca.* 5 100 and 3 000 in Germany, or *ca.* 2 600 and 1 600 in Italy. Spanish filling stations also have no cross-border competition from filling stations in other countries, and it is possible that existing filling stations have not been modernised as much as those in other countries with a low number of stations.

The majority of filling stations are owned by RepsolYPF (3 616 stations, 41.6%) and Cepsa (1 550 stations, 17.8%). There are 1 000 so-called "White Pumps" filling stations operated by agricultural co-operatives under special rules and regulations. While the number of stations run by hypermarkets has increased since 2001, it is still very low, with 194 stations. This may understate the actual share of oil product sales that hypermarkets have been able to capture, but it is another indication of a lack of competition in oil product retailing.

Vehicle fuel in Spain is taxed highly compared to non-EU IEA members, but lower than is the case in most other EU countries. In addition to federal taxes and VAT, there are taxes imposed by some Autonomous Regions in order to levy funds for health care and environmental activities (see Table 14).

Table 14

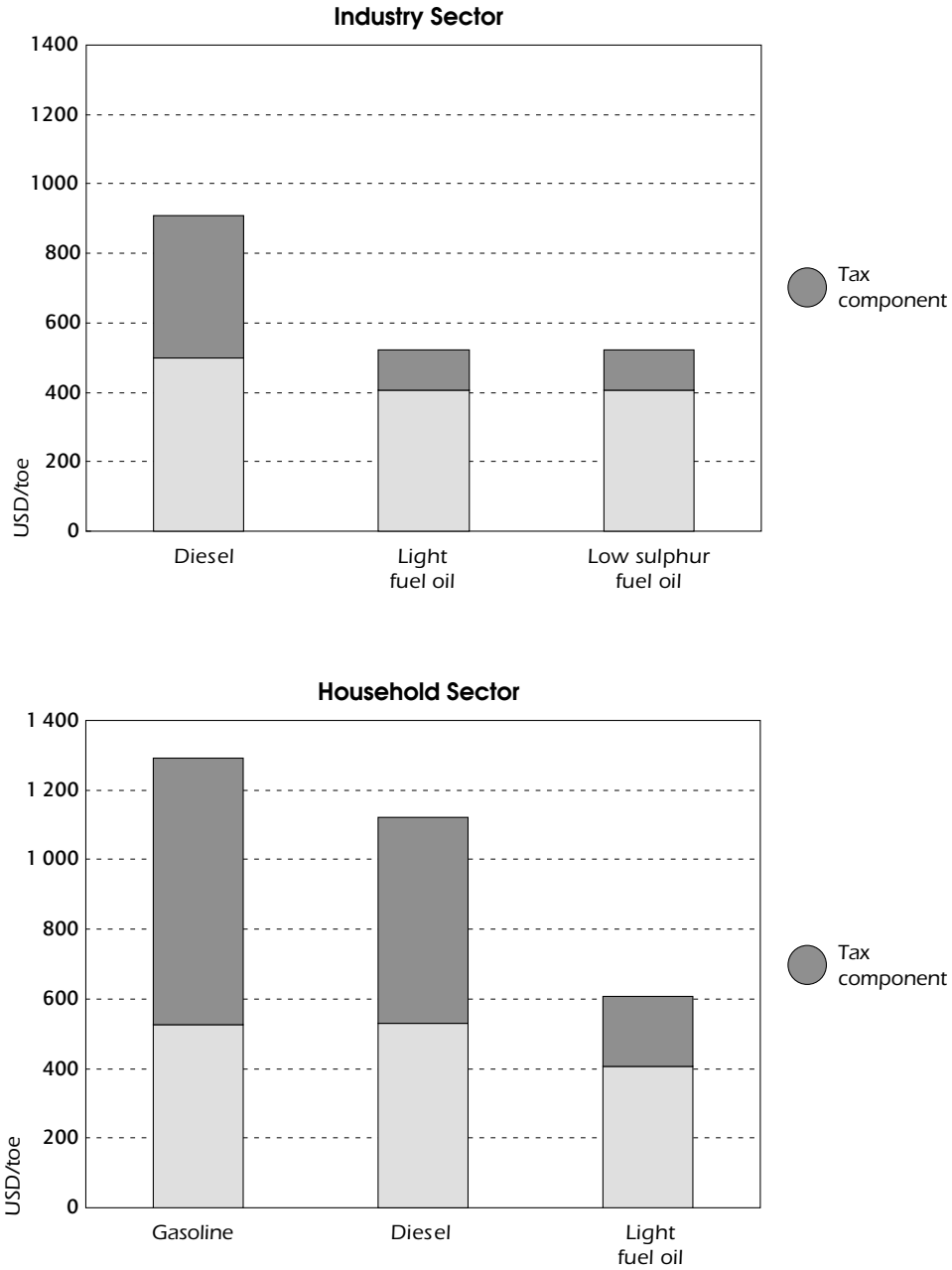
Regional Taxes on Motor Fuels

Region	*Gasoline tax EUR/litre*	*Diesel tax EUR/litre*
Asturia	0.048	0.041
Catalonia	0.048	0.048
Galicia	0.048	0.036
Madrid	0.041	0.041
All other regions	0.024	0.024

Source: AOP.

Figure 17

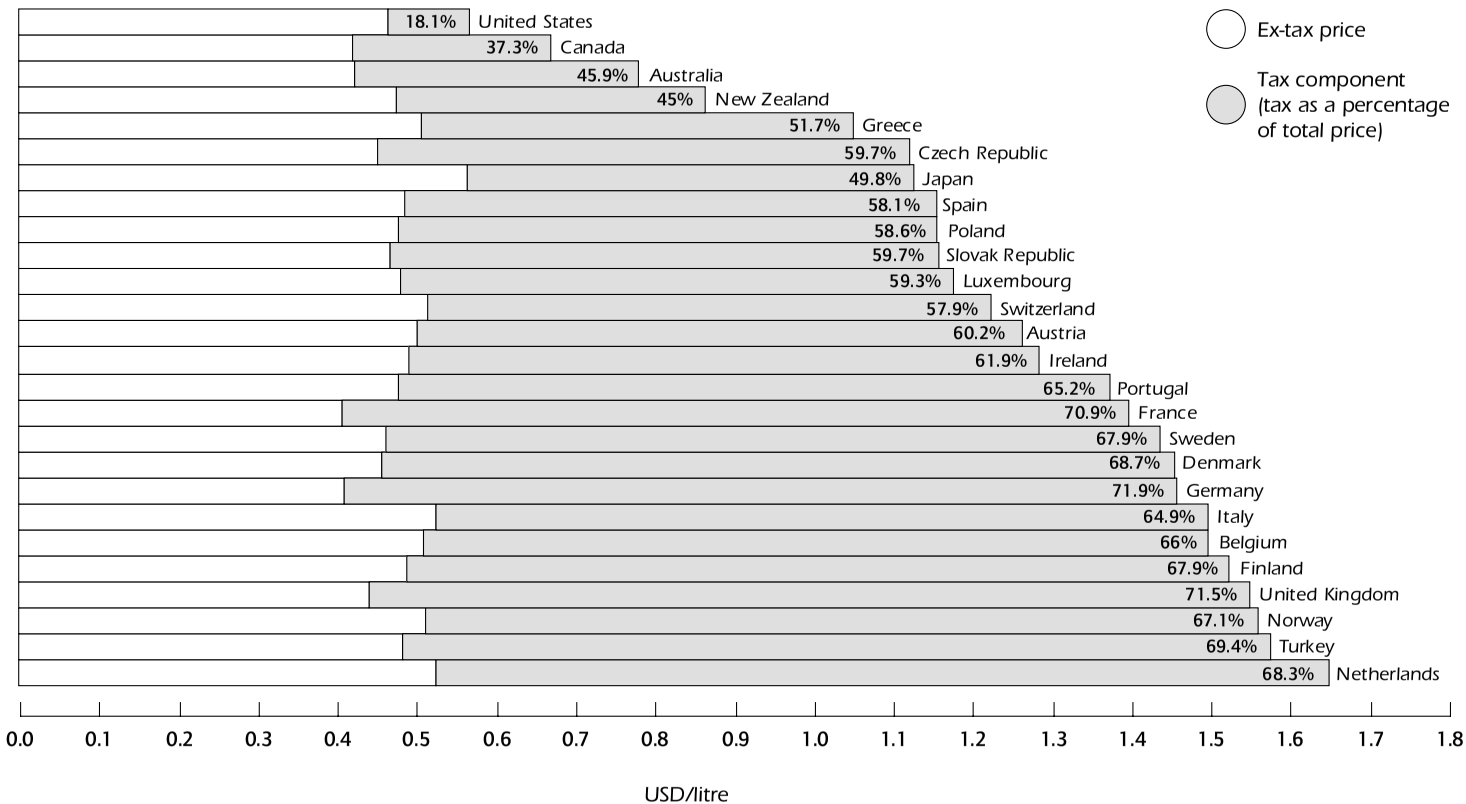
Fuel Prices, 2004



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

Figure 18

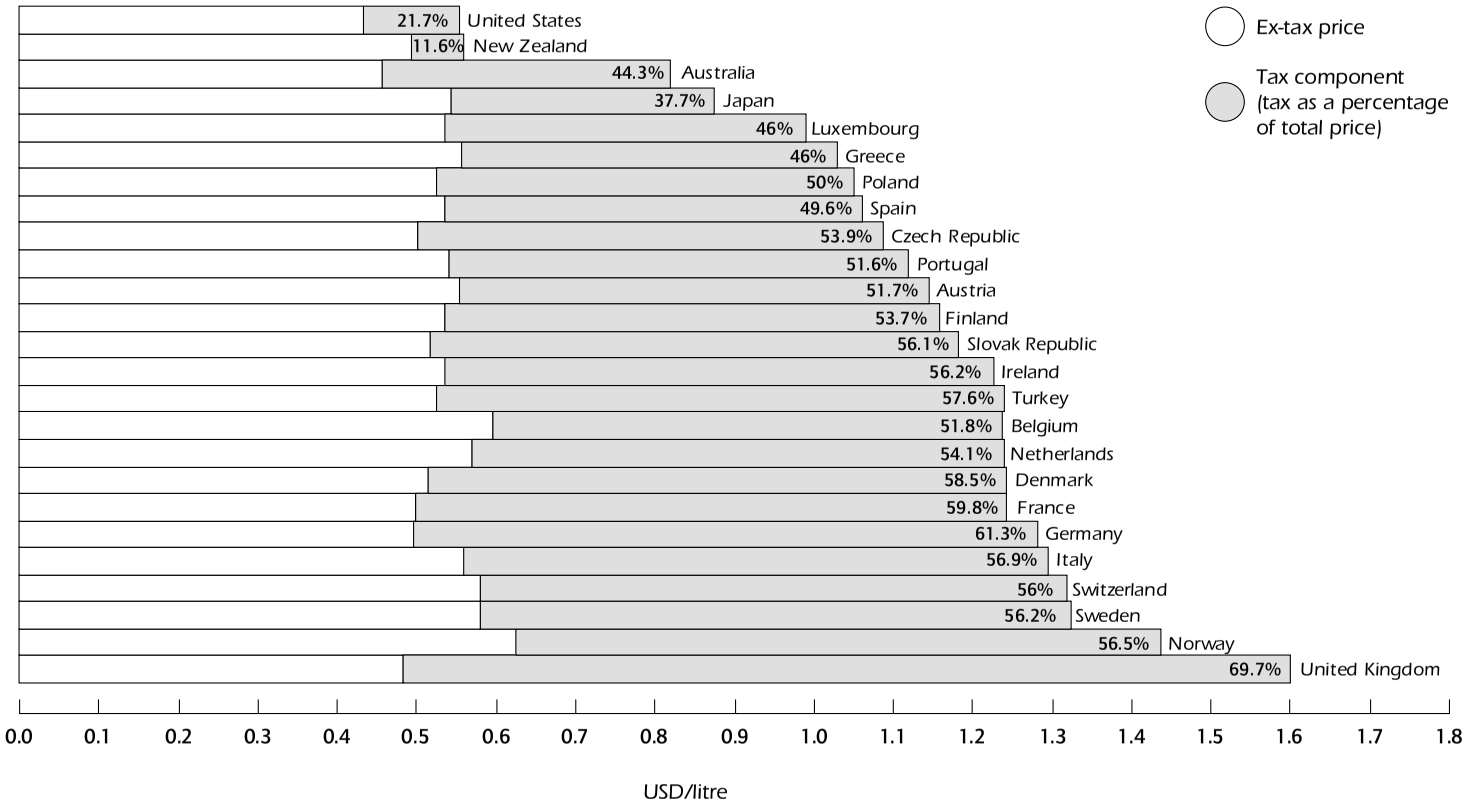
OECD Unleaded Gasoline Prices and Taxes, Fourth Quarter 2004



Note: data not available for Hungary, Korea and Mexico.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 19

OECD Automotive Diesel Prices and Taxes, Fourth Quarter 2004



Note: data not available for Canada, Hungary, Korea and Mexico.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Spanish road fuel prices are among the lowest in the EU, and the taxation differential between diesel and gasoline is leading to a significant increase in new registrations of diesel vehicles that is continuing unabated (see Figure 9, Chapter 4). For diesel, prices in Spain are also among the lowest in the EU, along with Portugal, Greece and Luxembourg.

Prices of heating fuel have risen fast over the past year with the pre-tax price of light fuel oil for households increasing by 35% between the end of 2003 and the end of 2004, to EUR 504.86/1 000l. This compares to a 21% increase in Germany, a 39% increase in France, and a 41% increase in Italy over the same period.

INFRASTRUCTURE

Distribution Network

Spain is unusual in possessing a quasi distribution monopoly owned by the major oil companies operating in the country. This quasi monopoly is a remnant of the pre-liberalisation oil market in Spain. The Hydrocarbon Logistics Company CLH owns 3 424 km of oil pipelines, 5.6 million m^3 of storage capacity and three tanker vessels. It also owns distribution trucks and barges. Since the last review, ownership shares in the company have shifted and are now in compliance with the law requiring that no oil company holds a share of over 25% of CLH.

Outside the CLH ownership, a further 3.5 million m^3 of storage are owned by a variety of companies, and these are primarily situated on the coasts of Spain. Since liberalisation, storage capacity has increased from 3.7 million m^3 in 1992 to an estimated 8.2 million m^3 in 2004, following the trend in demand growth. Most of the increase in storage has been outside the CLH system.

Refining

Spain is well served with refineries, with a total capacity that is close to covering Spanish demand levels for oil products overall, even though there are shortages in domestic production of specific products, such as middle distillates. Spanish refining capacity is 90% in the hands of the two successor companies that were established when the market was liberalised in 1992, RepsolYPF and Cepsa.

The activity of the refineries fell in 2003 in terms of crude distilling, down by 6.1%, with an increase in production of gasoline, kerosene or some types of gas oil and fuel oil, and a significant fall in the production of LPG, naphthas, type C gas oil, asphalts and coke. Refinery capacity utilisation remained high, at 88% on average throughout the year 2003.

Table 15

Spanish Refining Capacity, 2004

Name	*Owner*	*Capacity in mmt/a*	*Share of capacity*	*Company share*
Cartagena	RepsolYPF	5	7.8%	
La Coruña	RepsolYPF	6	9.3%	
Puertollano	RepsolYPF	7	10.9%	
Tarragona	RepsolYPF	8	12.4%	
Bilbao	Petronor[1]	11	17.1%	57.5%
Tenerife	Cepsa	4.5	7.0%	
Algeciras	Cepsa	12	18.6%	
Huelva	Cepsa	5	7.8%	33.4%
Castellon	BP	6	9.3%	9.3%
Total		**64.5**	**100%**	**100%[2]**
Asesa	RepsolYPF/Cepsa	1.1	Bitumen only	

1. 85.95% of shares owned by RepsolYPF.
2. Figures may be over 100% because of rounding.

Sources: AOP, CORES.

LPG

Liquified petroleum gas (LPG) is used as a heating and cooking fuel in some situations in Spain and is sold either in standard cylinders or piped to the users in bulk. In 2003, 1.5 Mt LPG was sold in cylinders (67% of the total), and 0.76 Mt (33% of the total) were sold in bulk and through pipes to final consumers. The price for the LPG sold in cylinders with a capacity over 8 kg, is set by the government in recognition of the fact that RepsolYPF exercises a *de facto* monopoly for the sale of the fuel with a market share of ~80%. This is likely to increase further if the planned purchase of Shell España's LPG business goes through. The maximum retail price of a 12.5 kg cylinder was EUR 8.35 at the end of 2004, while the same amount of piped LPG would have cost EUR 8.26. The LPG sold in bulk to final consumers is not regulated.

Despite the monopoly exercised by RepsolYPF, the real Spanish price for LPG (including tax) was the lowest price for LPG in small cylinders in the European Union in 2004. Portugal, with a price of EUR 0.99/kg, was the country closest to the Spanish price, followed by Luxembourg, at EUR 1.077/kg, 57% and 66% higher, respectively. With regard to other countries, the difference is much greater. For example, the average sale price in France was EUR 1.6624/kg, 156% higher than in Spain, Italy's average price was 104% higher and Germany's was 145% higher.

MARKET REGULATION

The National Energy Commission (CNE) has a regulatory role in the oil products market that is similar to its role in electricity and gas. This was established in the 1998 Hydrocarbons Act. CNE can act as an arbitrator in cases of conflict about access to CLH assets, and advises the government on the situation of the market relating to competition and transparency. Suspected breaches of competition law are referred to the competition watchdog. It is also responsible for ensuring quality of supply and has substantial information-gathering powers. The work of CNE is financed by a levy on wholesale volumes of oil products. The government sets prices for regulated markets such as LPG and has final regulatory powers. Spain is unusual in possessing an agency with a specialist role in the oil products market. In many other countries, this role is exercised by the general competition bodies.

EMERGENCY RESPONSE MEASURES

The law of January 1988 constitutes the legal basis for civil emergency planning in Spain. It established the National Civil Emergency Planning Committee (CNPCE) as part of an organisation responsible for handling general crisis situations. Ten working committees operate under the CNPCE, including the National Energy Resources Committee (CSRE) which forms the basis for the Spanish National Emergency Sharing Organisation.

Laws 34/1992 and 34/1998 as well as Royal Decree 1716/2004, which has substituted Royal Decree 2111/1994, provide the government with the powers to ensure that oil stocks are sufficient to meet the IEA emergency reserve commitment and to draw stocks during an emergency under a wide range of situations. The decree requires that oil operators hold minimum emergency reserves of 90 days of sales, plus a 10% margin for unavailable stocks. It also established a stockholding agency (CORES), empowered to build and manage strategic stocks representing one-third of the total obligations, and to monitor industry's compliance with the remaining 60-day obligation. Law 34/1998 allows the government to establish up to a maximum of 120 days of consumption as emergency stocks. Further, CORES is allowed to purchase strategic stocks or to rent up to half of them from operators. Therefore, Spain is well equipped to meet present and future international stockholding obligations. However, it should be noted that while Spain generally complies, it occasionally falls below its IEA stockholding obligation.

During an emergency, strategic and company stocks would be drawn down according to the procedures agreed upon by the CSRE. CORES would be in charge of releasing its own stocks, but the National Emergency Sharing Organisation (NESO) would oversee the release of industry stocks. Since strategic stocks are held together with company stocks, they would be released to the market through competitive sales using the existing distribution channels.

In accordance with Article 49 of Law 34/1998 and the IEA Treaty, the government has a wide range of demand restraint measures available in the case of an oil crisis. These include publicity campaigns to encourage voluntary actions to reduce oil consumption, speed and traffic limitations for vehicles, and rationing of oil products as a last resort. The scope and sequence of such measures would depend on the nature and magnitude of the oil crisis.

CRITIQUE

The Spanish oil sector is highly unusual in that it has a quasi distribution monopoly by CLH and is overseen by a regulator. The sector is still heavily concentrated, despite relatively open access being possible. Over the past years, storage capacity owned outside the common carrier system has increased significantly and now corresponds to almost 50% of the total oil storage in Spain.

There is a lack of new entrants into the oil market, while it is uncertain how much this affects competition across the value chain. Looking at the margins realised in the wholesale and retailing sector suggests that while wholesaling is a very competitive market, retailing suffers from a lack of competition. This is mainly due to the local planning regulation hampering the establishment of new filling stations. To achieve strong retail competition, hypermarket chains and other new entrants should be encouraged to enter the sector and the opening of new filling stations should be facilitated. While ensuring environmental protection, the siting regulations hampering new entry should be streamlined.

While Spain is well equipped institutionally to meet the present and future international stockholding obligations, it should be borne in mind that it occasionally falls below its IEA stockholding obligations. Given the growing oil demand, in particular for diesel, the government should take all the necessary measures to ensure that the IEA obligation is fulfilled continuously.

RECOMMENDATIONS

The government of Spain should:

- *Closely observe the market for oil products, including LPG, and promote further competition by* e.g. *encouraging new entrants, such as hypermarkets, and by removing planning obstacles.*
- *Co-operate with the local authorities to avoid delays in licensing new filling stations.*
- *Encourage the use of gasoline hybrid and alternative fuel vehicles, including converting bus operation to natural gas.*
- *Ensure continuous fulfilment of IEA emergency stock requirements.*

SUPPLY AND DEMAND

GAS DEMAND

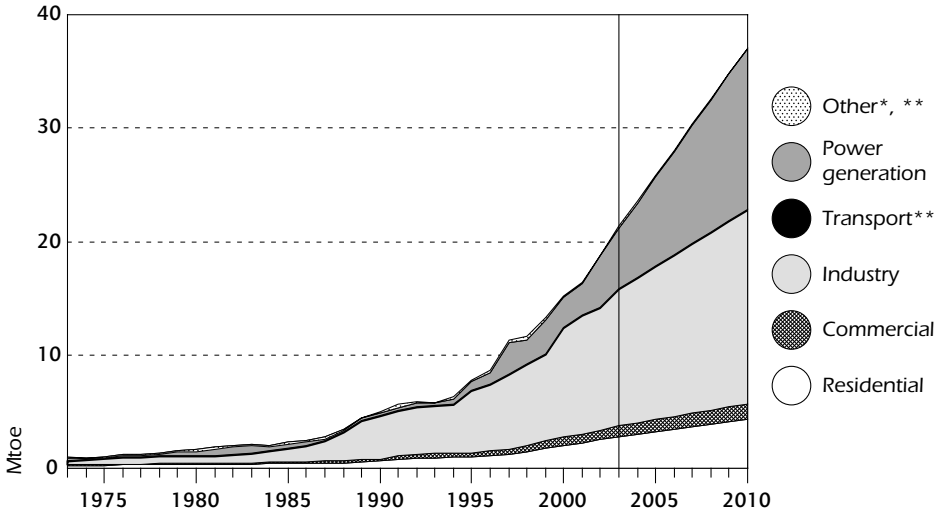
Spain has one of the most rapidly growing markets for natural gas in Europe, and is planning to further significantly increase the use of natural gas in coming years. Spain consumed 21.3 Mtoe of natural gas in 2003, an increase of 14% over 2002 (18.7 Mtoe). The natural gas sector continues to expand its share of TPES and reached 15.7% of TPES in 2003, an increase from the 5.5% it contributed in 1990. Gas's share of TFC was 15.4% in the non-industrial sector and 31.5% in the industrial sector. This was up from 5.8% in 1990 in the domestic-commercial sector and 14.9% in the industrial sectors. Around three-quarters of the Spanish gas demand enters the system at one of the five operational regasification terminals on the Iberian pensinsula (two more are under construction). Despite the rapid increase in recent years, Spain is still using less natural gas in its economy than the average of IEA Europe (24% of TPES). The country is planning to narrow this gap by reaching a 22% share (37 Mtoe) of natural gas use by 2010. Gas use is continuously increasing throughout all sectors of the economy with the exception of the transport sector, and the growth is most pronounced in the power generation sector, where gas has become the fuel of choice in recent years.

Between 1997 and 2003, Spain has experienced a rapid growth in its gas infrastructure – the pipeline network grew from 27 000 km to 48 000 km in length, the number of cities with gas connections increased from 621 to 1 106, and the number of gas connections exceeded 5 million for the first time in 2003, when 400 000 new customers were added. Of all connections, over 95% are domestic-commercial customers. Net customer growth in 2003 was 21% higher than it was in 2002.

Consumption of natural gas for electricity and heat generation alone in 2003 stood at 5.5 Mtoe, about 25% of total gas demand. Of this, 2.6 Mtoe were consumed in CHP plants, while 2.9 Mtoe were consumed in power stations, primarily CCGT. In 2004, the thermal power station demand for gas has again grown substantially. There are now 21 combined-cycle plants in Spain with a combined output of 8 400 MW (as of April 2005). Because of the high gas volumes needed at a single power station and special contract structures for gas delivery to power stations, this high share of gas consumption represents only 14% of total gas sales by value.

Figure 20

Supply of Natural Gas by Sector, 1973 to 2010



* includes other transformation and energy consumption (negligible).
** negligible.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

Gas Import

Spain is heavily import-dependent for its supply of natural gas with 99% of gas coming from imports, both in the form of liquefied natural gas (LNG) and natural gas coming from pipelines with international connections. In 2003, imports stood at 21.2 Mtoe, an increase of 17.5 Mtoe over the 3.7 Mtoe imported in 1990. LNG imports, brought in on methane tankers that are unloaded at regasification plants, made up 63% of imports. With rising gas consumption in Spain, the volume of LNG is likely to increase in the future, despite the planned increase in Algerian deliveries through the MedGaz pipeline due on line in 2008 (which will supply a further 4 to 8 billion cubic metres/year).

Spanish gas imports from any single country are capped by law at 60% of the total in a year. There are, however, doubts if this cap is observed in reality owing to the possibility to undertake physical swaps of gas that are not reflected in contracts, and the possibility to divert Atlantic LNG to US facilities if prices there are more attractive than those that can be realised in the Spanish market. Such swaps are not in contravention of the letter of the law capping the imports, and the government is not in a position to take action. It is also the government's view that what matters is the contractual position of the gas importers, and that the actual provenance of the gas in question is not relevant.

Because of the high growth of gas consumption and the vulnerability of the Spanish import system to either technical problems, such as faults on the pipeline to North Africa, or bad weather preventing unloading of LNG tankers or competition for LNG from North America, the overall position with regard to security of gas supply, and as a knock-on in electricity, has become weaker in recent years. This is particularly the case in light of the ever-increasing reliance on Algerian gas imports with the new MedGaz line recently given priority status by the Spanish government. This security of supply issue is routinely tested in periods of high demand, such as in the winter of 2004/05.

Spain has a well-developed although concentrated gas import infrastructure, with the exception of storage facilities. There are considerable facilities for LNG and import pipeline connections from Algeria and France. Further extensions of regasification (see Table 17) and an additional pipeline to Algeria are planned, along with more pipeline capacity to France which will allow some of the Algerian gas to transit the country. The critical bottleneck at this time is storage, and a shortage of gas storage has contributed to gas supply interruptions to large consumers, including power stations in the winter of 2004/05, with follow-on electricity shortages. This shows that the Spanish gas system has developed into a critical problem area for overall security of supply due to the high growth in gas demand over recent years driven predominantly by the increase in gas to power but augmented by more, uninterruptible, domestic connections. The Spanish government has also given the oil reserves corporation CORES the responsibility of handling security of gas supply. Procedures on this are being developed at the time of writing. The Spanish government also expects that the construction of the MedGaz European pipeline from Algeria through Spain, to be completed in 2008, will contribute to enhanced security of supply in Europe.

Table 16

Imports of Natural Gas by Origin, 2002 and 2003

	2002		*2003*		
Country	*GWh*	*Share %*	*GWh*	*Share %*	*2002/2003 change %*
Algeria NG	73 669	29.5	74 509	26.7	1.1
Algeria LNG	69 144	27.7	87 121	31.3	26.0
Nigeria	18 695	7.5	48 280	17.3	158.3
Norway	26 433	10.6	26 640	9.6	0.8
Gulf countries	43 306	17.3	30 123	10.8	–30.4
Libya	7 341	2.9	8 590	3.1	17.0
Trinidad & Tobago	5 342	2.1	977	0.4	–81.7
Domestic	5 831	2.3	2 529	0.9	–56.6
Total	**249 761**	**100.0**	**278 769**	**100.0**	

Source: Sedigas.

Table 17

Regasification Plants on the Iberian Peninsula

Existing LNG plant	*Storage cap kcm*[1]	*Regasification cap kcm/h*	*Docking cap kcm*	*Owner*
Huelva	1 160	1 450	140	Enagás
Cartagena	1 160	1 600	140	Enagás
Barcelona	1 390	1 200	140	Enagás
Bilbao	1 300	1 800	140	BBG
Sines (Portugal)	1 240	1 450	140	Transgas/Atlantico
Total	**1 240**	**3 500**	**700**	
New LNG plant (year of start)	***Storage cap kcm***	***Regasification cap kcm/h***	***Dock cap kcm***	***Owner***
Mugardos (2006)	1 300	1 323	1 140	Reganosa
Sagunto (2006)	1 300	1 750	1 140	Regasificadora
Total (existing and under construction)	**1 840**	**4 573**	**980**	
Additions to existing plant[2]	***Tanks under construction***	***Tank cap (kcm)***	***Further projects***	
Huelva	4th	150	5th tank	
Cartagena	3rd	127	4th tank	
Barcelona	6th (2006)	150		
Total		**427**		

kcm: thousand cubic metres.

1. Storage and docking refers to LNG, while regasification refers to natural gas; LNG is about 1/600th the volume of natural gas.
2. In all of these, the increase is in regasification capacity.

Source: Sedigas.

Domestic Production

Spain produces a small amount of natural gas from on- and off-shore fields. The contribution of national production of natural gas in 2003 was 0.2 Mtoe, a reduction of 57% compared to 2002. This equates to only 1% of all natural gas supplied in Spain. In 2003, prospecting activity in Spain increased compared to previous years with a volume of investment of about EUR 50m.

The main production took place in the *Poseidón* gas field in the Gulf of Cadiz, which has maintained a variable production throughout the year, supporting

the needs of the gas network. Other active fields are *Marismas*, *El Romeral*, *El Ruedo* and *Las Barreras*, in Andalusia. Total reserves of natural gas in these fields are estimated at 2 bcm.

POLICY FRAMEWORK

Legislative Development

Spain commenced the liberalisation of its gas markets much earlier than other Continental European countries. In 1996, legislation was introduced to allow third-party access to gas infrastructure and the toll levels for this access were fixed in 1997. In 1998, a new Hydrocarbons Act fixed the dates for future liberalisation of the market. From 1998, consumers with more than 20 mcm of annual gas demand, representing 45% of the market by volume, were free to choose their suppliers. In April 1999 this increased to 60%, and in June 2000, to 72% of the market by volume, when consumers with demand above 10 mcm and 3 mcm respectively were allowed to choose their suppliers. The 1st January 2003 saw the completion four years ahead of the schedule imposed by the EU directive of the opening up of the Spanish gas market. All customers, regardless of their consumption level, are considered qualified consumers and can freely choose their supplier although there is still a regulated tariff.

In 2001, Royal Decree 949/2001 introduced a new charging structure changing the end-use-based charging (domestic/commercial and industrial) to a system based on the pressure of the connected installations of the end-consumers and their yearly volume of consumption.

Despite these timely steps, Spain has yet to develop a liquid and transparent gas market. Without the pricing signals such a market would provide, the industry has not had the market incentives to develop supply-side management which would contribute to Spain's gas security. Although the government has tried to redress this balance with risk-mitigation incentives to develop new infrastructure, the strategy has left Spain short of storage as a supply-side tool. As a consequence, gas companies manage demand, with large discounts offered to industrial customers, in exchange for interruptible contracts. Thus, future failures of the gas industry to match supply with demand for whatever reason will increasingly lead to a volume response suffered by industrial users and power stations rather than automatic financial penalties suffered by gas suppliers in the form of higher market prices (as for example in December 2004 and February 2005). In turn, output from industry either bears the high cost of securing backup sources of supply itself, or stops altogether. A transparent spot and forward gas market, priced to reflect the fundamentals of Spanish supply and demand, would allow infrastructure companies to invest in new infrastructure capacity where it would be most valued, to ensure a reliable future supply of gas to end-users.

Governance

The Spanish gas sector is regulated by the Ministry for Industry, Tourism and Trade and the National Energy Commission (CNE). The ministry holds regulatory powers such as price-setting and carries out the *Planificacion* process under which most energy infrastructure in gas and electricity is built. The CNE holds substantial information-gathering powers and can act as an arbitrator in cases where conflicts about third-party access or other matters relating to regulated activities develop, and where both parties refer the case to it.

Historical development of regulation was primarily based on the Hydrocarbons Act 34/1998 from 1998. The act introduced legal unbundling between regulated and non-regulated activities, and launched competition in the gas industry in Spain. It regulated third-party access requirements and introduced standard contracts. The act also established measures to ensure security of supply, by outlining a requirement for minimum reserves of 35 days' consumption worth of stocks and putting a cap of 60% on imports from a single country. The latter measure was aimed at ensuring that Spain could not become overly dependent on Algerian gas. Another important development at this stage was the auction of 25% of Algerian natural gas in the dominant gas supplier's portfolio to allow other companies to access this resource.

Prices for TPA are fixed by the government on an annual basis. They are calculated to give a predetermined return to the developers of the infrastructure projects and are paid by all users of the infrastructure. TPA tariffs are uniform across Spain, and are based on contracted volumes, pressure and consumption. They are on a ship-or-pay basis.

INDUSTRIAL STRUCTURE

There are a total of 57 companies active in the Spanish gas market. Of these, six are transmission companies, Enagás being the main one and the system operator, 28 are distribution companies, and 26 are supply companies. The main company in the sector is the privately-owned former *de facto* monopoly operator, Gas Natural. Gas Natural was formed in 1992 from a merger between Catalana de Gas and Madrid Gas and the acquisition of Repsol's piped gas assets. In 1994 Gas Natural bought Enagás, but in the course of liberalisation, ownership had to be relinquished. Until the opening of the gas market, Gas Natural supplied almost all gas on the Spanish market. In 2000, it still held 90% of the market, but this has reduced to 59% by 2004. In an effort to diversify out of its shrinking market in gas supply, Gas Natural is now developing significant CCGT capacity in Spain, with a target of 4.8 GW installed capacity by 2008 which the company is in line to meet. The company also has substantial interests overseas.

Gas Natural supplied about 82% of the customers connected to the Spanish gas system in 2003 (latest figures available), although its market share was

considerably less by volume. Gas Natural also owns significant gas distribution network assets and, until June 2005, owned around 35% of Enagás, the gas transmission system operator. Gas Natural's shares are owned by the Catalan Savings Bank La Caixa (30%) and the Spanish oil major RepsolYPF (27%), and the company has had a central role in attempts to consolidate the energy sector in Spain, first through an aborted merger attempt with the second-largest electricity company, Iberdrola, in 2002, and currently through its link with RepsolYPF.

Gas Natural is supplying most of the gas consumers who are under administrative tariffs. This explains the very high share of connections it is servicing. In 2004, its market share in terms of volume was significantly below the share by number of connections and stood at 59%. The company also runs the major part of the distribution network, 34 701 km out of 37 457 km in 2003 (93%). It receives the most significant share of Algerian pipeline gas from the existing pipeline but is not expected to secure any supplies from the planned Medgaz pipeline.

Most of the Spanish gas upstream transmission infrastructure and 80% of the regasification terminal capacity is run by Enagás, a private monopoly operator. Enagás is also the system operator for the Spanish gas system, responsible for the management of the network, security of supply and co-ordination of all players in the gas system. Enagás is charging its customers on the basis of the administratively approved tariffs that allow it to recover its costs and make a profit.

There are restrictions on maximum ownership of Enagás shares by companies in the energy sector and also on cross-ownership of energy network company shares held, for example, by banks. Gas Natural owned almost 25% of Enagás until 2005. This arrangement had come under strong criticism because of the lack of a transparent network code by other electricity producers after the gas shortages of December 2004 led to supply interruptions to CCGT power stations. The government has recently reacted to this criticism by further limiting shareholdings. Enagás's shareholding will change considerably during the year 2005, when Gas Natural will have to divest most of its 25% shareholding to conform to the new maximum limit of 5% of Enagás shares being held by a single shareholder (Law 62/2003 of 30 of December 2003). Until 2005, this limit stood at 35%. Other shareholders at the 5% level at the time of writing are three Spanish regional banks, two investment companies and BP.

Electricity companies with an interest in the development of CCGT power stations such as Union Fenosa have become active in upstream gas, especially LNG developments, in recent years through direct contracts with production countries and ownership or part-ownership of transport and regasification facilities. They pursue this investment in order to ensure continued supplies to their power stations. Spanish companies have been instrumental in opening

production of Egyptian gas and LNG, and are generally very active in North African producer countries. The entry of the former gas monopoly Gas Natural into the power generation market may have encouraged this development. Gas Natural is developing significant amounts of gas-fired power generation, and has historically also been involved in transportation and regasification. Other major energy companies that have diversified into natural gas are Endesa, Iberdrola and RepsolYPF.

TRANSMISSION NETWORK

The Spanish transmission infrastructure for gas is developed under the regulated system allowing for full cost recovery by the developer. The Spanish government is using an infrastructure planning approach to assess the need for new developments in gas transmission and regasification. Companies building the required plant or pipelines will be guaranteed a return on their investment, but will have to make it available for use by third parties. The CNE is available as an arbitrator in access disputes if both parties agree to make their case before it. This is an arrangement that is bound to limit the amount of cases brought. While it is possible to develop infrastructure outside the regulated system, nobody has chosen to do so because of the higher risk incurred by developing without the guaranteed cost recovery.

The Spanish gas transmission and distribution infrastructure is still developing and is considerably less well developed than that of other countries. Spain had a total gas network of 48 148 km, 10 691 km of this in the transmission network and 37 457 km in the distribution network. In 1995, the total network length in Spain was 21 162 km, with 6 412 km of transmission network and 14 750 km of distribution network. Since then, network growth has primarily been in the distribution network length. Total investment in the gas infrastructure since liberalisation in 1998 has reached around EUR 5bn in 2003. During this time, annual investment levels have been relatively stable, between EUR 800m to EUR 1bn.

Table 18

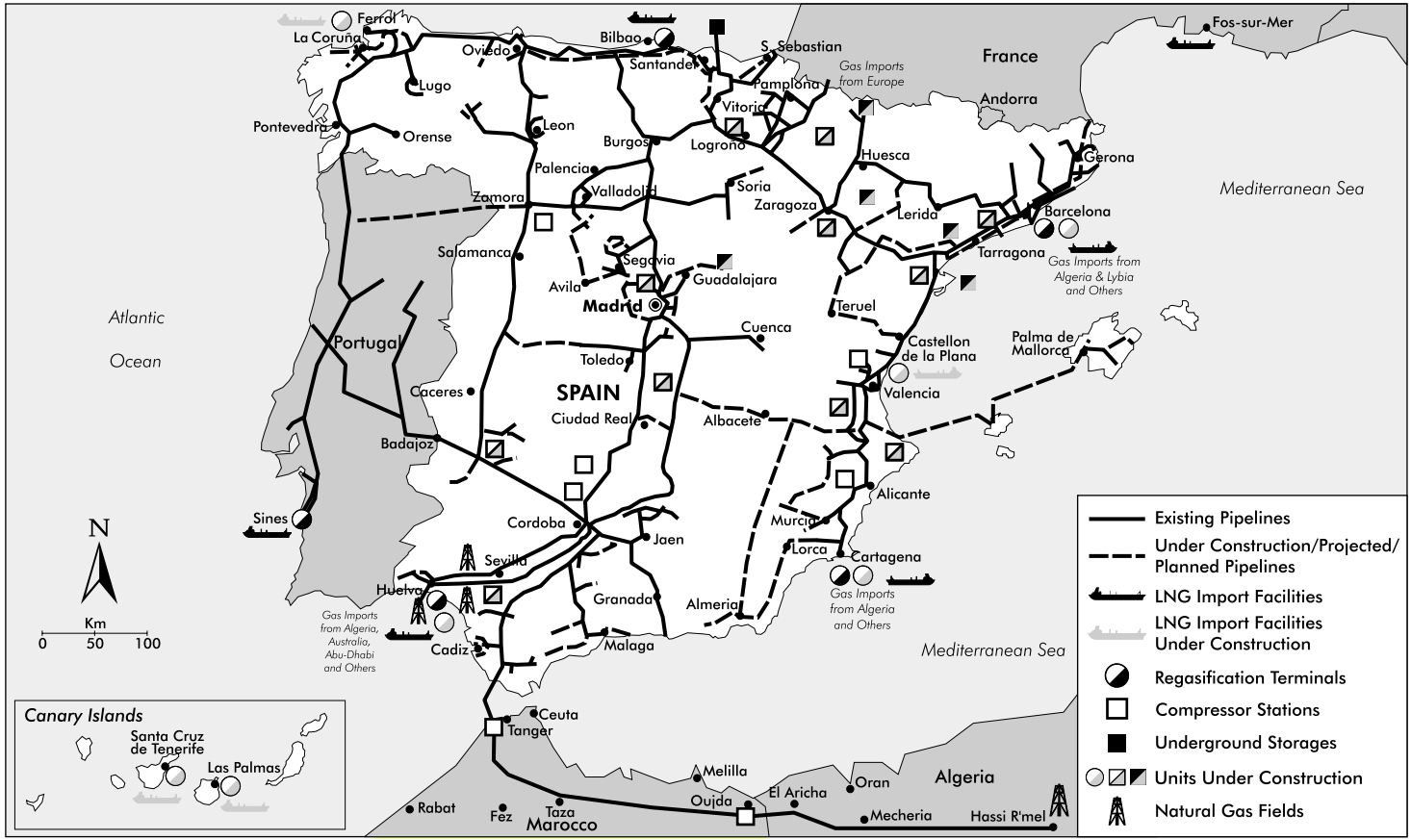
Annual Investment and Expansion of the Spanish Gas Network, 1993 to 2003

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Investments (million EUR)	266	376	567	626	500	614	759	912	801	781	1010
Annual addition to network	n/a	1 628	1 662	3 008	2 852	3 109	3 489	3 402	3 092	4 197	3 837
Total kms of network	**17 872**	**19 500**	**21 162**	**24 170**	**27 022**	**30 131**	**33 620**	**37 022**	**40 114**	**44 311**	**48 148**

Source: Government submission.

Figure 21

Gas Network on the Iberian Peninsula and Island Communities, 2004



Source: Spanish government.

By comparison, Germany has a network of 96 000 km of high pressure lines, and about 270 000 km of low-pressure distribution lines, both considerably in excess of the Spanish system. The difference in network length is explained to some degree by the role of Germany as an important hub in the European gas transmission networks bringing in gas from the North Sea and Russia to Western Europe, and by Germany's much more pronounced need for space heating with gas owing to a much colder climate, necessitating many more connections to domestic dwellings. Spanish gas demand is still primarily in the industrial and power generation sectors and, as such, requires comparatively shorter total network length.

Spain is connected to France through two pipelines. The Trans-Pyrenean natural gas pipeline, linking Calahorra, Spain to Lacq, France, began operations in 1993. The 330 million cubic feet per day (Mcf/d) connection allows Spain to import natural gas via France from Norway. In October 2004, Total began construction of the 48-Mcf/d Euskadour natural gas pipeline. The pipeline will connect a liquefied natural gas (LNG) receiving terminal in Bilbao, Spain to southern France. Total expects to finish construction on the Euskadour pipeline by 2006. A further pipeline connection from the Catalane coast to southern France has recently been discussed.

GAS PRICES

Consumer Tariffs

Spain is operating a dual system of regulated prices and of prices freely negotiated between suppliers and consumers. Both of these are accessible to all gas consumers, but over 80% of sales in volume[4] are now on the basis of freely negotiated tariffs. This share was 71% in 2003 and 56% in 2002. Spanish administrative prices are based on a simple formula, whereby the total supply costs are divided by the estimated demand within the market. Regulated tariffs treat the whole of Spain as one zone, and since 2001 prices are based on volume, pressure and type of consumption[5]. Prices basically consist of two factors, one reflecting the cost of gas, the Raw Material Unit Cost (RMUC) consisting of the raw material and the trading cost, and the other the fixed cost of operating the network. The latter include the costs of CNE, Enagás in its role as system manager, distribution and transport, including pipelines, regasification and storage. Over 99%[6] of the average tariff is made up of raw material and transport, distribution and storage cost.

4. In 2004 the tariff market share was 20.4% of the whole market.
5. The current tariff scheme was first described in the Royal Decree 949, published on 7 September 2001, but the initial end-use tariffs, stabilised in accordance with the new scheme, were published by Ministry Order on 18 February 2002.
6. The global budget of CNE and Enagás (as system manager) for the year 2005 is around EUR 13m. A figure nearly negligible in comparison with the EUR 1 600m (approximately) needed to pay the RMUC, high-pressure transport, storage, LNG terminals and distribution to the tariff market.

The smaller the amount consumed and the lower the pressure, the higher the share of fixed costs in the price becomes. Consumers on interruptible contracts receive a discount in the administrative system.

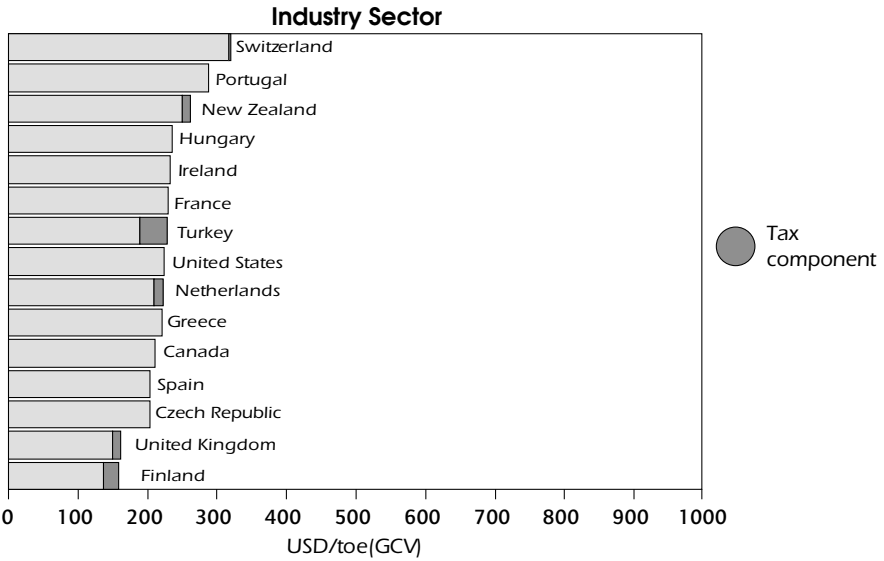
Figure 22

Natural Gas Prices in Spain and in Other Selected IEA Countries, 1980 to 2003

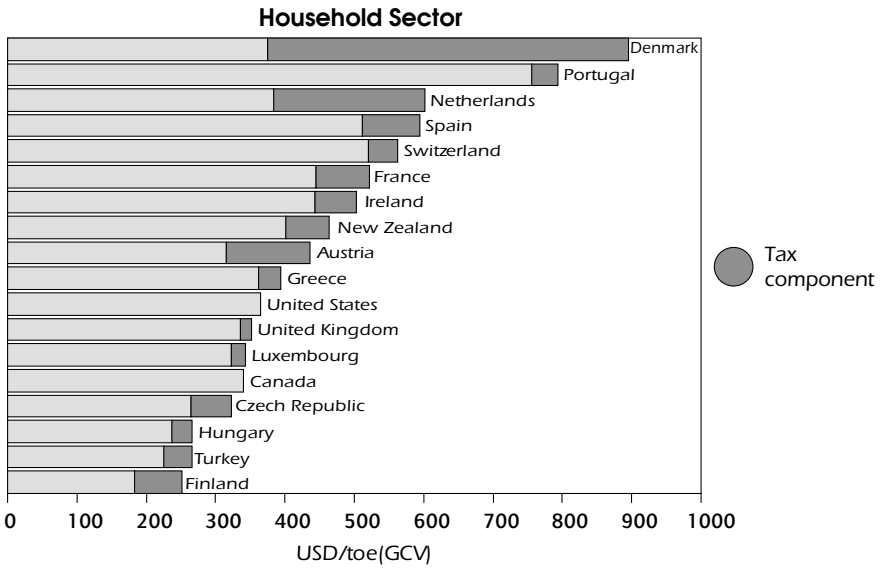
Sources: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 23

Gas Prices in IEA Countries, 2003



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



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

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

The rates in force are reviewed quarterly in the months of January (publication of the annual law setting the prices), April, July and October, taking into account the development of the RMUC. Between January 2003 and April 2004, five revisions brought down prices, compensating for price rises in July and October 2002. The administrative tariff covers 20% of total demand by volume, although this includes significant numbers of customers in the domestic sector, where only 5% of domestic and small commercial customers had switched supplier in 2003, the first year when they became eligible to do so. A much higher rate of switching was seen in 2004 when 20% (or 1.2 million) customers switched supplier. The dramatic increase has seen Gas Natural winning a large market share of the "liberalised" market in all sectors through attractive "dual fuel" offers of combined electricity and gas supply. Some electricity companies, like Endesa, Iberdrola and Unión Fenosa have followed the same strategy offering similar "electricity and natural gas" packages to their customers. It remains to be seen whether these prices can be sustained in the long term to the benefit of customers. For households and small commercial customers, price reductions were not as pronounced because of the relatively higher share of fixed costs, but still reached 5-6% between January 2003 and May 2004. Administrative prices for large consumers dropped by 13-14% in the same time.

Spanish prices may be more susceptible to short-term movements than those in other European countries owing to exposure to the transatlantic, and in particular the US market. It is expected that the Atlantic market may become the dominant LNG spot market in the world. In this case, Spanish regasification and storage capacity may need to be further developed to cope with short-term pressures resulting from such a development. Because of the nature of current infrastructure development in the Spanish gas sector, as a guaranteed return investment, additional investment will drive up fixed prices in the system.

CRITIQUE

The Spanish gas market has developed in a commendable way since liberalisation commenced. The market share of the incumbent has dropped rapidly, and the move to liberalised tariffs has gone quickly and generally smoothly. Spain has to be commended for liberalising its gas markets well ahead of the European directive's schedule. Introduction of LNG has significantly enhanced security of gas supply, which is enabling the rapid development of CCGT power stations and reducing CO_2 emissions in the electricity sector. Nevertheless, the rapid growth has created some problems in the Spanish energy markets which the government will have to address. It should be commended for having already started addressing these issues.

Spain has one of the fastest growing natural gas markets within the EU. The Spanish natural gas demand reached 320 TWh in 2004 and the government

forecasts a growth rate of 17% for 2005, mostly driven by consumption of new CCGTs. The high demand growth forecast by the government will require very important investments in gas infrastructure. The introduction of additional interconnections and the reinforcement of existing ones and the diversification of suppliers' portfolios through further development of the LNG market will enhance security of gas supply in the Spanish case. In 2002, the government produced a network development plan that is mandatory with regard to gas transmission networks, LNG regasification capacities and storage facilities. This document is expected to be revised in the summer of 2005. The government is mandating investment in the Spanish gas infrastructure and shoulders the risk for these investments by reimbursing the investors regardless of the economic performance or value of the assets once in operation. This has been instrumental in expanding gas infrastructure to date. On the other hand, the absence of developments where the developers carry the risk of providing the infrastructure, instead of being assumed by the system as a whole through the guaranteed remuneration system, indicates that the guaranteed rates of return may be too generous, which increases the cost of the whole gas supply chain. The government should regularly review the policy of applying guaranteed rates of return for infrastructure in order to make sure that new capital is not directed to facilities with which Spain is already well supplied (such as regasification terminals) or the government could encourage market-based development of these assets. Efficient markets are likely to marshal capital in a more timely way than government policy, but they require substantial volumes of gas to be released from long-term oil-indexed prices.

Imports account for 99% of gas used in Spain, both via pipelines and as LNG. While the legal limit of 60% on imports from a single country is not broken on a contractual basis, the dependence on Algerian gas could be even more important, owing to swaps of LNG being undertaken, and will certainly grow. In fact, it is possible that the real problem is less the dependence on a particular country for gas supply, but more the concentration of facilities for transporting it. Recurrent Spanish supply failures have not been related to activities in any source country and the risk of repeated failures should be mitigated to some degree by the commissioning of a second Algerian pipeline, despite the likelihood of breaking the 60% rule.

The government should consider either reviewing the 60% rule, or stronger oversight of the real origin of gas, and ways of ensuring that companies fulfil the letter and the spirit of the law.

In December 2004, natural gas supply cuts were imposed at 4 power plants because of problems in an Algerian gas pipeline (another supply incident had already happened in December 2003). Another round of supply cuts were imposed in February 2005 because of bad weather preventing unloading of LNG tankers at the same time as a compressor failure on a supply pipeline. The gas and the electricity transmission system operators (TSOs) co-operated

efficiently during this shortage period. Recent gas supply interruptions have, however, not resulted in fuel switching, but cessation of generation implying that the policy requiring gas users to store 35 days' equivalent supply of fuel in case of a supply emergency does not appear to be heeded. Questions have also been raised about the transparency of the decision-making process for the disconnection of interruptible consumers. For example, it is impossible to see the effect of the supply interruption reflected in the price of gas over the period. This means that there is little commercial incentive to invest in risk mitigation assets such as storage. Furthermore, the process of interruption is not governed by the market, meaning that the order in which this happens is irrespective of the lowest value usage.

The need for flexibility tools for the management of the system will increase as the grid expands and residential consumption grows. The impact of the natural gas supply cuts in December 2004 and February 2005 could have been minimised if there had not been a shortage of storage capacities. The planning and remuneration system does not seem to provide a targeted incentive to invest in the search for, and development of, underground storage facilities, and this is rapidly becoming a critical concern for Spain's security of supply both in gas and electricity. Insufficient storage capacity could also prevent entry of newcomers and discourage further competition because one of the key issues facing a small supplier is balancing in the event of interruptions. If balancing is unavailable, new entrants do not have a portfolio which can react and therefore will see their profit margin eroded by system penalties.

Storage is inherently more risky than transmission, which means that in the current regulated environment, the relative rate of return allowable for the two investments must reflect this. In a market-based environment, the Spanish supply and demand fundamentals would be reflected in very high volatility, which would encourage investment in storage assets. A further complication is the challenging geology in Spain, which increases the cost of storage, and the lead time to bringing new projects on line. Increased interconnection to France through further pipelines, or capacity extensions on existing pipelines, could allow Spain to access further supply and storage sources.

Spain currently has a regulated TPA regime for transmission and distribution networks, LNG terminals and storage facilities. The access tariff is identical across the system, with Spain being treated as one zone, thus not providing locational signals to the users of the system. The absence of locational signals removes a strong incentive for developers to site infrastructure such as CCGT power plants at places where they can support the operation of the system, *e.g.* by avoiding the creation of bottlenecks.

The gas market is fully open since 1 January 2003: each consumer, regardless of his consumption, has the choice either to remain in the regulated market or to enter the competitive market. Once the choice to leave the competitive tariff has

been exercised, the consumer is locked into the regulated market for twelve months. Customers consuming over 100 GWh/year are locked out of the administrative market for three years if they choose to go to the liberalised market. There is no minimum period of stay in the competitive market for other customers.

In 2004, 80% of gas was delivered to the competitive market where almost all industrial consumers are supplied. Nevertheless, it appears that the competition process mostly affected larger users, as only 21% of residential consumers were supplied in the competitive market in 2004. There are indications that residential contract standardisation and supervision should be strengthened in order to ensure consumer confidence in the gas market. This could be a role for the CNE in co-operation with the government. Furthermore, it should be analysed whether there is still a strong need for regulated tariffs after eliminating impediments for going to the liberalised market and whether it can be replaced with general service standards enforced by CNE. The regulated tariff also needs constant review in light of the level of the competitive price available.

The development of competition has been encouraged by the Spanish government. At the end of 2001, it awarded 25% of the natural gas contracted by Gas Natural coming through the Maghreb-Europe pipeline to 6 suppliers (4 Spanish electricity companies, BP and Shell), in order to help new companies to enter the gas market. Gas Natural was also requested to divest 60% of Enagás and its share in the TSO is due to decrease further to 5% at the end of 2006. While its market share has decreased faster than in other countries where liberalisation has taken place, Gas Natural has still had a dominant share (57.2%) in 2003, which raised many concerns among the other actors of the gas market. The government will need to ensure proper supervision of Gas Natural's activities to prevent cross-subsidisation and exercise of market power.

The independence of Enagás is not considered as satisfactory by the majority of electricity industry players, despite management unbundling. The decision-making process leading to the interruption of supply to some CCGT power stations in December 2004 has been heavily criticised by some of the affected operators as not being transparent. The network operators maintain that the decision was correct from the system operation perspective and that no regard was taken of the ownership of the plants that were interrupted. If Spain had more transparent access to prices, some customers would have simply decided to switch fuels for economic reasons rather than wait to be interrupted – removing the perceived arbitrary nature of the decision. In order to avoid such conflicts in future cases where supply interruptions become necessary, it would be useful to increase the transparency of the decision-making process that is jointly carried out by Red Electrica de España (REE) and Enagás. A large part of these players believe that the publication of a network code would be very useful in increasing the transparency of the transmission system operation, thus contributing to the achievement of effective competition.

RECOMMENDATIONS

The government of Spain should:

- *Closely monitor and encourage the development of interconnections and LNG terminals, wherever possible, by market-funded developments outside the system of guaranteed returns. Investigate whether especially new regasification capacity can be developed outside the regulated system.*
- *Create an environment in which the development of new storage facilities will be encouraged by allowing market fundamentals to be reflected in the price of gas; by reviewing the rate of return allowable for storage facilities relative to that for transportation; and by addressing siting, NIMBY and permitting issues to speed up the planning process.*
- *Set up an emergency plan in line with the EU directive on security of gas supply (2004/67, article 8).*
- *Monitor closely the development of the competitive market for natural gas, and ensure that Gas Natural does not abuse its market power.*
- *Increase the transparency and independence of the TSO to avoid any risk of discriminatory behaviour.*
- *Review the access tariffs to the gas network with a view to introducing locational signals and correct pricing of congested assets.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Finalise and adopt a network code to ensure fair and standardised technical and commercial decisions for connection and access of third parties to the gas infrastructure.*
- *Promote and facilitate the development of the Spanish gas hub, and a liquid spot and balancing market.*
- *Review the policy on security of gas supply (particularly the 60% quota) in light of new developments in LNG and pipeline and move the focus towards the density of supply.*
- *Facilitate the timely transfer of market information to all participants.*

SUPPLY AND DEMAND

Spain is the fifth-largest coal consumer and sixth-largest coal producer in IEA Europe. Spanish reserves of hard coal are abundant, but difficult to mine. They are centred in the north of the country, in particular the Castilla-Léon Autonomous Region. Brown coal is primarily mined in the Autonomous Region of Galicia, in Spain's north-west.

Spanish hard coal is produced in regions with little other economic activity. Because of the high cost of mining coal deposits and its low quality, Spanish hard coal has become uncompetitive over recent years without government support, with estimates of domestic production costs for the public operator of up to seven times that of imported coal. For private mines, the average cost is twice the price of imported coal. HUNOSA's cost is EUR 320/tonne of coal equivalent (tce), while the average cost of mined coal in Spain is EUR 120/tce, and that of opencast mined coal is EUR 70/tce. The Spanish government has acknowledged this and has introduced a long-term restructuring plan in order to diversify the economy of the regions dependent on coal mining while reducing capacity over the long term. Spanish coal is primarily used for electricity generation, with some power stations built at the mine-mouth. A small amount of coal is used in industry and the same amount is used in the domestic sector as heating fuel. Spanish brown coal is not subsidised and Spain is importing all its coking coal for industrial use.

Table 19

Average Heating Values of Coal Used in Spain by Type

Origin/type	*Lower heating value*	*Higher heating value*
Imported	5.827	6.083
Spanish hard coal	4.690 – 4.920	4.850 – 5.070
Lignite	3.020	3.270
Brown coal	2.010	2.370

Source: Spanish government.

Coal's share in TPES is dependent to a large degree on the availability of hydro stations for power generation. A lack of rainfall will lead to increased production of electricity from fossil-fuel power stations, including those fired by coal. This explains the significant year-on-year variations that can see different volumes of imported coal. National coal is used under fixed-amount,

variable price contracts. Volume adjustments due to other factors in electricity generation, therefore, affect only imported coal. The Spanish government forecasts a reduction of coal's share in TPES from 17% in 2000 to 9% in 2010. The recently introduced National Allocation Plan and restrictions on power station emissions under the EU Large Combustion Plant Directive may become the major drivers for reductions in coal-fired power generation at a time when the increasing use of natural gas in power generation will provide an attractive alternative.

National production of hard coal has fallen by 43% from 10.5 Mtce[7] in 1990 to 6.0 Mtce in 2003. Brown coal (including sub-bituminous coal) production has fallen by 42% from 6.2 Mtce to 3.6 Mtce over the same period and this type of coal is exclusively used in mine-mouth power stations. Significant amounts of steam and coking coal are imported into Spain, and imports of steam coal have risen by 83% from 10.2 Mtce in 1990 to 18.7 Mtce in 2003. Coking coal use is down from 4.3 Mtce in 1990 to 3.4 Mtce in 2002, a reduction of 21%. Coal's share in TPES has, therefore, decreased from 21.2% in 1990 to 14.8% in 2003. The balance between imports and domestic production shifted in the 1990s and is now firmly in favour of imports. Imported steam and coking coal is used primarily in power stations as blast furnace input and in the cement industry.

In 2003, the main source countries for imported steam coal were South Africa (48.5% of steam coal imports), Indonesia (18.1%) and Russia and Australia (with 10.6% each). For coking coal, the main source countries were Australia (57% of coking coal imports) and the US (33%). Spain is well integrated into the international coal markets and has sufficient port capacity to handle coal imports.

Table 20

Total Coal Supply, 1980 to 2003 (in Mtce)

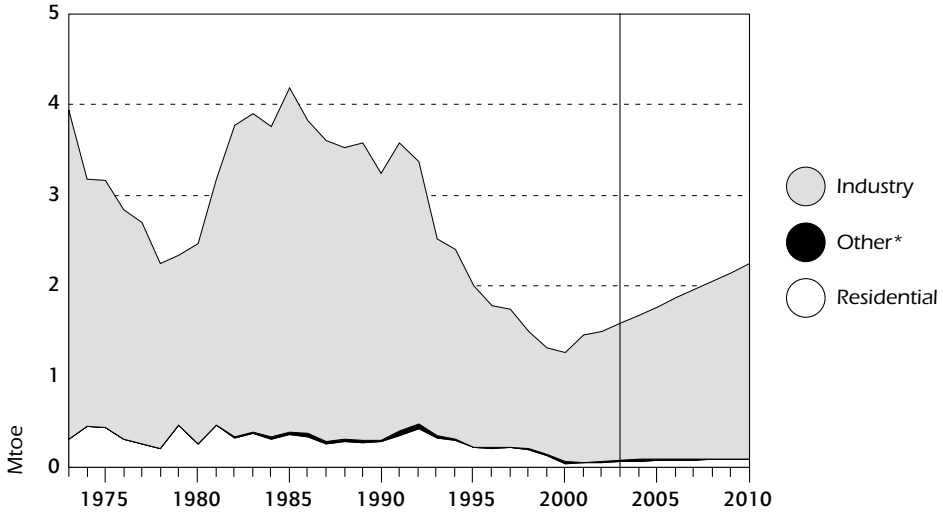
	1980	*1990*	*2000*	*2001*	*2002*	*2003*
Production	14.0	17.0	11.4	11.1	10.6	10.0
Import	5.9	10.2	19.1	16.6	21.2	18.7
Export	–0.0	–0.0	–0.8	–0.6	–0.6	–1.0
Stock changes	–2.2	0.7	0.2	0.3	–0.3	0.3
Primary supply	**17.8**	**27.7**	**29.9**	**27.4**	**30.8**	**28.1**

Sources: *Coal Information 2004*, IEA/OECD Paris, 2004.

7. 1.43 Mtce = 1 Mtoe.

Figure 24

Final Consumption of Coal by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

COAL INDUSTRY

Structure

The coal market was further liberalised in January 1998 when a long-term restructuring plan was introduced. While quotas for the use of Spanish coal were continued, power producers were allowed to directly contract with mining companies for the amount and price of coal under their quota. There are several different types of contracts. Each power station sets out the technical and quality characteristics for the coal it purchases, and applies tolerance limits and penalties on an individual basis. Prices may vary for the same power station depending on the contractor and they vary between power generation companies. The total value of domestic hard coal sales delivered to power stations was EUR 442m in 2003. Brown coal sales were worth EUR 180m for a total sales value of EUR 622m. A further EUR 54m sales income was generated from coal sales to final consumers.

Restructuring of the Spanish coal-mining sector is ongoing. There have been further mergers that reduced the number of companies extracting hard coal to 41. Through these mergers, the private UMINSA (a result of the merger of 17 independent mining companies) has now become the largest producer, exceeding two million tonnes of production per year with 1 437 workers. Other major operators are the state-owned HUNOSA and the private company

ENCASUR, as well as the utility company Endesa, the major operator in brown coal mining. Despite this, over half of the companies active in the Spanish mining industry are employing fewer than 50 workers and over 90% employ fewer than 500 workers.

Table 21

Spanish Mining Companies by Employees (end of 2003)

	Number of companies	*Share of total*
< 25	14	33%
25 - 50	8	19%
50-100	6	14%
100-500	11	26%
>500	4	9%
Total	**43**	**100%**[1]

1. Number may differ from 100 because of rounding.

Source: Country submission.

Employment

The workforce in the coal sector was further reduced through a lowering of retirement age to 52 in 1998. Between 2002 and 2003 this led to a reduction of 10.4% in employment. Most of these reductions occurred in the hard coal sector, where 94% of all Spanish mining-related employees work. At the end of 2003, there were 11 453 employees in this sector, down from 12 798 in 2002. In the brown coal sector, employment reduced from 763 to 694.

COAL POLICY

Production and Subsidies

Spain has reduced its production of coal by 33% and restructured the sector with the aim of creating larger and more competitive enterprises between 1990 and 2000. Between 2000 and 2003, further production reductions of 12% were undertaken. Restructuring is undertaken under a long-term plan, running from 1998 to 2005. Under this plan, the targeted production level of hard and sub-bituminous coal for 2002 was 14.5 Mt, but in reality, restructuring has been faster than expected and the 2002 production level stood at 8% below the target at 13.3 Mt. The Spanish government is now viewing any further restructuring primarily as a social, rather than an industrial policy measure owing to the industrial structure of the regions where coal is mined, and there is no indication whether a new restructuring plan will be implemented once the current one runs out this year.

Table 22

Total Coal Production by Type of Coal, 1998 to 2002

(in million tonnes)

	1998	*1999*	*2000*	*2001*	*2002*	*Total reduction over period*
Total under restructuring plan[1]	**15.91**	**15.44**	**14.94**	**14.00**	**13.31**	**–16%**
Anthracite	*5.86*	*5.44*	*5.14*	*4.69*	*4.39*	*–25%*
Hard coal	*6.13*	*6.30*	*6.17*	*5.80*	*5.36*	*–13%*
Sub-bituminous coal	*3.93*	*3.70*	*3.63*	*3.51*	*3.56*	*–9%*
Brown lignite	**9.75**	**8.83**	**8.52**	**8.72**	**8.73**	**–10%**
Total[1]	**25.66**	**24.27**	**15.79**	**22.72**	**22.03**	**–15%**

1. May not add up due to rounding.

Source: Spanish Ministry of the Economy.

Table 23

Spanish Hard Coal Producers (end of 2003)

Annual production capacity by size	*Number of companies*	*Total annual production kt*	*Share of total production %*
< 25kt	12	155	1.2
25-50kt	4	181	1.4
50-100kt	9	688	5.5
100-500kt	9	1 813	14.4
> 500kt	7	9 747	77.5
Total	**41**	**12 584**	**100%**

Source: Country submission.

Coal subsidies and coal industry restructuring are subject to EU rules. The ECSC (European Coal and Steel Community) Treaty governing coal aid and restructuring expired in June 2002. The EU legislation regulating the granting of aids up to that date was Decision 3632/93/ECSC. Since the expiry of the treaty, state aid to the coal sector has been treated as general state aid according to EU rules. For clarification regarding state aid to the coal industry, Council Regulation (CE) 1407/2002, approved in June 2002, defines three types of aid. All aid is granted to companies but applies to specific production units:

- Aid to cover the difference between costs and income of companies that are set to close in 2007 at the latest (Aids for reduction in activity, Art. 4 of the regulation), and aid to cover differences between costs and income

in companies that are to maintain a minimum production that can guarantee access to coal reserves for security of supply reasons.

- Investment aid for companies that have never received aid to cover the difference between costs and income, given that both aids are incompatible (Aid to guarantee access to coal reserves, Art. 5).

- Aid to finance exceptional costs incurred in the closing of production units (Art. 7).

Spanish coal subsidies are paid in various forms. The most important is direct aid to support steam coal sales to private and public operators. In 2003, this aid totalled EUR 308m to private mine operators and EUR 96m to public operators. The public operator Hulleras del Norte SA (HUNOSA) will also receive an additional EUR 175m from the state enterprise participation organisation (SEPI) to cover the operating losses of the company. Further support was paid directly to workers taking early retirement and in coal vouchers[8] (EUR 199m altogether), transport from remote mines to power stations (EUR 3m), and the construction of storage facilities at mine-mouth power stations to enable storage of beyond 720 working hours (EUR 0.4m). Additionally, SEPI has created a fund of EUR 241m for supporting the early retirement of its workers. Total central government support to the coal industry in 2003 was, therefore, worth EUR 1 111m and stood almost unchanged from 1999.

For 2004, coal subsidies to support steam coal sales were EUR 543m, divided into aid for operation and reduction of activity which were budgeted at EUR 388m (General State Budget) and EUR 155m from SEPI funds, respectively. The support for early retirement of private industry was EUR 219m and SEPI's basic fund was EUR 282m for that year. Additionally, EUR 3m was earmarked for the support of coal transport between mines and power stations and EUR 8m for financing storage beyond 720 working hours in power stations.

There have been no funds available for investment aid to extend production capacity since 1996 and such aid would not be covered under the EU regulations (Decision 3632/93/ECSC). It is therefore only possible to indirectly estimate investment in coal extraction projects on the basis of auditing data from coal companies. This investment is estimated at EUR 90m in 2003.

The European Commission is still investigating Spanish subsidies for coal, blocking the Spanish government's dispersal of grants under the 2003-2005 coal plan.

8. Coal vouchers give a free amount of coal to workers and pensioners of mining companies, who can opt for a cash payment instead.

Economic Regeneration

Economic regeneration of coal-producing regions is important in the context of ongoing restructuring of the industry. Consequently, the remaining Spanish regulations concerning domestic coal production are solely concerning reactivation of mining districts:

- Law 66/1996, establishing the Institute for the Restructuring of Coal Mining and Alternative Development of Mining Districts.
- Royal Decree 2020/1997, which outlines the aid scheme for coal mining and alternative development of mining areas.
- Royal Decree 1561/1998 amending Royal Decree 2020/1997.

In 2003 the Spanish government approved various budgetary provisions concerning production aid under Articles 4 and 5 of Council Regulation (CE) 1407, as well as budgetary provisions for the activity of the Institute for the Restructuring of Coal Mining and Alternative Development of Mining Districts. The institute is distributing aid to support projects that can generate employment and promote alternative development of mining areas to reduce their dependence on mining.

To encourage a move away from mining, activities for the economic development of mining districts were undertaken by the institute. Agreements were signed between 1998 and 2002 with the Autonomous Regions for the development of a total of 671 projects at a cost of EUR 1.7bn, 75% of this investment was aimed at infrastructure development, while the rest was distributed among projects creating business parks, supporting urban planning, environmental improvement and the creation of training centres. So far EUR 1.1bn has been disbursed for these projects.

Between 1998 and 2002, financial support was also granted to 860 private projects which are expected to generate 13 149 new jobs involving an investment of EUR 2.7bn with public support of EUR 419m. The total 2004 budget for restructuring measures was EUR 115m for financing the alternative development of coal mining districts and EUR 426m for infrastructure development.

CRITIQUE

Domestic coal production was developed during the 1970s and 1980s to increase Spanish security of supply and reduce the dependence on oil imports following the oil crises. Quality problems and cost of production due to the structure of Spanish hard coal deposits have combined to make Spanish coal uncompetitive compared to imported coal. It is unlikely that recent price increases for coal on the world markets will change that situation.

With the next phase of the implementation of the EU Large Combustion Plant Directive and with the relatively low allocation of CO_2 emissions allowances to coal-fired stations in the National Allocation Plan, published in October 2004, the future for the comparatively high-sulphur/low calorific value Spanish coal is looking increasingly uncertain. While Spanish power producers are still obliged to support the domestic industry under the quota system running to 2005, it remains to be seen whether this support will continue once these environmental constraints become effective. Acceleration in the transformation of the mining regions should, therefore, be considered, even if the plan for the construction of a new 800 MW coal-fired power station in Asturias should come to fruition.

Spanish coal production was further reduced between 2000 and 2004, in line with the number of miners leaving the industry, mostly as a consequence of low retirement age. Significant investment is expended to attempt to restructure the affected areas economically. Because of the importance of coal mining in the already depressed areas of central and northern Spain, the government sees coal issues primarily in terms of a social, and not an environmental problem.

Subsidies to the sector are not reducing in line with the reduction in capacity and employment. This raises the cost per unit of domestic production to the Spanish taxpayer. The Spanish government is paying significant amounts of support to encourage the development of alternative economic structures in the mining regions. Close evaluation of the effect of this spending and an exchange of experiences with other countries in a similar situation, *e.g.* Germany and the UK, could help to achieve better results from the money spent.

RECOMMENDATION

The government of Spain should:

- *Continue to reduce the subsidy to the coal sector, and at the same time accelerate investment into the regeneration and economic change of regions affected by reductions in mining in order to reduce the welfare and regional impacts.*

SUPPLY

Spain has made a strong effort to develop renewables production over recent years and is now one of the world leaders in electricity production from wind. Spanish renewables policy is driven by EU policy and a desire to diversify Spain's energy sources and reduce import dependence. The policy is widely supported by the society and all major utilities are investing in renewables production, with Iberdrola being a world leader. The significant home market for wind generation has supported the development of a company, GAMESA, capable of operating and competing internationally.

Spain has a significant number of large hydro installations[9] that contribute to electricity production in a variable manner, depending on rainfall during the winter. Additionally, there are plans to expand renewables production from other sources, such as small hydro sites, biomass and solar. Spain has considerable renewables potential, primarily for the production of electricity and biofuels. Renewable heat production is restricted in its potential owing to the low heating requirements of Spanish homes and the already high penetration of CHP into the Spanish industrial heat and steam market.

Hydropower dominates renewable electricity generation in Spain. Total renewables production is therefore considerably influenced by the replenishment of water in the reservoirs. Even in dry years, and excluding pumped storage, hydro provides almost two-thirds of the total renewables production. In recent years wind power has grown in importance. In 2003 it generated an estimated 11.5 TWh of electricity, or 20% of total renewables production. Expansion of wind power generation is continuing unabated, on the back of a generous promotion system with direct investment support, capacity payments and a feed-in tariff.

In 2003 the installed renewable electricity generating capacity increased by 1 507 MW, primarily through wind generation. The delivered thermal renewable energy for final uses increased by 108 ktoe and the overall contribution of renewables to TPES stood at 6.9% – higher than in previous years: 5.6% in 1999 and 2000, 6.6% in 2001 and 5.4% in 2002 – because of new capacity added in wind generation and high water availability in 2003.

Overall, the strong growth in renewables generation is having less of an impact than might be expected in view of the continually increasing demand for electricity in Spain.

9. In this review, all references to hydro, or total renewables production, exclude pumped storage.

Table 24

Incremental Installed Capacity of Renewables, 1999 to 2003

Technology	*Unit*	*1999*	*2000*	*2001*	*2002*	*2003*	*Total*	*2006 Obj.*
Micro-hydro	MW	36	43	42	37	55	212	48%
Hydro	MW	0	0	20	0	0	20	10%
Wind	MW	642	815	984	1 615	1 344	5 401	113%
Biomass	MW	6	3	20	115	44	187	23%
Biogas	MW	12	5	5	18	52	91	265%
Solar PV	MWp	1	2	4	5	7	19	30%
Biofuels	ktoe	0	51	0	70	63	184	74%
Solar thermal	m^2	22 716	41 565	56 510	65 101	83 272	269 164	18%

Source: Country submission.

GOVERNMENT POLICY

PLAN FOR THE PROMOTION OF RENEWABLE ENERGY (2000-2010)

The government has detailed targets for the introduction of renewable energy. The current plan came into force on 30 December 1999, and is called the Plan for the Promotion of Renewable Energy in Spain (2000-2010). It established that renewables should contribute 12% to the total primary energy supply by 2010 and that 29% of electricity should be generated from renewables, in line with the requirements of EU Directive 2001/77/EC. The plan also established a monitoring system that is supposed to guarantee the control, quality and efficiency of its implementation. Monitoring is part of the activities of the Institute for Energy Diversification and Saving (IDAE).

The plan is divided into two stages, one running from 1999 to 2006, and a second stage running from 2006 to 2010. It covers all forms of renewables, giving them sectoral targets. Up to the end of 2003, the plan has only been partially successful. Since it was set up, renewables have significantly advanced in Spain, with an annual increase of about two million toe produced from renewables, but the overall growth is below that required to attain the very ambitious objectives of the plan and is also uneven in terms of sectoral development. By the end of 2003, around 42% of the overall objective of the plan for the period 1999-2006 has been covered, and 21% of the overall growth objective up to the end of the plan in 2010, although these figures hide considerable differences between technologies.

Renewables production in Spain is well monitored. The latest available monitoring data reach to the end of 2003. On the basis of these data and the associated financial information, IDAE produces a summary for monitoring

the plan: energy data, investments and public support for projects set up between 1999 and 2003. IDAE also conducts an analysis of projects carried out each year, and those carried out in total since the plan came into force to establish performance in each target area compared to the plan's targets. Monitoring by IDAE covers the period 1999-2003, including projects begun before or during the preparation of the plan. Because of this, different financial support criteria applied to earlier projects.

Growth in renewables production in 2003 reached 588 ktoe and was lower than in 2002. This amounted to 12.2% of the objective for the period 1999-2006. In finance terms, investment by 2003 reached 14.9% of the total amount planned for the period 1999 to 2006. Public support accounted for 2.5% of spending for that period. This figure excludes support from feed-in tariff payments or aids to investment in accompanying measures. The total achievement towards the aims of the promotion plan up to 2006 in the period 1999-2003 was:

- 42.2% of delivered energy.
- 58.9% of total financial investment.
- 10.2% of public support (only counting support to investment in production facilities, not including premiums, tax incentives or aids to investment in accompanying measures).

IDAE summarises the performance of different renewable energy sources as follows:

Wind

Wind energy continues to show the strongest and most significant growth, with around 1 350 MW of new generating capacity added in 2003[10] and 1 920 MW added in 2004. This was in line with the planning for the electricity and gas sectors for 2011, which forecasts a total installed wind power capacity of 13 000 MW in 2011. At the end of 2004, 90% of the objectives stated for the year 2010 in the plan and 60% of the objectives in the "Planning of Infrastructures for Electricity and Gas 2002-2011" had been met. Wind is very clearly the success story of the plan, achieved with considerable financial support.

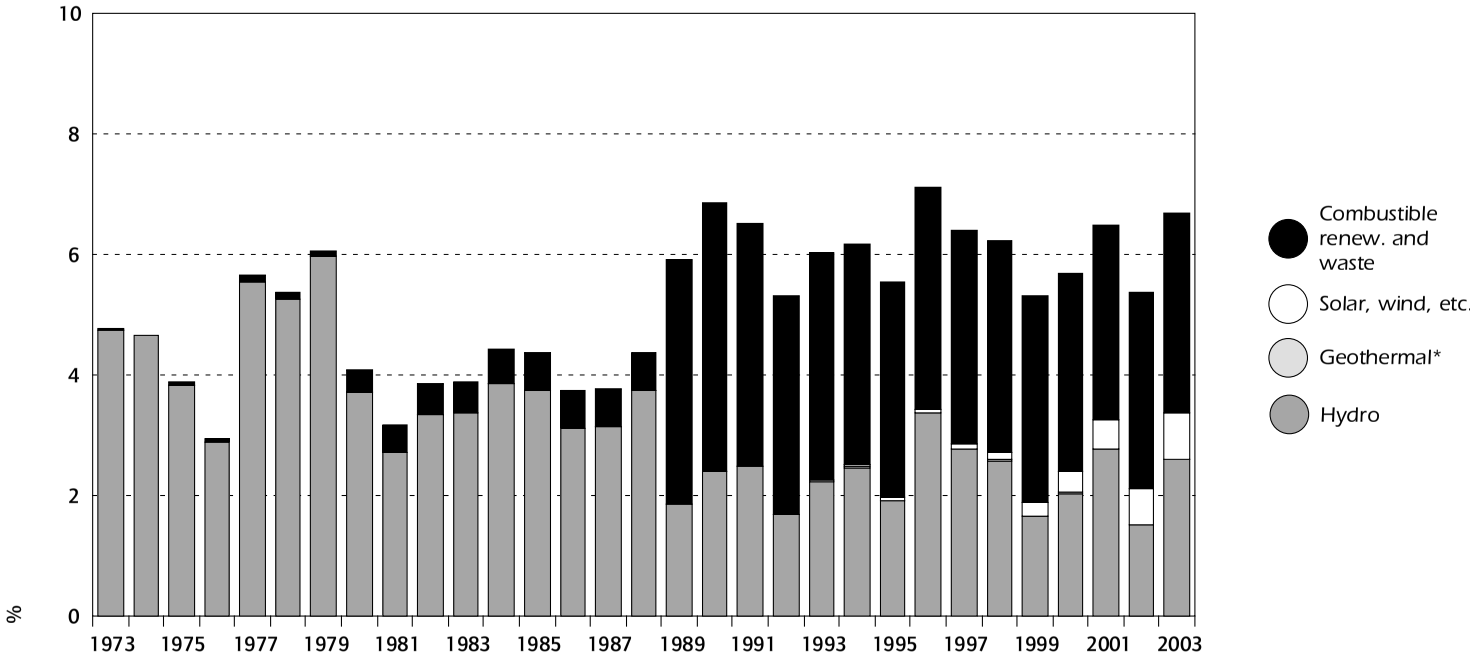
Hydro

Since the plan was implemented, the micro-hydro sector (installations with a generating capacity below 10 MW) has advanced more slowly than was required for it to achieve the plan's targets. Hydroelectric stations with a capacity from 10 to 50 MW have also performed below expectations,

10. This is a lower figure than the previous year which, with something more than 1 600 MW, registered the maximum new capacity installed.

Figure 25

Renewable Energy as a Percentage of Total Primary Energy Supply in Spain, 1973 to 2003

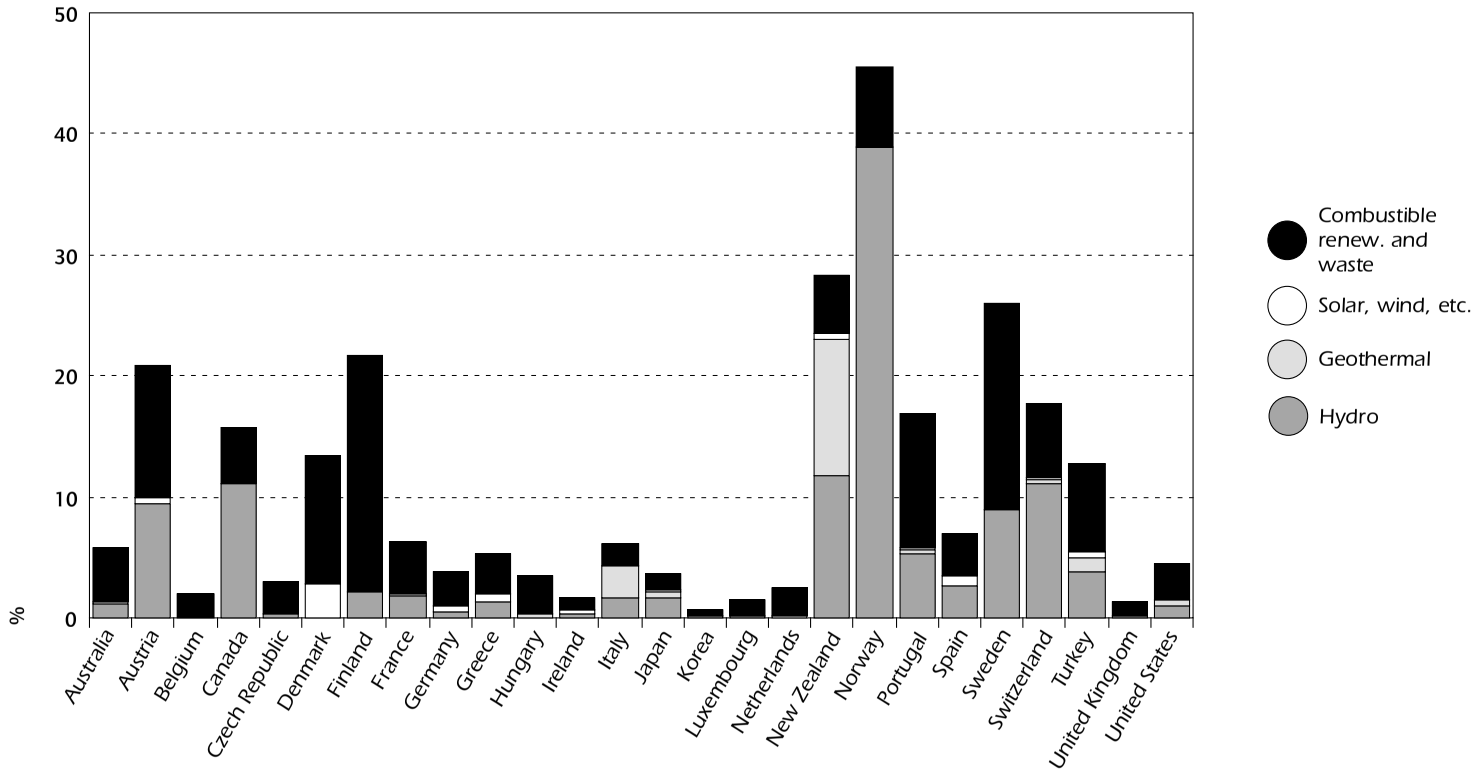


* negligible.

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

Figure 26

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Countries, 2003



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

although the targets for these were quite low. With the installation of around 55 MW in new plants, 2003 showed the strongest growth in terms of micro-hydro since the approval of the plan. By the end of 2003, 48.4% of the energy objectives were achieved and 34.8% of investment objectives for 2006. In 2004 an additional 68 MW has been installed in hydro, 49 MW of this in small hydro (less than 10 MW), which means that in 2004, 33% of the objectives set in the promotion plan for 2010 were attained.

Solar

Solar water heating and solar photovoltaic power generation also saw an increase in 2003, but growth is still much lower than necessary to reach the aims of the plan, especially in solar thermal. In 2003 only 80 000 m^2 of solar water heating was installed and the achievement up to the end of last year stands at 18.5% with respect to the forecasts of the promoting plan for the period 1999-2006. In 2004, 90 000 m^2 were installed which means that at the end of 2004, 8% of the objectives fixed by the plan had been achieved. Nevertheless, for solar water heating the number of projects carried out may be higher than recorded because the evaluation only covers installations that have received public funding. Furthermore, the new regulations governing the obligatory installation of solar systems in many new and refurbished buildings will lead to a significant increase in facilities of this type over the coming years if the Technical Building Code[11] is implemented in its current form. The main effect is expected in the area of solar thermal energy. In 2004 an additional 10 MWp has been installed which means that at the end of 2004, 21% of the increase aimed at by the plan had been achieved.

Solar photovoltaics benefit from increased feed-in tariffs in the new legislation of 2004. By the end of 2003, 30.4% of the objective of the plan for 2006 had been achieved, *i.e.* an installed capacity of 18.6 MWp. Thanks to the increased premiums and the changes to the building code, it is now assumed that the installations of solar photovoltaic power will increase.

Interestingly, Spain has established high targets for solar thermoelectric energy, although no commercial installations have so far been planned. The government hopes that increased support available through the most recent legislation will bring this technology forward. The first commercial PS-100 Plant will enter into operation in 2006.

Biomass, Biogas, and Biofuels

The growth objective for biomass, which is the central element of the plan, is 6 000 ktoe by 2010[12] (5 100 ktoe in electrical applications and 900 ktoe in thermal applications), an objective which is significantly increased for 2011 in

11. The second draft of the Technical Building Code is currently going through the administrative process for approval.
12. And somewhat less than half that (2 886 ktoe) for 2006.

the planning of the electricity and gas sectors. Between 1999 and the end of 2004, only 158 ktoe (18% of the objective of the promotion plan for 2010) had been achieved for thermal uses and less than 8% of the total objective of biomass for electric uses established in the Infrastructure Plan 2002-2011.

Biomass for electrical and thermal applications is failing in comparison to the ambitious targets that were set. Spain has a good resource for biomass from the agricultural sector. Some biomass is exported to the UK, where biomass co-firing in old coal-fired power stations is very popular. The Spanish government is now looking at ways to increase the use of biomass for power generation and is encouraging power generators to explore co-firing.

Over the past year, the biogas sector experienced a level of growth very much higher than that of previous years, with the coming on stream of several facilities which, in terms of electricity generating capacity, meant the commissioning of 52 MW of new capacity, a figure that far exceeds the growth objective established by the plan for the entire period 1999-2006. At the end of 2003, biogas had exceeded its energy objective for 2006 by 250% – slightly more in installed electrical capacity – and 110% of that envisaged throughout the entire life of the plan to 2010.

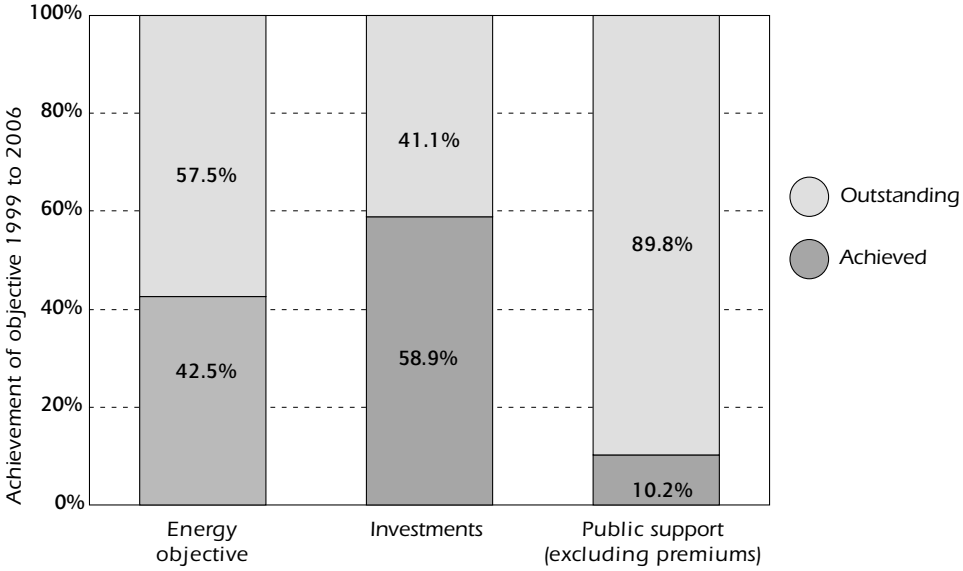
The development of biofuels is continuing at a satisfactory level compared to the plan as described above. Two new biodiesel plants were brought into service in 2003, with a production capacity of 18 and 45 ktoe, respectively, which means that over the last year, 25.2% of the energy objective of the plan for 2006 was covered, whilst the accumulated compliance at the end of 2003 was 73.6% of the 2006 objective. At the end of 2004, eight facilities were operational, with a production capacity of 180 000 tonnes of bioethanol and 125 800 tonnes of biodiesel. Therefore, 46% of the goal devised in the promotion plan for 2010 has already been met.

This strong performance will, however, not be sufficient to achieve the far more ambitious goals set in EU Directive 2003/30/CE, which has so far not been transposed into the Spanish plan. For the year 2010, the Spanish plan aims for biofuel consumption to stand at 500 ktoe per year [13]. The directive on the promotion of the use of biofuels or other renewable fuels in transport lays down a series of indicative objectives for 2010, representing 5.75% of all the gasoline and diesel sold for transport. In Spain this would mean a consumption of biofuels in 2010 of ~2 000 ktoe. The Spanish government assumes that this goal can be reached. The success of recent developments and the legal approval[14], at the end of 2002, of zero taxation on biofuels in the special hydrocarbons tax up to 2012, are the basis for this optimism.

13. When the plan was approved, its use in Spain was limited to a few pilot experiences in buses.
14. Law 53/2002 on Tax, Administrative and Social Order measures.

Figure 27

Comparison of Achievement by 2003 of the Plan for the Promotion of Renewable Energy to 2006 Targets



Source: Country submission.

SUPPORT MECHANISMS FOR RENEWABLE ENERGIES

Renewable energy is supported in various ways by the Spanish government. The most important support for the investment in renewables is the system of premiums and prices set[15] for the generation of electricity from renewable sources. This represents half the total support dedicated to renewables up to 2006. Additionally, the promotion plan allocates EUR 987m in tax incentives up to 2006 and EUR 202m in investment support in accompanying measures such as support for investment in capital assets, infrastructure, promotion and follow-up. The monitoring data are currently restricted to investment support for production facilities. They also only partially address support for R&D.

Special Regime with Feed-in Tariff

Until 2004, all Spanish renewable electricity production was sold within the so-called "Special Regime", under which any generation had to be purchased by the network operator at a fixed price. This price is calculated by the

15. Regulated fees, according to the terminology of Royal Decree 436/2004, of 12 March.

government and contains a premium depending on the technology or fuel from which the electricity is generated. The regulated price is calculated on the basis of the market price. In future, this will create a problem when the cost of CO_2 is included in the market price. If the methodology is not changed, then renewable generators will be paid twice for their contribution to CO_2 emissions reduction.

The government can change the amount of the premium in an annual review. Table 25 contains the information on premiums by technology for the years 2000–2004. This gives the government the flexibility to amend price levels in order to support particular renewable energy technologies, or to reduce support for them. This flexibility has a price in increased uncertainty for the operators of renewable installations, and the renewables trade associations expressed their unhappiness with the reduction of the wind premium in 2003. The cost for supporting renewables through the Special Regime is recovered within the administrative tariffs (see Chapter 10 on Electricity).

Table 25

Feed-in Premium Tariff Levels[1] and Annual Change for Selected Technologies, 2000 to 2004

(in eurocents/kWh generated)

Technology	*2001*	*2002*	*2003*	*2004*	*2001/02 % change*	*2002/03 % change*	*2003/04 % change*
Solar PV <5 kWp	36.0607	36.0607	36.0607	36.0607	0	0	0
Solar PV >5 kWp	18.0304	18.0304	18.0304	18.0304	0	0	0
Wind	2.8788	2.8969	2.6640	2.6640	0.63	–8.04	0
Mini-hydro <10 MW	2.9870	3.0051	2.9464	2.9464	0.60	–1.95	0
Hydro >10 <50 MW	2.9870	3.0051	2.9464	2.9464	0.60	–1.95	0
Primary biomass	2.7707	2.7887	3.3250	3.3250	0.65	19.23	0
Secondary biomass	2.5603	2.5783	2.5136	2.5136	0.70	–2.51	0

1. The premium is paid in addition to the administrative price per kWh. The information given in Table 26 shows the total subsidy, combining the premium and the regulated price.

Source: Country submission.

New Mechanism with Premium

A significant change in the support methodology came with the passing of Royal Decree 436/2004, published in the *Official Journal of the State* of 27 March 2004. This establishes a new methodology for updating and systematising the legal and financial regime of the Special Regime. Under the new decree, the owner of a renewable generator can choose to receive the feed-in price when selling all surplus electricity to the network operator or can sell surplus electricity through the electricity market at a premium price. In the case of sale to the distributor, the owner of the installation receives a set payment which is defined as a percentage of the average or reference electrical rate regulated in Royal Decree 1436/2002, and this is, therefore, indirectly based on the wholesale market price. Should the owner of the installation decide to sell his surplus production directly into the market, he will receive the negotiated market price, plus an incentive for taking part in the market, together with a premium, if the installation is entitled to receive one. This incentive and this complementary premium are defined as a percentage of the average or reference electricity rate and are established on a case-by-case basis. Table 26 compares the 2004 feed-in premium support with the new market-based support. Generators opting for the market have the ability to revert back to the old system. Whichever system they choose, they have to stay in it for one year.

Taxation

The taxation system for renewables was updated throughout 2003, with the approval on 13 March 2005 of Royal Decree 436/2004 establishing a new legal and financial framework for renewables in the Special Regime.

Direct Support

The other main pillar supporting the development of renewables is the direct support with public funds. The ICO-IDAE financing line became available once again in 2003, complementing previously existing programmes of support for solar energy. Other support mechanisms are tax incentives, new building regulations, the PROFIT programme relating to renewables RD&D and the EU support lines of the 6th Framework Programme. The public subsidies are oriented to the interest rates and are divided into two fields: renewable energy projects and efficiency projects. For 2003, the figures are EUR 15.29m for renewables and EUR 3.5m for efficiency. The budgets for 2004 are not yet totally assessed but the amounts are nearly three times those of 2003. The subsidy has led to private investment of about five times the subsidy volume.

Table 26

Changes from the Special Regime to the Market Incentive, 2004

(in eurocents/kWh generated)

Special Regime				*Market participation*				
Technology	*Tariff*	*Premium*	*Total price*	*Technology*	*Tariff*	*Premium*	*Incentive*	*Total price*
Micro-hydro <10 MW	6.4909	2.9464	9.4373	Micro-hydro <25 MW	6.4865	2.8829	0.7207	10.0901
Hydro 10-50 MW		2.9464	2.9464	Hydro 25-50 MW	5.7658	2.1622	0.7207	8.6487
Wind	6.2145	2.664	8.8785	Wind (on/offshore)	6.4865	2.8829	0.7207	10.0901
Primary biomass	6.8575	3.325	10.1825	Biomass (primary, biogas, forestry residues)	6.4865	2.8829	0.7207	10.0901
Secondary biomass	6.0582	2.5136	8.5718	Biomass (industrial, agricultural, forestry industry residues)	6.4865	2.8829	0.7207	10.0901
Solar PV	39.6668	36.0607	75.7275	Solar PV <100 kWp	41.4414			41.4414
Solar PV >5 kWp	21.6364	18.0304	39.6668	Solar PV >100 kWp	21.6216	18.018	0.7207	40.3603

Source: Country submission.

CRITIQUE

Spain has ambitious targets on renewable energy: increasing its share in TPES to 12% in 2010 and increasing its share in electricity generation to 29.4% in 2010 (indicative target for Spain mentioned in the EU directive). To achieve this target, Spain has set up the 2000-2010 Plan for the Promotion of Renewable Energy. This plan is based on a complex set of support mechanisms and has technology-specific targets.

In the past, the differentiated and fixed feed-in tariff has been the primary tool to promote renewable energies and has been instrumental in expanding renewable energy, in particular wind energy. In 2004, the government introduced a new regime where the renewable energy producers can directly sell their power to the market and receive the average market price plus differentiated premiums (variable percentage of the average market price). The intention of the new system is to be commended as a first step to incorporate a market-based element into the support framework.

Despite this change, care should be taken by the Spanish government to ensure that the whole system to promote renewables is cost-effective in achieving its goals. The current support system does not have a strong incentive for cost reduction because the premium will be reviewed only once in four years. With the strong growth in renewables, it may become difficult for the government to introduce tariff reductions in the future. It would, therefore, be preferable to outline feed-in tariffs over the long term, giving producers security for their investments. In such a system, the technology learning curve should be appropriately incorporated in the feed-in tariff and the market premium.

There is also a concern that the overall cost to promote renewables will increase under the new scheme. To encourage producers to move to the new system, they will receive an additional incentive on top of the premium and they have a choice to go back to the old regime whenever they judge it to be more profitable. This is a safety cushion for the producers who may be afraid of increased risk. However, this could reduce the opportunities for cost reduction if the market price falls, because then producers could switch back to the old system. This opportunity for maximising the income by playing off the different support schemes should be eliminated.

The feed-in tariff or premium scheme should apply only for a predetermined period in the case of new installations. Guaranteeing prices without a time limit could result in the over-subsidisation of existing projects after these have been amortised.

Renewable energy projects in Spain are supported by a number of subsidy schemes and tax incentives and will also gain benefits from the EU Emissions Trading Scheme (ETS). Consolidation of these support schemes for renewable energy projects in the electricity sector should be considered to reduce costs to the electricity users and the State. In particular, care should be taken that co-existence of the EU-ETS and the feed-in tariff or premium scheme will not result in the double counting of carbon value and over-subsidisation for renewable energy projects.

It should also be considered that the renewable promotion scheme should be as compatible as possible with the liberalised electricity market. In this regard, in the mid- to longer-term perspective, a more market-oriented approach, such as a quota obligation with a green certificates trading system, could be explored to achieve the national target. While this system is still relatively new, the experience accumulated in other countries so far could be studied.

Rapid growth of intermittent wind power could have a significant impact on the stability of grid and optimal operation of baseload power capacity. Such an impact has cost implications (*e.g.* necessary expansion of the transmission system) that should be thoroughly analysed. Ways to mitigate such an impact through research and development should be explored. A more market-oriented approach in electricity trading of renewable electricity and network

development for all additional generation could help address this issue more effectively by giving the right incentives to the developers of renewables.

In clear contrast to wind power, the introduction of biomass is far behind the target set in the government plan. Given that the major bottleneck appears to be the collection and transport of biomass, which is beyond the scope of policies coping with the electricity sector, closer co-operation among municipalities, regional governments and relevant ministries, in particular the Ministry of Agriculture, is essential. Due attention should also be paid to the availability of biomass resources for biofuel.

While the focus of the government plan for the introduction of biofuels in Spain is on bioethanol to add to gasoline, this may not be the most economically beneficial form of biofuel production because Spain is already a net exporter of gasoline. There are also concerns about the quality of some forms of biodiesel available in Spain and it will be important to accompany the increased production of biodiesel with stringent quality controls to ensure that consumers do not reject the product. The high production cost of biofuels and the availability of land for farming them are further concerns.

The planned obligation in the new Building Code to make the installation of solar water heating systems mandatory in new buildings and at the time of major refurbishment is commendable.

RECOMMENDATIONS

The government of Spain should:

- *Increase the transparency of the costs and benefits of the current renewables support system.*
- *Review the current scheme in order to assure cost-effectiveness while ensuring investor confidence with a view to reflecting the technology learning curve. Consider limiting the duration of the subsidy.*
- *Avoid hopping back and forth between old and new schemes.*
- *Eliminate possible double counting of carbon value between EU-ETS and renewable energy promotion schemes.*
- *Consider and investigate more market-oriented mechanisms different from feed-in tariffs, taking into account other countries' experiences.*
- *Investigate the requirements of reliability and stability of the electricity network, given the significant increase of wind power on the grid.*
- *Identify the barriers to the increased use of biomass and address them in close co-operation with local governments and relevant ministries, in particular the Ministry of Agriculture. Due attention should also be paid to the potential available for the use of biofuels in transport.*

OVERVIEW

POLICY FRAMEWORK

Market Reform

Spain was one of the first IEA member countries to embark on an electricity market liberalisation process in 1998. The Electric Power Act (Royal Decree 54) of 27 November 1997 transposed the 1996 EU market directive into Spanish law. The path towards liberalisation has been ahead of the EU market directive schedule on many accounts, *e.g.* in opening all market sectors to competition, or in legal unbundling, and the introduction of a regulator, the National Energy Commission (CNE).

The eligibility has been phased in starting with the largest consumers using more than 15 GWh/year in 1998. From 1999 consumers with consumption higher than 5 GWh/year have been eligible and during 1999 and 2000 the threshold was lowered in four more steps. Since 1 January 2003 all electricity consumers in Spain have been free to choose their electricity supplier.

Unbundling of transmission system operation was already achieved in 1985 by the formation of the transmission system operator, Red Electrica de España (REE). The Spanish government still owns 28.5% of the shares in REE, and there are now plans to reduce this further. Four of the major utilities own 8% of the REE shares, and the remainder is freely floated on the Spanish stock exchange. REE operates the transmission system and owns almost the entire 400 kilovolt (kV) grid and two-thirds of the 220 kV grid. The Electricity Act also regulates the activities of the market operator, OMEL (Compañia Operadora del Mercado Español de Electricidad), which also has a wide range of owners.

Distribution grids are required by law to be legally unbundled from other activities, but a holding company can own distribution, retail and generation companies at the same time. The major part of the distribution grid is owned by large utilities that also own generation and retail businesses and, in the case of Endesa, coal mining operations.

Stranded Costs

Prior to liberalisation, maximum prices for utilities were regulated through detailed cost calculations. The calculations were based on technology, fuel, lifetime, etc. for each specific plant.

Spanish utilities and the government signed an agreement in December 1996 that set the framework for a development towards a liberalised electricity industry. Utilities accepted that the liberalisation would reduce the companies' revenues compared to the regulated costs and that the market opening would take place faster than was required by the EU market directive. On the other hand, they were given a compensation for stranded costs called costs of transition to competition (CTC).

Costs of Transition to Competition

The CTCs are calculated as the difference between the calculated costs and the expected revenues in the market, where the revenues from the market are set at a fixed reference of 6 pesetas/kWh (approximately 3.6 eurocents/kWh. The total amount of CTC was approximately EUR 8.7 billion to be collected from 1 January 1998 over a maximum period of 13 years, of which a share is related to compensation for the purchase of domestic coal. The government establishes an annual rate for CTCs. In doing so, average annual revenues from the market in excess of the 3.6 cEUR/kWh will be deducted from the annual CTC rate. The argument is that at market prices above 3.6 cEUR/kWh, all costs are indeed recovered in the market.

The CTCs are allocated to the generators depending on the generation assets that they possess, in the same way as had been done before in the calculation of generation costs. The consequences of this formula are that *e.g.* Iberdrola has already recovered a relatively large share of the CTCs that it is entitled to, and Endesa has recovered a relatively low share. The relationship between the share of a company's CTC entitlement and the same company's overall market share has a strong influence on how the spot price is perceived by that company. A company with a relatively high CTC entitlement will have an interest in an annual average spot price as close to the reference market price of 3.6 eurocents/kWh as possible.

Only generators who are not eligible for CTCs, or those with low CTC entitlements, will benefit from average yearly revenues in excess of 3.6 cEUR/kWh in the market. This may create very strong distortions to the market price.

The CTCs are collected from the consumers as part of the access tariffs or the integrated regulated tariffs. After the 7th yearly settlement of the CTC payments, some 57% of the total costs had been paid and correspondingly 43% still remained to be paid.

The European Commission started to investigate the legality of the CTC in 1999 from the point of view that it may be state aid. The CTC was then approved by the European Commission in July 2001 after the amount was lowered from EUR 10.2 billion. The period of uncertainty of the legality of the CTC coincided with the period where wholesale spot prices at OMEL were significantly higher than the average since liberalisation.

White Paper on Electricity Market Reform

A panel of academic experts has been commissioned by the Spanish government to produce a white paper on the reform of the Spanish electricity market. In the current situation, the market price is not sufficiently used as a signal by consumers and producers to achieve overall efficiency in the Spanish electricity sector. The white paper will explore all the barriers affecting the passing of the price signal through the entire value chain. Some of the issues that will be addressed are the integrated regulated tariffs, the costs of transition to competition (CTC – payments for cost that became stranded at liberalisation), the capacity payments and the need for the introduction of locational price signals. The analysis and proposed reforms will also relate to the establishment of the Iberian energy (or electricity) market, MIBEL. The panel is expected to present the white paper in the summer of 2005.

Governance and Regulatory Arrangement

The Ministry of Industry, Tourism and Trade has the task of establishing the rules and regulations for market design and operation in order to carry out the regulation of system operation and regulated activities. The ministry also has the responsibility for transmission system planning.

Regulatory approval and permits for the construction of generation, transmission and distribution facilities are a matter for the autonomous regional and local authorities where they take place solely within a region. The Ministry of Industry, Tourism and Trade has the regulatory responsibility in cases where new transmission and distribution lines cross regional borders. The process of approval of new electricity plants and transmission lines is complex in order to ensure a proper democratic process with involvement of all the affected parties.

The National Energy Commission (CNE) has primarily a consultative role, but has strong powers allowing it to request information from market actors. It provides the ministry with reports as input into the regulation and system

planning processes. The CNE Secretariat is well resourced and the procedure for appointing the governing commission as established by the law should also accommodate the professional and independent governance of the commission. Past appointments have been driven by politics, however, and this has led to conflict with the government, when the government changed. The limited direct role that CNE plays in regulation leaves most regulatory powers such as permitting, price-setting and market governance with the Ministry of Industry, Tourism and Trade. Consequently, CNE cannot be regarded as being a regulator independent of government policy-makers.

DEMAND, SUPPLY, TRANSMISSION AND TRADE

ELECTRICITY DEMAND

Electricity consumption in Spain has increased by an average yearly growth rate of 5.3% during the last decade and reached 239 TWh in 2003. This is one of the highest growth rates among IEA countries and it is mainly driven by the strong growth of the Spanish economy. The industrial sector's share of electricity consumption was 45% in 2002, a strong reduction from the 65% share it held in 1973. Electricity consumption in the commercial and public services sectors has been growing at more than 7% per annum in the last decade and the growth in residential consumption has been at the same level as the average growth rate; 13 TWh (5% of the total) was consumed on the Balearic and Canary Islands and in the Autonomous Cities of Ceuta and Melilla – the extra-peninsular regions where annual demand growth is reaching 8%.

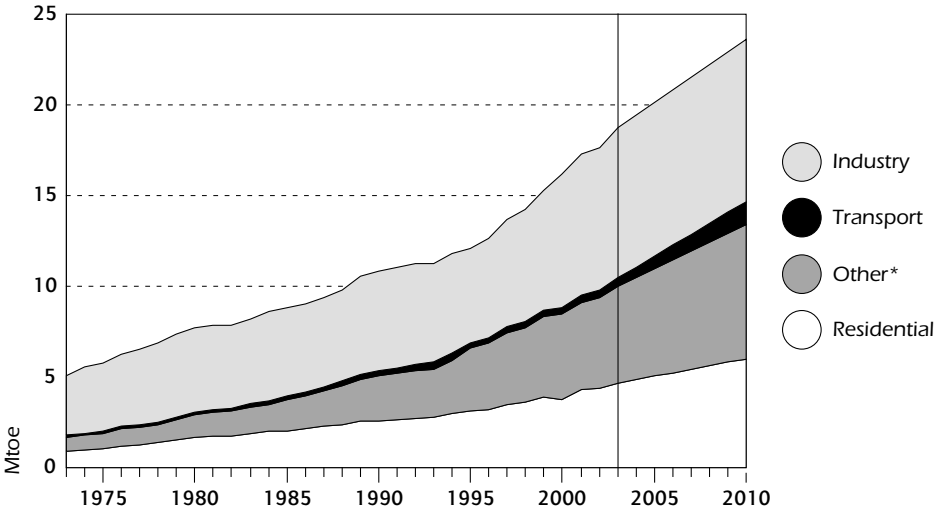
Electricity consumption is traditionally peaking during the winter. The maximum demand load on the mainland was recorded on 27 January 2005 with 43 708 MW. Peak load consumption has increased by an average of 4% per year from 1995 to 2004. Historically, peak load during summer periods has traditionally been below 90% of the winter peak. During the last 2 to 3 years, however, the summer peak has increased and in 2004 reached 96% of the winter peak. This is a development mainly driven by the increased use of air-conditioning.

ELECTRICITY SUPPLY

Spanish electricity demand is covered from a diverse range of generation sources; 263 TWh gross was generated in Spain in 2003 and 1 TWh was imported; 29.5% of the production was generated by coal, 24% by nuclear, 15.9% by hydro (including pumped storage), 15.3% by natural gas, 9.3% by fuel oil and the final 6.1% was generated by wind, biomass, waste and other

Figure 28

Final Consumption of Electricity by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

sources. In 1995 the shares were 41% for coal, 33% for nuclear, 14% for hydro, 9% for fuel oil, 2% for gas and the final 1% for wind, biomass, waste and other sources. The share of natural gas is increasing rapidly and is expected to continue to increase at an even higher rate for the next 10 years. The share of hydro generation can fluctuate significantly from year to year. 2002 was a relatively dry year so the share of hydro was only 9.5%. A large share of the power generation from fuel oil takes place in the extra-peninsular regions where this is a practical energy source considering their relative isolation. Plans for the construction of a CCGT on the Balearic Islands have now been submitted.

Generating capacity can be divided into two groups based on how it interacts with the competitive electricity market. Generators under the ordinary regime sell their production in the wholesale market. Generators receive remuneration for electricity sold in the market, plus a capacity payment for being available and CTC payments (see textbox above). The capacity payment depends on the declared availability of each specific plant. The eligible production capacity can receive a payment of 4.808 EUR/MWh. In 1998 and 1999 the capacity payment was 7.8 EUR/MWh and it was reduced to 6.9 EUR/MWh in 2000 before reaching the current level from 2001.

Production capacity from the Special Regime *(Regimen Especial)* receives remuneration from special support schemes and is not necessarily operated with consideration for the supply and demand balance in the market. Renewables and co-generation are primarily under the Special Regime (see Chapters 5 and 9 for more information). Co-generation receives a subsidy of 2.1276 cEUR/kWh for plants below 10 MW and 1.0638 cEUR/kWh for larger plants up to 25 MW (2003 figures). The subsidy is adjusted to the development of the price of gas on an annual basis. In 2003, 28% of the installed capacity was under the Special Regime, producing 15% of the gross generation output.

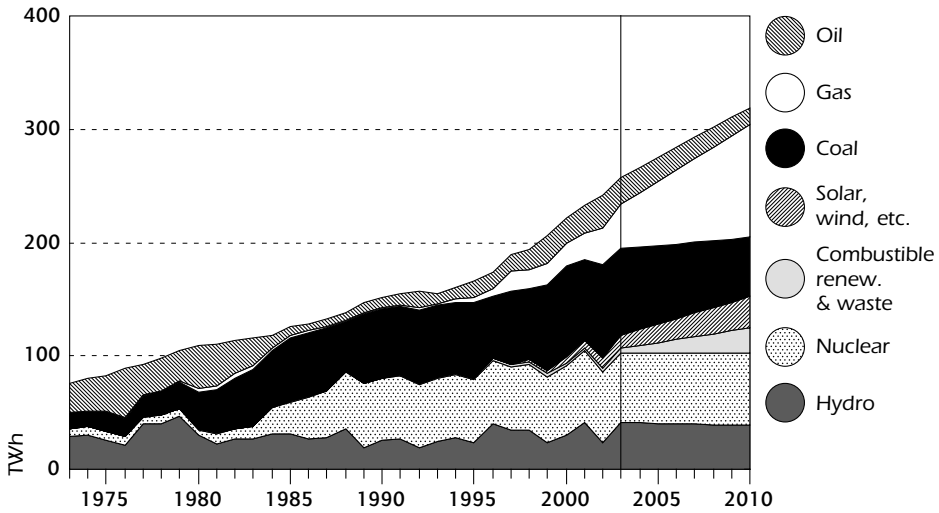
During the first years after liberalisation in 1998, almost the only new capacity to the generation pool that helped meet the increasing demand was added under the Special Regime: 4 676 MW was added from 1998 to 2001 of which 4 149 MW under the Special Regime. The increase in capacity additions under the Special Regime has continued mainly driven by an increase in wind capacity. At the end of 2004, there was 8 133 MW of installed wind capacity and more than half of this capacity has been added since 2001. The increase in installed wind capacity is expected to continue but REE has announced a physical connection limit for wind generation of 13 GW. At the end of 2004, it stood at 8.3 GW.

Since 2002, combined-cycle gas turbines (CCGT) have been commissioned at a very fast rate. Much of this capacity is being built by the smaller of the five largest companies and also by several newcomers. The natural gas company, Gas Natural, operates 1 600 MW of CCGT capacity in the peninsular system, with an additional 1 200 MW under construction and a further 2 000 MW undergoing the process of approval. This development is expected to continue and will be the driver for a shift to natural gas at the expense of coal. In 2005 an additional 5 300 MW of CCGT is expected to be commissioned, bringing the total installed capacity up to almost 16 GW. Investors have informed the Ministry of Industry, Tourism and Trade about plans to add up to 40 GW CCGT in total.

The Spanish electricity system is not so much constrained by generating capacity, but by the fluctuation of the power generation due to the significant share of hydro (25% of installed capacity on the peninsula). During the last five years, the installed hydro capacity has operated at an effective load factor of less than 20% of its theoretical capacity. Taking this into account, it is not surprising that the system was becoming constrained in 2000 and 2001 before the new CCGTs started to be commissioned. During the winter of 2004/05, a new system constraint has emerged in the Spanish electricity system. When technical problems occurred in the gas system, owing to insufficient gas storage, they led to supply problems to CCGT plants during periods with high electric and gas loads.

Figure 29

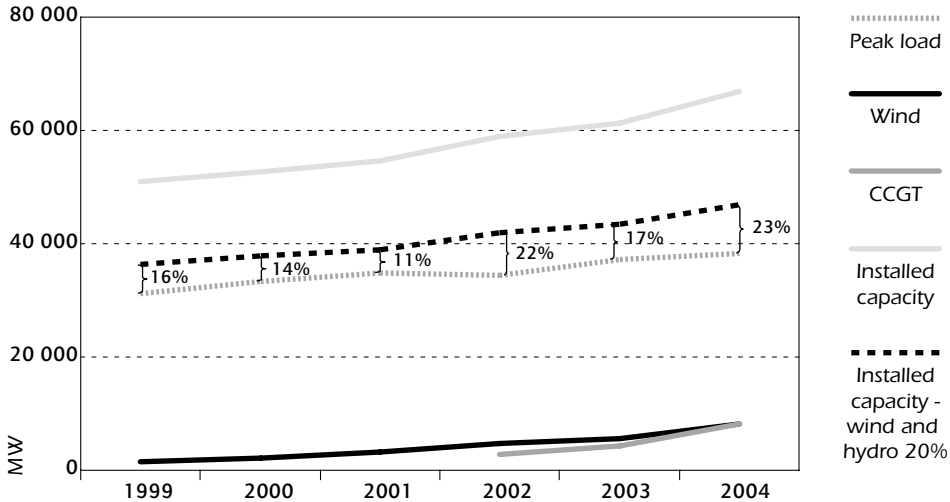
Electricity Generation by Source, 1973 to 2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005; and country submission.

Figure 30

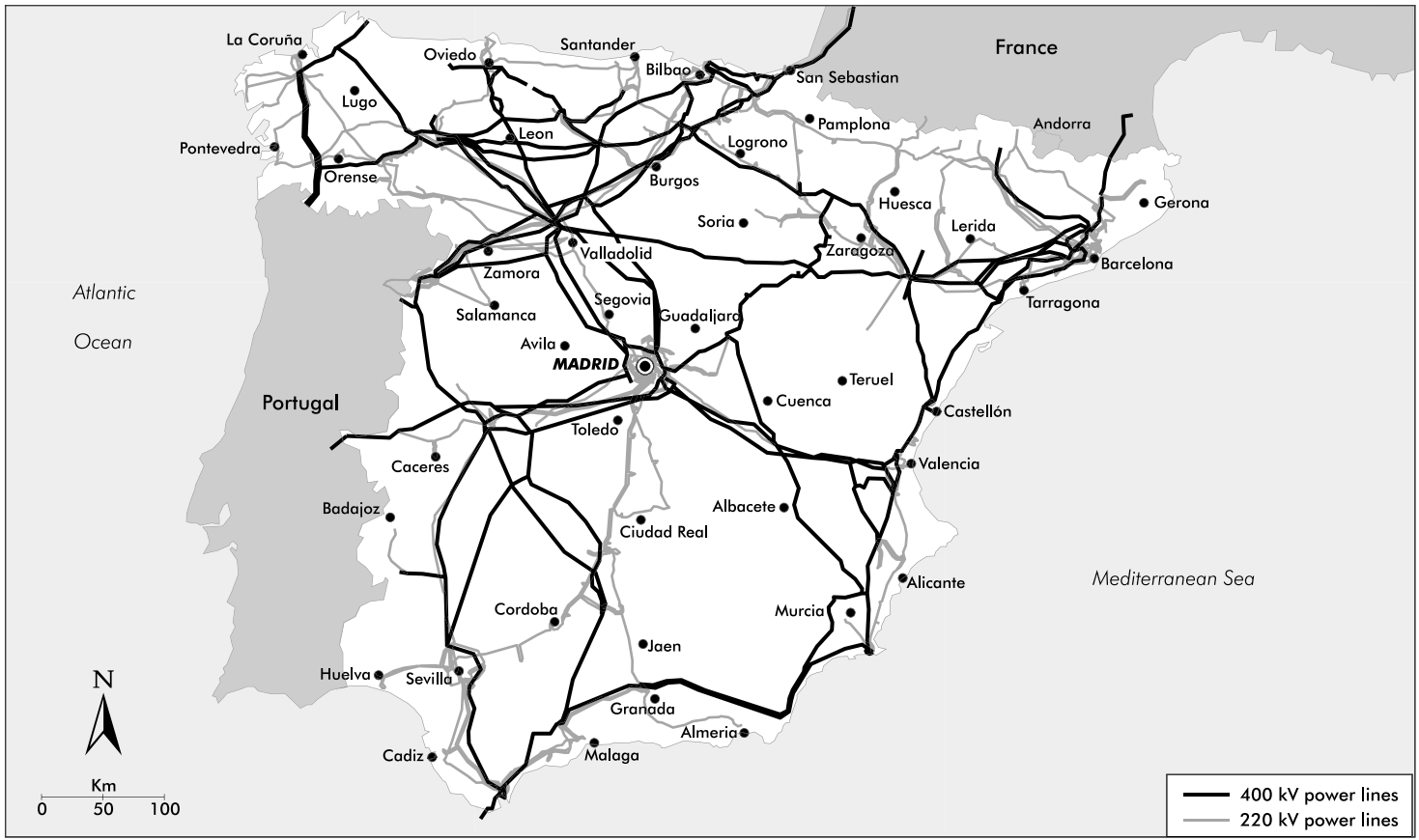
Installed Capacity and Peak Load, 1999 to 2004



Note: Peninsular system only; 2004 preliminary figures.
Source: REE.

Figure 31

The Spanish Electricity Transmission Network, 2004



Source: REE.

Table 27

Installed Capacity (31 December) and Peak Load, MW

	2003	*2004**
Hydro	16 658	16 658
Nuclear	7 876	7 876
Coal	12 075	12 075
Fuel oil/gas turbine	9 926	9 953
CCGT	4 394	8 259
TOTAL ordinary regime	**50 929**	**54 821**
Wind	5 491	8 133
Co-generation	5 600**	5 600**
Other special regime	2 951	2 012
TOTAL Special Regime	**14 042**	**15 745**
TOTAL	**64 971**	**70 566**
Of which:		
Islands	3 748	3 781
Peak load	37 212	38 210[1]

Cross-border Available Transmission Capacity, Maximum Values MW

	Current capacity	*Planned****
France – Import	1 400	+ 2 600
France – Export	800	
Portugal – Import	1 250	+ 2 000
Portugal – Export	1 400	
Morocco – Import	400	+ 700
Morocco – Export	400	

* Preliminary data, ** 2002. Sources: REE, Ministry of Industry, Tourism and Trade, IDAE,
*** Government announcement.

1. In February 2005 a new peak of 44.8 GW was reached.

Electricity Grid

Despite some well-publicised failures, transmission and distribution networks have been reliable with low levels of unserved energy since the beginning of the 1990s. There were problems with the reliability in 2001, where REE had to manage rolling disconnections on the distribution level. These events were related to the tightness of supply rather than to the quality of transmission and distribution services.

The transmission grid is strong and has been extended continuously. By the end of 2004, there were 16 831 km of 400 kV circuits and 16 417 km of 220 kV circuits. The extension of the 400 kV transmission system has been at 2-3% per annum over the last three decades. The largest share of the congestion that has been managed by OMEL in the market clearance has been in Andalucía in the south. Large shares of wind production take place in the north (Navarra, Aragón, La Rioja) and the north-west (Galicia). A relatively large share of other generating capacity is also located in the northern parts of Spain, so it will be a continuous issue to bring the production to the load centres, particularly with the expected increase in wind capacity. The Madrid area is the largest load centre but has very little generating capacity. This poses one of the specific challenges for the transmission grid.

Transmission is a regulated activity with costs determined on the basis of planned and approved investments, the development in demand, the availability of installations and an efficiency requirement.

Distribution is also regulated by a methodology that determines requirements of efficiency improvements and the development in demand. The only specific incentive that addresses the reliability and thereby the investments is a requirement to compensate consumers in case of disconnection. The size of the compensation is not related to a measure such as actual non-served energy multiplied by the assessed value of that energy – the "Value of Lost Load". The few weaknesses that have been observed in the reliability have been on the distribution side, which could suggest that the methodology needs a higher focus on quality and a better remuneration for efficient investment.

Electricity Trade

Spain has transmission interconnections with France, Portugal, Morocco and Andorra. The share of cross-border trade compared to total supply and demand is low. Spain has been a net importer since the introduction of

Table 28

Annual International Trade Balance in GWh

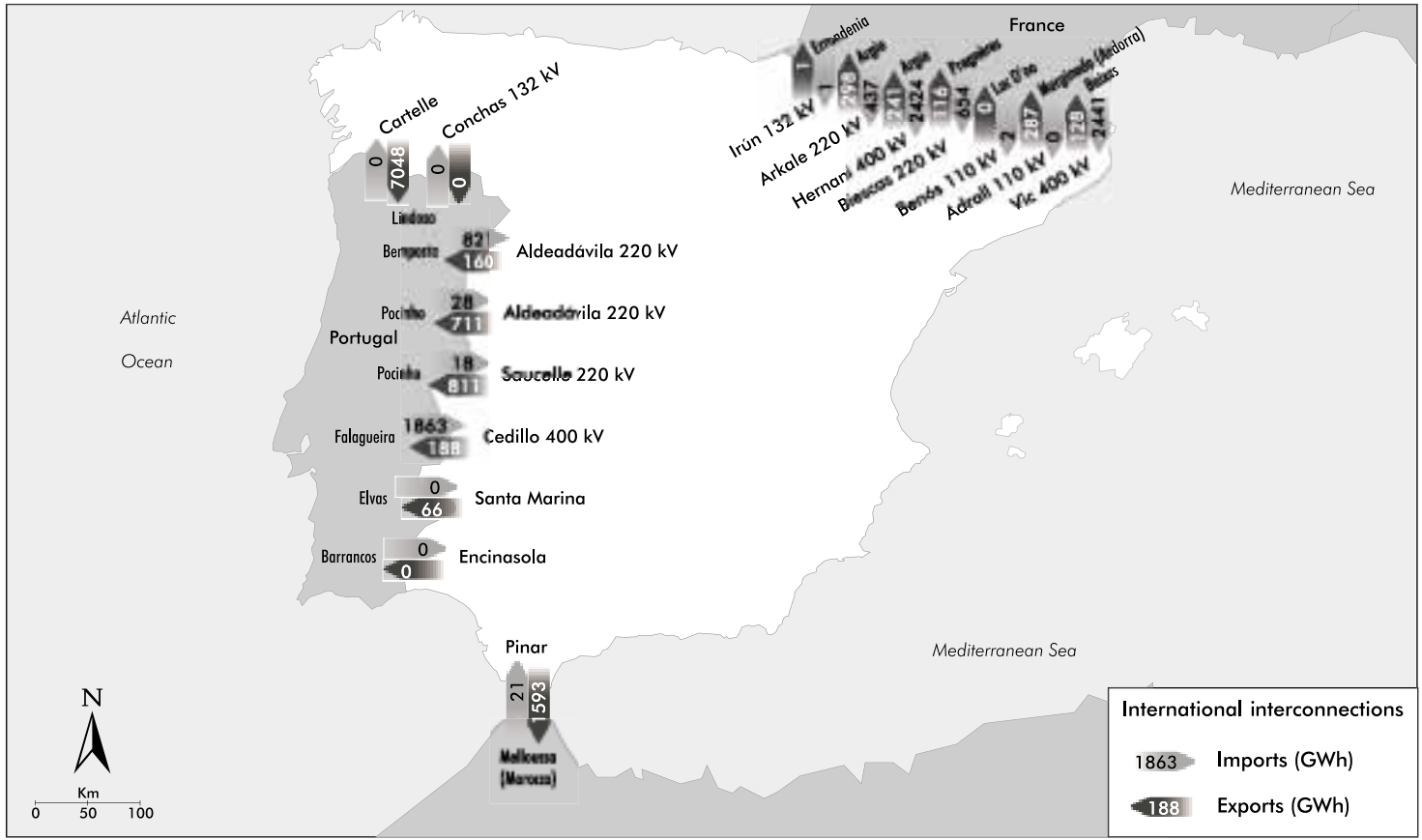
Country	*2000*	*2001*	*2002*	*2003*	*2004**
France	7 907	5 552	8 835	5 785	5 174
Portugal	–931	–265	–1 899	–2 794	–6 254
Andorra	–272	–249	–292	–270	–287
Morocco	–2 263	–1 780	–1 315	–1 457	–1 572
TOTAL	**4 441**	**3 258**	**5 329**	**1 264**	**–2 939**

Note: Positive is import; Negative is export; * Preliminary data.

Source: REE.

Figure 32

Interconnection Capacity, 2004



Source: REE.

liberalisation from 1998 until 2004 when the flow turned to net export. This was mainly due to a significant increase in exports to Portugal. Currently the direction of the flow across the Spanish/Portuguese border is mainly exports from Spain to Portugal. An extension of the available transmission capacity between Spain and France will probably have the highest influence on the competitive pressure in Spain.

Iberian Market

In November 2001 the governments of Spain and Portugal signed a protocol of co-operation for the creation of the Iberian Electricity Market (MIBEL). The actual establishment of the market was agreed upon in a memorandum of understanding in November 2003. According to the original agreement the MIBEL was to open by 1 April 2004.

The key point in the agreement was to form a common electricity market on the Iberian Peninsula. The point of departure for the agreement was the recognition that all agents in the MIBEL will enjoy equality of rights and obligations. The market will be based on marginal pricing, following the principles used in OMEL. OMEL will be the spot market operator for the whole market and a new market operator will be formed to manage trade in financial longer-term contracts. This market operator will be established by REN, the Portuguese TSO. Eventually these two market operators will be merged into one company.

It was not possible to launch MIBEL as scheduled. For this and other reasons, on 1 October 2004, a new international treaty on the MIBEL establishment was signed between Spain and Portugal. MIBEL will start operating before 30 June 2005. System operators, regulators, market operators and the relevant authorities have worked closely together to resolve all the technical, organisational and market rule issues. There are still important issues unresolved, and these include:

- The CTC in Spain and the corresponding handling of stranded costs in Portugal.
- A decision on how to deal with the current Spanish capacity payment.
- A decision on the model for management of the transmission congestion between Spain and Portugal.

A market coupling approach is the most obvious way to actually determine a price for the congestion and to manage the flow according to dynamic economic criteria. However, this may make any possible abuse of market power in Portugal more transparent, with direct consequences mainly for Portuguese producers.

Increase in cross-border transmission capacity is the most straightforward way to enhance cross-border competition and this is specifically included in the

agreement on MIBEL. Available transmission capacity between Portugal and Spain has often been congested. Therefore, cross-border capacity is already being reinforced, and is expected to double by the end of 2005. Several other projects are planned, but REE has also announced that the goal of continued reliable operation of the Spanish system imposes a limit on the level of additional interconnector capacity that they can accept.

Trade with France

Interconnector transmission capacity across the Spanish/French border is allocated under principles that currently do not take economic criteria into account and it is not co-ordinated between the two TSOs. Consequently, the transmission capacity is not used in a way that dynamically reflects the value of electricity on both sides of the border. This does not ensure efficient utilisation of the capacity. The regulators and TSOs from Spain and France have agreed on a plan for the step-by-step introduction of economically-based allocations of transmission capacity. The intention is first to introduce explicit auctioning of the capacity, where the available transmission capacity is put up for sale in an auction over different time segments, one day being the shortest. This will be under the use-it-or-lose-it principle, so that unused capacity can be resold. The next phase is to run a pilot scheme with market coupling, where the exchanges on both sides of the border, OMEL and Powernext, will receive an allocation of the transmission capacity. This capacity is taken into account when the two exchanges find the marginal price of a given hour and, through changes in their respective price calculations, make sure that the flow on the cross-border line is from the low-price area to the high-price area. This is called market coupling.

WHOLESALE MARKET

Most electricity wholesale trade takes place in OMEL, the electricity market that has been operating since 1998. OMEL is not an obligatory pool but its share of all traded electricity is very high (92%). The costs of operating OMEL are recovered through the regulated tariff so there is no trading fee for users of the exchange. Until now, the capacity payment has only been paid to generators who sell through the exchange. Together these are strong incentives for using the exchange. OMEL's activities are centred on the day-ahead spot market where a marginal price of supply and demand bids is determined for every hour of the following day. OMEL also operates an intra-day market where trades can be made closer to the hour of operation through six additional trading sessions.

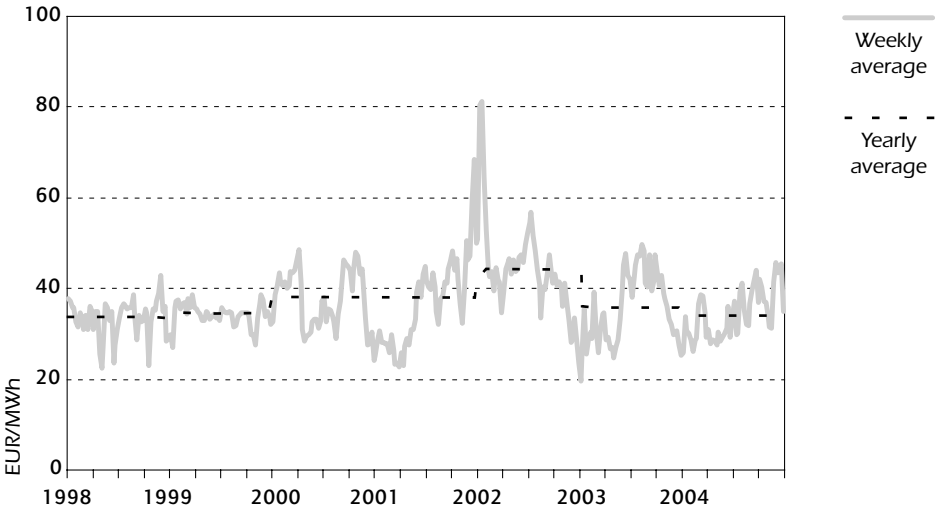
When OMEL opened in 1998, it had 20 registered participants. By January 2005 this number had increased to 215, 118 of which are generators. A large share of the generators is selling to OMEL under the new Special Regime

conditions (see Chapter 9), using the option to sell directly to the market and receive a premium.

After the final trades have been made and the operating schedules have been set, the system operator REE takes over. REE balances the system in real time through trades in the real-time market where generators can bid. REE also conducts an auction where generators can sell other ancillary services such as operational reserves. This market is not open for generators with a capacity below 1 000 MW or for large industrial consumers, even if they have the technical capability to participate.

Figure 33

OMEL Day-ahead Spot Prices, Weekly and Yearly Averages, January 1998 to December 2004



Source: OMEL.

Prices at OMEL are determined for the whole of Spain as one large zone. Day-ahead spot prices at OMEL have been fluctuating around 35 EUR/MWh in current values. Adjusted for inflation, the yearly average price in 2004 was 25% lower than it was in 1998. The price plummeted in the first half of 2001, mainly driven by the very high water reserves during that period. The general trend since then was of an increasing price, reflecting the tightening of reserve margins. Prices peaked in the winter of 2002/03 with weekly average prices above 80 EUR/MWh and the highest price recorded at 158 EUR/MWh. Since then, prices have started to fall back to the previous levels as new CCGTs are

being commissioned. In 2003 and 2004 the prices also show another change in pattern, with relatively low prices during winter and higher prices during the summer indicating the increased summer peak.

The price formation seems to reflect well the broad fundamental conditions at play in the market. The interrelation between OMEL market prices and investments in new generating capacity is not clear, however, because investments in generating capacity have the additional incentive of the significant capacity payment which must be added to the OMEL prices.

Congestion management within the Spanish transmission grid is handled through re-scheduling. Only 2-3% of the total electricity demand is re-scheduled because of constraints, so it does not appear that congestion is a critical problem. Prices received by the generators who are involved in the re-dispatch are, however, often more than double the price in the spot market. CNE has conducted investigations into the alleged abuse of market power in this segment of the market and has concluded that there are problems.

OMEL and REE publish much of the important information required for the understanding and analysis of the wholesale market in the longer term. It is more difficult, however, to analyse the market on a day-to-day or real-time basis, particularly for smaller companies and newcomers. Market players are obliged to immediately inform REE of planned outages or failures of production plants. However, this information was not made available to the broader market by REE. On 11 March 2005, the Royal Decree 5/2005 has established some measures to assure information transparency in the market.

There is currently no market for longer-term contracts. Hedging of price risks is done physically by keeping generation and distribution/retail within integrated holding companies. It is the intention to establish a common Iberian exchange for longer-term financial contracts with the establishment of the Iberian market.

MARKET STRUCTURE AND COMPETITION

Endesa is the largest generation company in Spain. In 2003 it had almost 23 GW installed capacity of which some 3.5 GW was in the islands. In mainland Spain, Endesa generated 40% of the total production with 28% of the total generating capacity including the maximum import capacity of the interconnectors. Endesa was a 100% state-owned utility until 1998 when it was privatised. Before and after privatisation, it acquired several smaller companies.

The second-largest company, Iberdrola, has a higher share of the installed capacity on the mainland but a significantly lower share of total generation. It was the result of a merger between two companies. Iberdrola has a relatively high share of hydro and wind capacity in its portfolio.

Union Fenosa is the third-largest electric utility. It has a diversified portfolio of generating capacity with the largest shares in hydro and coal but a strong growth in CCGT.

Two of the five-largest companies are owned by foreign utilities. Viesgo is owned by the Italian utility Enel, and Hidro Cantabrico is owned by the Portuguese utility EDP. The three-largest companies together have a share of 81% of the capacity of the ordinary regime, excluding import capacity. Generation and wholesale trade are dominated by six companies.

Table 29

Market Shares of the Ordinary Regime Market on the Peninsula, December 2004

Company	*Capacity (%)*	*Generation output (%)*
Endesa	35	39
Iberdrola	34	27
Unión Fenosa	12	11
Hidro Cantabrico	4	7
Viesgo-Enel	5	3
Gas Natural	3	3
Others	8	3

Source: CNE.

The competitive pressure in the wholesale market will depend on the number of market players, their market shares, the technologies used and the available interconnector capacity. When keeping the relatively low interconnector capacity in mind, the market shares of the largest companies could be a threat to competition. Considering the following market conditions, the picture becomes even less reassuring:

- Cross-border trade is not integrated in the day-to-day dynamics of the market on the basis of economic criteria.
- Generating capacity in the Special Regime is not responding to the fundamentals of the market, as it will receive its remuneration regardless of the market price, when the owners decide to sell the surplus of energy they generate to the distributor and not to participate in the market.
- Two of the most important technologies, wind and hydro, are dependent on weather conditions which will limit their ability to respond to market fundamentals, even if they were in the ordinary regime. The average capacity factor of wind power during the last five years has been 26%, which is high compared to other countries with large shares of windpower.

Table 30

Market Shares in Regulated and Competitive Markets, 2004

	Regulated market – 61%	*Competitive market – 39%*
Endesa	40%	38%
Iberdrola	37%	36%
Unión Fenosa	15%	10%
Hidro Cantabrico	6%	6%
Viesgo-Enel	2%	1%
Gas Natural		6%
Others		3%

Source: CNE.

An effective inclusion of the capacity currently under the Special Regime in the market place, an extension of transmission capacity to Portugal and France, and investments in CCGTs by smaller companies can help to diversify the supply side and significantly contribute to effective competition in supply. Positive developments on all these accounts are taking place. The cross-border capacity between Spain and Portugal is already being increased and there are immediate plans to extend this capacity even further and also to increase the cross-border transmission capacity between France and Spain. Adding 1 000 MW each to the maximum available transmission capacity from Portugal and France and including the CGGT plants that are under construction and planned to come on line from 2004 to 2009, would reduce the market share of Endesa to 24% and the market shares of the three-largest companies to 60%.

PRICES, TARIFFS AND COSTS

Electricity tariffs in Spain are in the mid-range compared to other IEA countries, with a relatively low tax share. Electricity consumers in Spain pay a special tax of 4.864% on the price of electricity, and household consumers pay an additional value-added tax of 16%. There are two types of electricity tariffs; consumers who choose to go to the market and obtain a negotiated price pay an access tariff, including costs for transmission and distribution, costs for the Special Regime and other fixed costs in the system (see Table 31). Consumers who do not want to go to the market can stay on the integrated regulated tariff from the local distribution company, covering all these costs and a calculated cost of production according to a formula set annually by the ministry.

Differences between the calculated costs of production on which the integrated regulated tariffs are based, and the actual cost paid for electricity at OMEL, are paid by the distribution companies' other regulated activities. In principle, the differences will be offset by differences in the CTC but there is no direct

Table 31

Regulated Costs in the 2004 Budget

	Costs, million EUR	*Percentage*
Capacity payment	898	6
Special Regime – extra costs	1 157	7
Other*	8 473	
TOTAL production	**10 528**	**65**
Transmission	**834**	**5**
Distribution	**3 284**	**20**
Retail	**286**	**2**
Diversification and security of supply	**375**	**2**
of which Nuclear Moratorium	*241*	
TOTAL permanent costs	**881**	**5**
Subsidies to extra-pensinsular system	*472*	
System operation, OMEL & CNE	*54*	
Coal stocks and subsidies to autonomous coal	*192*	
Compensation for transition to competition	*117*	
Others	*46*	
TOTAL	**16 188**	

*Budget for integrated regulated tariff. Other production costs are determined in the market for those consumers who choose to go to the market.

Source: CNE.

relationship between these two cost components. Therefore, consumers who stay on the integrated regulated tariffs are indirectly subsidised through the access tariff paid by consumers who have gone to the market. Consumers can switch between the market and the integrated regulated tariffs as they wish and are only limited by lead times to handle the administration.

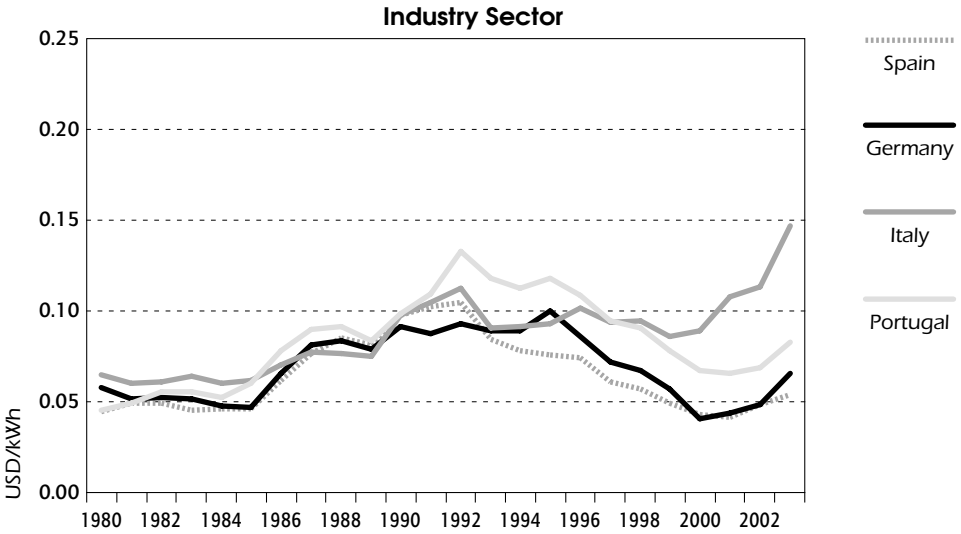
Large industrial consumers can also sign a contract with a special integrated regulated tariff for consumers who can adjust their consumption when asked to do so or who are fully interruptible. Large industrial consumers receive a very substantial discount for such flexibility. The discount for interruptability is 25-75% compared to the general tariff at the same voltage level.

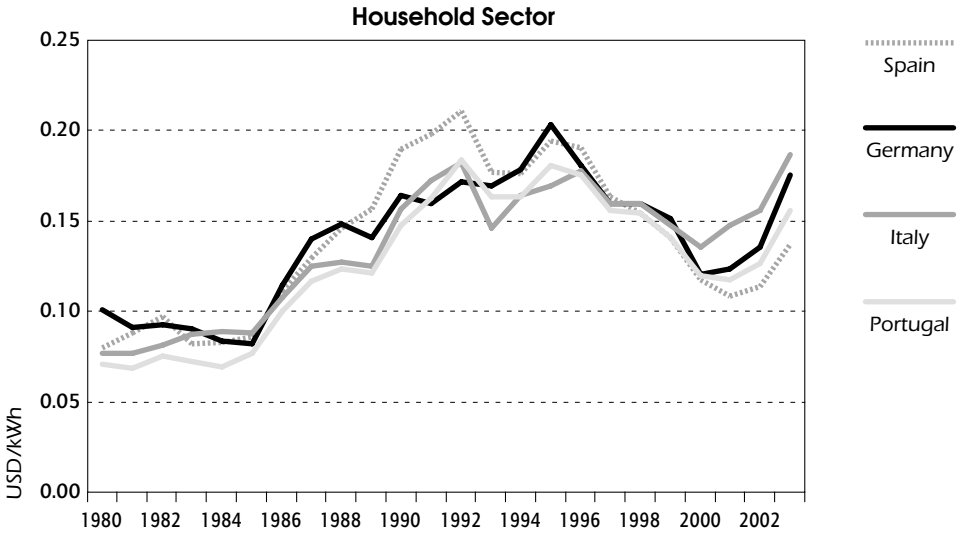
The concentration in market share of the three-largest companies in the distribution and retailing of electricity is even higher than in the generation sector, particularly so in the distribution sector.

In 2004, 39% of all energy consumed was contracted in the liberalised market, and the remaining 61% were sold under the integrated regulated tariffs. During

Figure 34

Electricity Prices in Spain and in Other Selected IEA Countries, 1980 to 2003

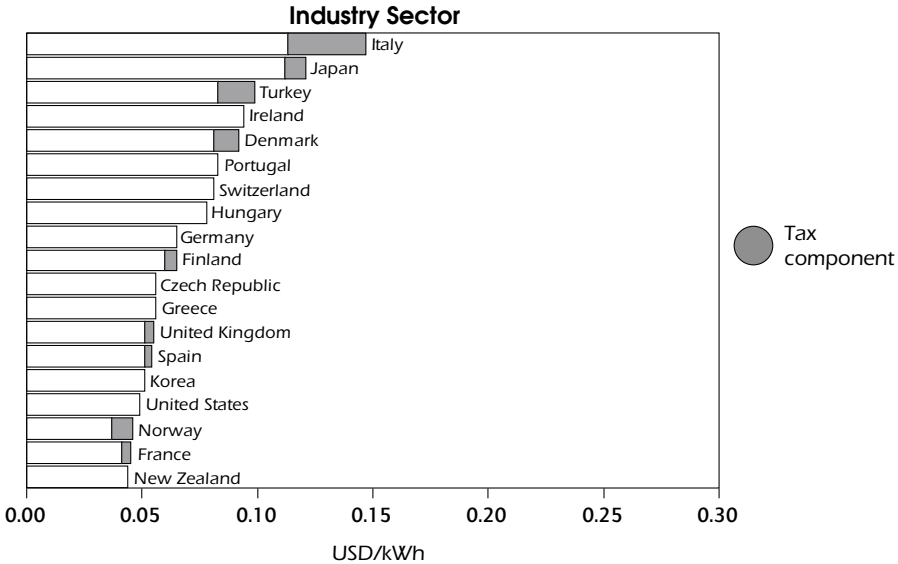




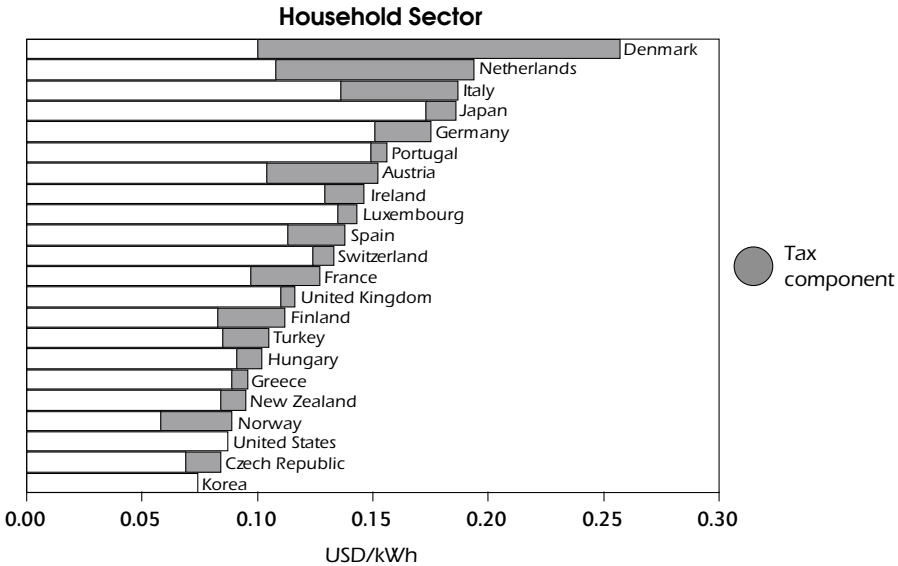
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 35

Electricity Prices in IEA Countries, 2003



Note: Price excluding tax for the United States. Data not available for Australia, Austria, Belgium, Canada, Luxembourg, the Netherlands and Sweden.



Note: Price excluding tax for the United States. Data not available for Australia, Belgium, Canada and Sweden.

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

1999 and 2000, the amount of energy contracted in the market increased from very low levels to some 30%. Since 1 January 2003, when all consumers became eligible to choose their supplier, the share of electricity delivered in the market started to slowly increase again. It is mainly the small and medium industrial consumers who have left the integrated regulated tariffs. Around 80% of consumers connected at the 1 kV to 36 kV levels have gone to the market. Households, small industry and services connected at low voltage are only a small segment in the market, although their numbers are increasing. At the end of 2004, some 11% of the electricity consumed by this group was no longer under the integrated regulated tariff. For households, this figure was only 2%. Most of the consumers who leave the integrated regulated tariffs stay with the same retailer; 23% change supply company, which implies that only some 0.5% of households have switched supplier since 1 January 2003.

Electricity tariffs have been falling nominally by an annual rate of 1.7% since 1998. During the same period, the consumer price index (CPI) increased by 2.8% annually making this an even stronger decrease in real terms. In the decade up to 1998, the electricity price increased by 2.9% annually and the CPI increased by 4.9% annually. The largest decreases in tariffs occurred in the first years after liberalisation. This suggests that implementation of the restructuring of the industry to improve efficiency had been successful. It must be recognised, however, that many of the restructuring developments were driven by regulatory pressure rather than by competitive pressure. A large share of the decrease in prices from 1999 to 2000 was due to the decrease in the capacity payment.

Essentially all domestic consumers up to 15 kW maximum load can change supplier according to a profile of their load, and do not, therefore, have to have an hourly meter. All other consumers are required to be equipped with an hourly meter; for small industry and service companies, a meter that reports 6 periods per day.

CRITIQUE

Spain embarked on the liberalisation of its electricity sector in the mid-1990s, ahead of the timetable set by the European internal market directives. The liberalisation process was very comprehensive and led to the establishment of all the necessary regulatory and market institutions. Spain is now among the IEA member countries with the longest experience in electricity market reform. Spain is still in a transitional phase where commitments made by companies ahead of liberalisation have been addressed, and where one aim has been to protect consumers from the effects of the uncertainties liberalisation may bring. The transitional phase has also taken place at a time when environmental and other energy policy issues have been addressed. Spain should be commended for its liberalisation efforts as one of the pioneer

countries during a period where other important energy policy challenges also had to be met.

Spain has managed to develop well-functioning regulatory and market institutions and thereby possesses the framework for an efficient electricity market. With the many other energy policy challenges that have also been met during the transition, the electricity market has, however, evolved with a continuously high level of regulation and political involvement. This regulation has served a purpose but has also created many distortions in the market. The greatest challenges ahead allowing Spain to reap the full benefits of market liberalisation now appear to be in dealing with these distortions. The Spanish electricity market is now at a stage where the regulation that was meant to ease the transition has become a hindrance for its further development. Spain has an opportunity to revise the role that the market is given in the Spanish electricity sector to meet the objective of higher efficiency for the long-term benefit of all electricity consumers in Spain. Political and regulatory involvement should then be focused on establishing a regulatory framework for the areas where transparent regulation is crucial to maintain market efficiency, such as system reliability, market design, competition, regulation of networks and the exercise of public service obligations.

Prices on the electricity exchange, OMEL, have fallen in real terms since the introduction of liberalisation. After some tightness in the supply/demand balance in 2001, there has been substantial investment in new generating capacity, mainly in CCGT and wind power. The investment has been driven by many factors, but it is likely that an important factor for the investment in CCGT is the ability of the market to signal the tight balance resulting from growing demand. This is an important success for the Spanish electricity market, although it is vulnerable in some critical areas.

Capacity payment has been another important driver for investments in new generating capacity so it may be considered effective in this narrow sense. Yet capacity payment has not proven to be an efficient policy to secure adequate supply. It should therefore be considered whether the payment should be either removed, or whether, as a temporary measure, it should be replaced with a more efficient instrument. If there is concern for the ability of the market to provide timely and adequate incentives for investment in a transitional phase, one suggested instrument could be to let REE temporarily buy access to reserves in an open tender. It is crucial that such reserves are only activated at a very high price level justified by analysis of the "value of lost load". The justification for a capacity payment is also more complicated when seen in an international context. The efficiency of a specific capacity payment will be difficult to analyse in MIBEL. Therefore it may become a barrier for the formation of MIBEL. Its potential elimination is also an indication of the efficiency gains that can be achieved from an internal Iberian market.

Successful liberalisation with the objective of increasing efficiency in the sector is achieved by introducing competition among market players. Success

will depend on the market concentration of incumbent utilities and whether there is regulation in place to enable newcomers to build new plants and to easily trade electricity in the market. In this context, the Spanish electricity market is also vulnerable because of the relatively high concentration of large electricity companies. It is important to ease the access for newcomers to lower the entry costs into the market. The number of generating companies is increasing and an important share of the new and expected investment in CCGT is made by the smaller and newer entrants. CCGT plants are likely to set the market price in many hours in the future, so this may prove a particularly important development for market efficiency and competition.

One of the greatest barriers to effective competition is the current system of reimbursement for the costs of transition to competition. Incumbent utilities that still benefit from this payment have a clear incentive to influence electricity prices at OMEL to keep them at EUR 36/MWh, because if the market price is above this level, no CTC payments will be made to them. This may distort the market price and harm those players who do not benefit from the payments and are at the same time unable to realise higher prices in the market. It also makes it more difficult, particularly for newcomers, to analyse and understand the market. Consideration should be given to redesigning the CTC system to have a less direct and distorting influence on price formation.

Electricity market liberalisation has brought a comparatively high level of transparency to the Spanish electricity system. Through information published by OMEL and REE, it is possible to acquire a great level of insight into the day-to-day fundamental conditions of producing and consuming electricity. However, there are still some important bits of information that are not published broadly. Information about the status of production plants, such as their availability and technical status, is not submitted to the market place. This allows the owner of the affected plant to be the only one who knows that the power plant is out of operation and allows trading on this information to his own advantage. This information can make a big difference to market prices, particularly in the case of nuclear power plants and other large generation units. Hiding such information is especially harmful for the development of a credible and transparent market for longer-term financial contracts and it is a particular barrier for newcomers who will not have had a fair chance to analyse the market and understand market outcomes. Information that is fundamental for analysing the demand/supply balance should be made public to all market players without delay.

The demand side constitutes an important resource for the electricity system. In particular, large industrial consumers have the potential to play an active role in balancing supply and demand when supply is tight. With a more transparent and easily accessible market place, they will be able to actively participate in the market. Active participation by the demand side in the form of direct demand response to prices is an important potential for efficiency gains.

So far, large industrial consumers have not had the incentive to participate in the liberalised market or even to change supplier. All consumers have the opportunity to be supplied through an integrated regulated tariff. The regulated tariff is based on a calculation of costs and the outcome of the calculation makes it difficult for suppliers to compete with an offer based on real market prices. In particular, the integrated regulated tariff offered to large industrial consumers and households seems to deprive these consumer groups of the incentive to go to the liberalised market.

The very low participation by the largest industrial consumers in the liberalised market in Spain is one of the main differences with other liberalised electricity markets. The integrated regulated tariff gives substantial discounts to consumers who have some flexibility in their consumption and with these discounts it is not surprising that large consumers stay out of the market. Large electricity consumers with energy-intensive processes can adjust their consumption by several thousand MW with varying flexibility. This is a resource much called for in all electricity markets but it is also a resource which should be priced in the established markets, such as the day-ahead spot market, intraday markets, the real-time market and the market for ancillary services, and not within the tariff system. It is not transparent whether the size of the discounts can be justified by the prices in the market and it is not clear whether this resource is used efficiently.

The lack of direct participation by the largest industrial consumers in the market is depriving the retail market of an important source of dynamic and competitive pressure. A flourishing retail market with high demand for tailored contracts from the largest industrial consumers would be an important contribution to the initiation of financial trade with longer-term contracts and other financial risk hedging. Such a development can prove very important for new entrants, enabling them to operate in niches in the wholesale and retail markets.

The transmission grid and the operation of the Spanish system seem to be able to meet the challenges from the increasing share of intermittent resources and other generating capacity. The few problems in the delivery of electricity to Spanish consumers that were observed in recent years seem to derive from problems in the distribution grid. This could indicate a need for a revision of the regulation of distribution activities. It should be considered whether local grid companies have the right incentives to make efficient investments. The introduction of a regulation with an element of financial responsibility for the failure to deliver is commended.

Spain covers a large geographic area. There are several demand centres, while generators have preferred locations that are not necessarily close to these. As a consequence, the transmission grid is likely to come under more pressure with the expected increase in wind and CCGT capacity. Because prices at OMEL are determined for the whole of Spain as one large zone, the wholesale trading at OMEL does not give transparent locational signals for

market players within Spain, which means any congestion in the Spanish grid is not reflected through separate prices at OMEL. Stronger locational signals are likely to improve system efficiency. This could consist of making access tariffs to the grid dependent on the location of a new generator, and/or by the establishment of nodal or zonal prices for electricity. REE´s current mechanism of congestion management is to re-dispatch generation. With such a procedure and with the present level of market concentration, it is likely that incumbent generators can gain and potentially abuse market power in the congestion management process. If the congestion management is not made more transparent through locational pricing, it is critical that this part of the market is at least supervised closely.

Careful market surveillance, an improvement of the trading regime on the Spanish-French border, an extension of the available transmission capacity on the Spanish-French and Spanish-Portuguese borders as planned, and further development of the Iberian market together with Portugal (MIBEL), will all be very important measures in the further development of a fully competitive market.

With a view to maximising the available interconnection capacity, strong and transparent locational pricing may also serve an important role, in particular in the common Iberian market with the existing bottlenecks in interconnection. Real available interconnection capacity is often limited compared to its theoretical thermal capacity. If these limitations are due to congestion in other parts of the grid, overall system efficiency would be improved if the real areas of congestion were identified. This can be accomplished by dividing the bids in OMEL according to the zones that are identified by the real physical transmission bottlenecks. This would allow the establishment of a separate price for each zone by OMEL. Market coupling or a similar mechanism across neighbouring countries' borders is also recommended, particularly in MIBEL.

Because of the need for continuous investments in new generation plants (particularly by smaller newcomers) and power lines, to meet the increasing demand and to increase the competitive pressure, it is important that the approval processes are continuously improved to become as transparent and fast as possible.

RECOMMENDATIONS

The government of Spain should:

- *Consider removing the capacity payment or, as a temporary measure, replace it with a more efficient instrument.*

- *Redesign the CTC system to remove its distortionary effect on the formation of electricity prices as soon as possible.*
- *Redesign the integrated regulated tariffs so that they only serve to guarantee service for small consumers.*
- *Ensure that all market players have equal access to all information that is fundamental to the demand-supply balance, including the status of generating plants.*
- *Encourage participation of particularly large-scale consumers in the wholesale market,* e.g. *through load-shifting.*
- *Review the regulation of distribution grids to ensure that the right incentives are given to allow for efficient investment and operation.*
- *Consider the introduction of transparent locational signals in price formation and tariffs. This is particularly important with the development of the Iberian market.*
- *Reinforce efforts to establish the Iberian market by agreeing on common rules.*
- *Improve trade across the Spanish-French border.*
- *Ensure transparent licensing procedures for electricity-related infrastructure.*

OVERVIEW

Spain has nine nuclear reactors operating on seven sites (see Table 32). Seven units are pressurised water reactors (PWR) and two are boiling water reactors (BWR), having a total generating capacity of about 7 886 MW_e. One unit, Vandellós I, has already been taken out of service and partly decommissioned, and another will follow in 2006. Spain's nuclear capacity represents 12% of its total installed electricity generating capacity. The Spanish reactors are privately-owned by the major electricity generating companies in Spain, with most stations owned jointly by Endesa, Union Fenosa and Iberdrola.

In 1984, the government postponed the construction of two nuclear power units and ceased the construction of three nuclear units for ten years. The moratorium was confirmed as definitive for these units in 1994 by the law on electricity. The same law recognised the right of the owners of these projects to receive compensation for the losses that they sustained. This law did not rule out nuclear power as an option for future capacity needs. The current government has expressed its desire to phase out all nuclear power units in the medium term.

Spanish nuclear reactors continue to perform very efficiently. The average load factor was 89.7% in 2003 and has been around 90% for over 10 years. This trend is also confirmed by safety indicators. In 2004, nuclear power plants (NPP) produced 63.6 TWh, supplying about 23% of the country's electricity requirements. Although the electricity produced by nuclear reactors has increased by about 16% since 1995, its share in total electricity production has dropped from 33% to 23%. This reduction is the result of the significant increase in demand for electricity in recent years that has been satisfied primarily by the construction of a new natural gas plant and renewable generators.

Spain has gained about 586 MW of additional gross nuclear capacity since 1990 by capacity upgrades implemented in existing nuclear units. In 2002 and 2004, upgrades were performed in Cofrentes (thermal power increase) of about 60 MW_e and 7 MW_e respectively. In 2003, upgrades were performed at Ascó-I (new instrumentation and equipment) of about 4.5 MW_e.

Regulatory policy in Spain allows the renewal of the operating licences of nuclear power plants following a rigorous safety review. The current policy has included the option of licence renewal for up to 10 years. Garoña, Almaraz, Vandellós-II, Cofrentes, Ascó and Trillo have been granted ten-year extensions. Assuming a typical 40-year life, and having in mind that in October 2002,

Table 32

Operating Nuclear Power Reactors in Spain

Plant	*Year of commissioning*	*Capacity(MW gross)*	*Type*
José Cabrera (Zorita)	1968	160	PWR
Santa Maria de Garoña	1971	466	BWR
Almaraz-I	1981	973	PWR
Ascó-I	1983	1 032	PWR
Almaraz-II	1983	982	PWR
Cofrentes	1984	1 092	BWR
Ascó-II	1985	1 027	PWR
Vandellós-II	1987	1 087	PWR
Trillo	1988	1 067	PWR

PWR = pressurised water reactor. BWR = boiling water reactor.

Source: International Atomic Energy Agency.

José Cabrera NPP was granted a new operating authorisation until 30 April 2006, when the plant will finally cease operating, one reactor would be stopped around 2010 and the remaining seven after 2020. There is, however, no formal assumption of an operating life and consequently, reactors can continue to operate for as long as they have a current operating authorisation.

At the same time, the capacity of other nuclear power plants could still be increased, by optimising the thermal performance of equipment and/or increasing the thermal energy produced by the fuel. Under these assumptions, the overall nuclear power capacity could be maintained during the next 10-15 years.

In addition to nuclear power plants, other elements of the nuclear fuel cycle exist in Spain, such as fuel fabrication and the fabrication of heavy nuclear components. In 2004, 836 nuclear fuel bundles with 276 tonnes of uranium were fabricated. Around 46% of the fuel elements have been exported to Belgium, Finland, France and Sweden.

Until 2000, some of the uranium used in Spanish nuclear reactors had been produced by ENUSA in the uranium mine and mill located in Saelices el Chico (Salamanca). At the end of 2000 all mine activities were closed. In July 2003 the operation of the plant Quercus on the same site was finally shut down.

KEY ORGANISATIONS

The Nuclear Safety Council (Consejo de Seguridad Nuclear, CSN) is the independent regulatory agency. It has the power, for safety reasons, to

suspend the operation of nuclear plants and to propose the initiation of procedures to impose sanctions on operators, as well as to cancel licences and authorisations. CSN submits reports on issuing licences for the operation of nuclear plants and other facilities handling radioactive material to the government. The statements given by CSN must be followed up when they are different from those in the application. CSN is funded by the general state budget (the Ministry of Industry, Tourism and Trade) and by licensing fees.

The National Radioactive Waste Corporation (Empresa Nacional de Residuos Radioactivos, ENRESA) is a state-owned company responsible for the activities of the back-end of the nuclear fuel cycle. These activities include spent fuel and radioactive waste management, together with the dismantling and decommissioning of nuclear and radioactive installations. In addition, ENRESA manages the fund for financing the back-end activities of the nuclear fuel cycle and developing related research and development programmes. ENRESA is funded by a special levy included in the administrative tariff for electricity, paid by the majority of electricity customers.

The Centre for Energy, Environmental and Technological Research (Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, CIEMAT) is an institution established by the Ministry of Education and Science. One of its duties is nuclear research. It collaborates with several institutions in Spain and abroad. CIEMAT is funded from the government's research budget and undertakes contractual research for third parties.

ENUSA Industrias Avanzadas, S.A. is the government-owned Spanish company in charge of activities relating to the front-end of the nuclear fuel cycle.

ENSA (Equipos Nucleares, S.A.) is a state-owned manufacturer, which designs, produces and inspects the primary circuit equipment of nuclear power plants and other heavy nuclear components, such as dry spent fuel storage casks.

NUCLEAR SAFETY

Nuclear safety is measured by long-term nuclear plant performance indicators[16]. All indicators show a decreasing tendency, indicating safer operations during the previous ten years with two exceptions: the average number of automatic scrams with the reactor critical and the average number of significant events. In the short term, all the performance indicators are also decreasing and only one of them, the average rate of forced outages, has increased during the past three years.

16. The performance indicators are: average number of automatic critical reactor shutdown; average safety systems performances; average rate of significant events; average rate of safety systems failures; average rate of forced shutdowns; average rate of forced shutdowns due to failure equipment/1 000 critical commercial hours; and average rate of collective radiation exposure.

Vandellós II issued an event report describing the breaking of a main access to one of the trains of the Essential Water System on 25 August 2004 and in March 2005. The CSN has ordered a list of several repair measures to be implemented during the refuelling period of Vandellós II power station, planned for March 2005. As of today, this event is still under evaluation.

WASTE DISPOSAL AND DECOMMISSIONING

Nuclear waste management activities and plans in Spain are currently defined by the Fifth General Radioactive Waste Plan, which was issued in 1999. The plan covers all the activities and technical solutions applicable in the different areas of radioactive waste management. In summary, the plan calls for the following:

- Delaying the decision on the final solution of spent fuel and high-level radioactive waste to after 2010.
- Construction of a centralised interim storage facility for high-level waste by 2010.
- Continued dependence on the El Cabril facility as the basic site for the management of low- and intermediate-level waste.

In terms of the strategy established by the Fifth Plan, no decision needs to be taken with respect to final disposal of the spent fuel prior to 2010. However, research and development will continue on geological disposal that would allow the maintenance of the technological know-how for site characterisation and barrier performance evaluation. The strategy also calls for the promotion of research and development of new technologies for final disposal and, in particular, on partition and transmutation.

The total estimated volume of conditioned low- and intermediate-level waste to be managed is around 190 000 m^3 and the total volume of spent fuel is estimated to be around 10 000 m^3. The spent fuel is assumed to be packed in casks for final disposal in deep geological repositories. Additionally, around 5 000 m^3 of high-level waste comes from other sources such as the decommissioning of nuclear facilities and old vitrified waste from spent fuel reprocessing (coming from France) that should be disposed with spent fuel.

The waste plan includes the temporary and final technological solutions for spent fuel and high-level waste, and considers a period of prior analysis to establish in detail the required strategies and actions. The establishment of a centralised temporary storage facility is being planned by the year 2010 in order to solve the problem of storage of vitrified wastes of spent fuel and others types of waste. In 2002, a temporary dry storage facility commenced operations in Trillo NPP, which houses the plant's spent fuel in dual-purpose (transport and temporary storage) metallic casks.

The El Cabril Centre is the central location for the management of low- and intermediate-level waste in Spain. This facility, which was opened in 1992, provides an integrated management system that includes waste collection, transport, treatment and conditioning, and accurate information on the waste inventory, radiological characterisation and on quality assurance, all of which are compatible with the type of disposal applied for nuclear waste. In December 2004, some 22 500 m^3 of conditioned waste had been disposed of, and some 4 600 m^3 of conditioned and unconditioned waste had been placed in existing storage facilities at the installation.

In 2003, following a resolution of the Congress (the lower chamber of the Spanish Parliament), ENRESA submitted a project application to build a disposal facility for very low-level waste at the El Cabril site with a storage volume of about 130 000 m^3. This new facility would complement the existing facility for disposal of low- and intermediate-level waste. It is still under review at the time of writing.

In October 2003, all the works related to Level 2 decommissioning of Vandellós I (the only Spanish gas-cooled reactor) were successfully completed. In January 2005 the latency period was approved and it is foreseen that the installation will remain in this situation for about 25-30 years, with the reactor building enclosed in a metallic containment. After this time, it is expected that the works for the total dismantling of the installation (Level 3) will be authorised. Thereafter, the site will be completely free for subsequent unrestricted use.

At the end of October 2003, the Spanish government approved a Royal Decree on the governance of activities performed by ENRESA and their financing, regrouping into a single text all the former standards related to the activities and financing of ENRESA, as well as the fund for the financing of activities included in the General Radioactive Waste Plan, regulating its management, follow-up and control.

CRITIQUE

Up to now, nuclear power has been benefiting from a reasonably stable and predictable market and regulatory environment. This has enabled nuclear to play a vital role in Spain in terms of security of supply and GHG emissions reduction, even though its share in TPES and total electricity generation is gradually declining. The nuclear industry in Spain offers services and products that largely cover the needs of its nuclear power plant operators. This provides a favourable background for nuclear power production for GHG emissions reduction and energy security in the future.

There is no longer a formal nuclear moratorium in place. The law of 1994 does not rule out nuclear power as an option for future capacity needs. On the

other hand, the Spanish government has publicly expressed its desire to phase out nuclear energy, at least in the medium term. This ambiguous situation could hamper stable and predictable markets and the regulatory environment and discourage investments by the nuclear industry and nuclear power companies. While the construction of new nuclear power plants may be complicated in the competitive market owing to the economic risks associated with long lead-time and high capital costs, there are countries where these projects are proceeding. In any case, regulatory uncertainties caused by the government should be minimised. The government should ensure a stable and predictable operating and regulatory framework. In this context, the government should present a clear vision about the future of the nuclear option in Spain. If the government maintains its position of desiring a nuclear phase-out, it should conduct a thorough quantitative analysis of the impact of a nuclear phase-out on supply security, GHG emissions mitigation and electricity prices. Such an analysis should also include the costs and benefits of extending the operating lives and increasing the capacity of nuclear plants. The result of such an analysis should be widely disseminated to the general public to facilitate the process of informed decision-making.

In OECD countries in general, the currently operating nuclear power plants tend to have the lowest short-run marginal generation costs that in an open market situation encourage power companies to maximise the production capabilities and operate their plants as long as possible. In this case it is crucial to continue to ensure a high level of safety. For example, the nuclear safety authority should continue to increase the efficiency and transparency of the regulatory processes.

Recent reports about a late-reported leakage in Vandellós II in August 2004 confirm the importance of full compliance with a transparent and immediate information disclosure by plant operators on such events and a close monitoring of safety performance by CSN.

The storage of spent fuel and disposal of low- and intermediate-level nuclear wastes is well organised. However, the final disposal of high-level radioactive waste is not yet defined. The programme to develop a final disposal facility for high-level radioactive wastes is still in a very early phase and several important political and technological steps need to be taken. The government should also ensure that the project to build and operate a disposal facility for very low-level waste goes ahead.

The review team welcomes the initiative of the government to discuss to move the costs of radioactive waste management and decommissioning of the nuclear power plants from electricity consumers to the waste producers. Such a change should, however, be undertaken in a transparent manner, and in close co-operation with the stakeholders, ensuring a stable long-term framework.

RECOMMENDATIONS

The government of Spain should:

- *Ensure a stable and predictable operating and regulatory framework for nuclear.*
- *Assess the implication of extending the operating lives and increasing the capacity of existing nuclear plants on the national energy policy objectives, while ensuring high safety levels.*
- *Develop a clear vision about the future of nuclear backed by a quantitative assessment of the consequences of the nuclear phase-out on energy security, environmental protection and economic growth. Make such analysis publicly available and understood before taking a national decision.*
- *Ensure transparent and immediate disclosure of information on nuclear safety-related events and close monitoring of safety performance by CSN.*
- *Continue to develop high-level radioactive waste management solutions and take all the necessary steps to facilitate the decision-making by 2010 as planned.*

OVERVIEW

Spanish energy RD&D is driven by plans formulated by the Ministry of Education and Science (formerly Ministry of Science and Technology) and is primarily carried out by an institute working with the ministry, CIEMAT. Some market development work is undertaken by IDAE. The CIEMAT budget in energy-related R&D reached EUR 85m in 2004. The total budget for energy-related research in the 3rd National Plan which ran from 2000 to 2003 was EUR 34m.

The 3rd National Plan of Scientific Research, Development and Technological Innovation 2000-2003 was completed in 2003, and the 4th RD&D Plan 2004-2007 was drawn up. This includes a new National Energy Programme that is considerably more ambitious than the previous one. The focus areas of the 4th Plan are based on the results of an evaluation of the 3rd Plan that are described below. For the 4th National Plan, funding increased to EUR 42-44m over the three-year period during which the plan runs.

THE 3RD NATIONAL PLAN FOR RD&D

The 2000-2003 RD&D Plan focused on the following key areas for research and development efforts into more energy-efficient and environment-friendly fuels, systems and plant:

More Efficient and Less Polluting Energy Systems

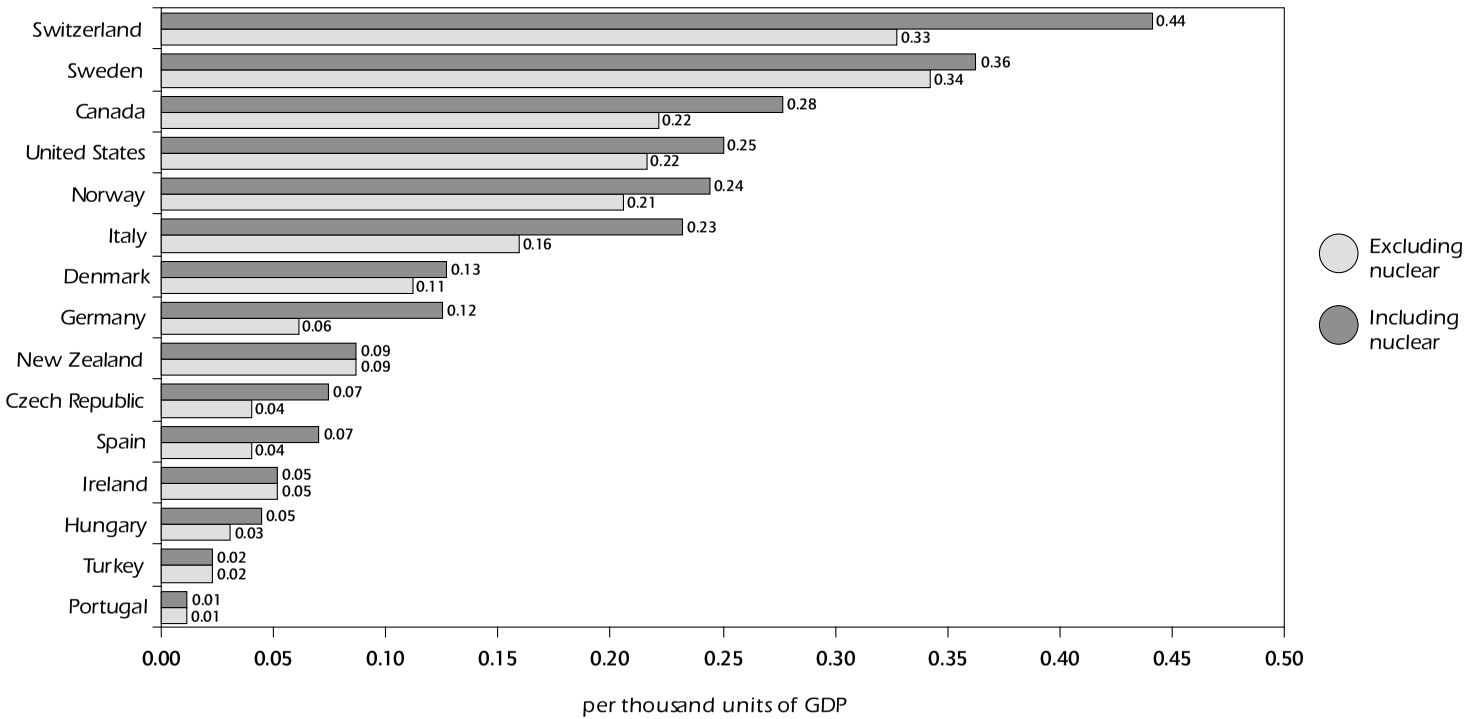
This was aimed at facilitating the development of scientific and technological means to increase the share of new energy systems. These would primarily be renewable energy technologies and fuel cells which fulfil the criteria of increased efficiency, competitiveness and reduced environmental impact.

Transport, Storage, Distribution and More Economical and Efficient Use of Energy

The aim was to develop reliable, efficient, safe, clean and economical energy services in order to increase the overall competitiveness of Spain's industry. RD&D activities focused on the promotion of the rational use of energy in industry and in the residential sector, as well as increased efficiency in the transport, distribution and storage of electricity.

Figure 36

IEA Government Budgets on Energy R&D per GDP, 2003*



*estimates.

Note: data not available for Australia, Austria, Belgium, Finland, France, Greece, Japan, Korea, the Netherlands and the United Kingdom. Luxembourg has no energy R&D programme.

Sources: Country submissions and *OECD Economic Outlook No. 75*, OECD Paris, 2004.

Alternative Systems of Propulsion and New Fuels for the Transport Sector

The transport sector is one of the most significant sources of CO_2 emissions in Spain and compliance with the Kyoto commitments will ultimately require the development of technologies able to considerably reduce emissions. The research projects in this key area focused on the development of new vehicle fuels and the improvement in the use of existing fuels and electric propulsion. Priority was given to the use of new technologies in mass transport modes.

Other Activities

In addition to the research fields outlined above, other actions to cover lines of special interest in the energy sector were undertaken. These looked at the optimisation of fossil fuel use, the integration of renewable energy into the energy system, nuclear safety, environmental and socio-economic aspects of energy and the setting-up of specialised R&D Centres.

RESULTS OF THE NATIONAL ENERGY PROGRAMME IN 2003

The Ministry of Science and Technology (now Ministry of Education and Science) managed the National Energy Programme through the Programme for Promoting Technical Research (PROFIT). Financing was based on grants and refundable loans distributed in research areas of the plan.

The results achieved in the 2003 call for projects can be summarised as follows:

- The number of projects presented was 199, against 197 in 2002. Although the total number of projects presented was practically the same, there were differences with respect to the previous year among the strategic actions, with an increase in renewable energy projects and a corresponding reduction in the headings concerning other actions.
- The projects submitted represented a total budget of EUR 140m for 2003, a fall of 4% compared to the 2002 budget of EUR 146m.
- 97 projects were approved; double the figure for 2002, thanks to the increased budget available for grants and loans in 2003 (EUR 13.7m as against EUR 4.4m in 2002). Individual projects received considerably more generous funding in 2003.
- The support from the programme stood at EUR 3.3m in the form of grants and EUR 29.6m in the form of refundable loans. Compared with 2002, this represents a tripling of the available funds.

The distribution of the results by key area as described above was as follows:

- More efficient and less polluting energy systems were covered in 104 projects with a budget of EUR 90m, of which 57 (55%) were approved, with subsidies of EUR 2.1m and refundable loans of EUR 18.9m.
- 37 projects with a budget of EUR 14.4m on systems of transport, storage, distribution and more economical and efficient use of energy were submitted. Of these, 11 (30%) were approved, and received grants of EUR 0.3m and refundable loans of EUR 3.5m.
- 22 projects with a budget of EUR 22m on alternative propulsion systems and new fuels for the transport sector were submitted. Of these 12 (55%) were approved and they received EUR 0.2m in grants and EUR 3.2m in refundable loans.
- Among other areas of the 36 projects submitted with a total budget of EUR 15m, 17 (47%) were approved with grants of EUR 0.7m, and refundable loans of EUR 4m.

The results were also evaluated by looking at the types of projects approved: 61% of the total grants and 77% of all refundable loans were awarded to projects aimed at developing potentially marketable products, while technological demonstration projects took up 16% of the grants. The Eureka and Iberoeka programmes[17] received 12% of the total grants awarded and special actions were awarded 16% of the refundable loans.

Some projects of considerable interest are listed below. These are selected either because of their importance in terms of technology innovation or because of their relevance in energy and environmental terms.

- A 10 MW thermal solar plant for the generation of electricity in Sanlúcar la Mayor (Seville). The total budget is EUR 36m, with a reimbursable advance of EUR 1.7m already paid and a non-refundable grant of EUR 0.2m awarded. Once running, the plant will be able to benefit from preferential tariffs for its output if that is exported to the electricity network.
- A pilot wave energy project. The project is part of a group of renewable energy projects combining wind and wave power. The budget for the financial year 2003 is EUR 0.4m and a refundable loan of EUR 0.2m has already been paid.
- The design and manufacture of a reactor for converting bioethanol into hydrogen for use in fuel cells for transport, with a budget of EUR 0.14m.

17. EU-funded RD&D projects.

THE 4TH NATIONAL PLAN FOR RD&D ENVIRONMENT-FRIENDLY

The 2004-2007 RD&D Plan's targets are to guarantee environment-friendly energy supply, utilising cost-benefit analysis, while increasing renewable energy and other new technologies. the Ministry of Industry, Tourism and Trade manages this plan. There are two key actions as follows:

1st Key Action: "Cleaner and more efficient energy uses"

- Fuels for the transport sector
- Fossil fuels
- Nuclear fission
- CHP/CCP
- End-use energy efficiency
- Energy transmission
- Distributed generation

2nd Key Action: "Development of RES technologies"

- Evaluation of renewable resources
- Wind energy
- Solar: thermal (HT & LT), PV and passive
- Biomass
- Other RES: geothermal, mini-hydro, tidal, etc.
- H_2
- Fuel cells

RD&D BODIES

IDAE, THE INSTITUTE FOR ENERGY DIVERSIFICATION AND SAVING

While IDAE is primarily engaged in marketing and supporting established technologies, some of its work is attempting to provide the bridge from the laboratory to the market. IDAE has in the past been involved in the development of innovative products, such as LED traffic lights or biomass co-generation.

CIEMAT, THE ENERGY, ENVIRONMENTAL AND TECHNOLOGICAL RESEARCH CENTRE

CIEMAT is a public research body with a special focus on the fields of energy and the environment, and is attached to the Ministry of Education and Science. In 2004, the total financial resource of CIEMAT was EUR 85m, including internal financial assets, and it had a final budget of EUR 69m. Not all of this was spent on energy-related research. Non-energy research covered a group of projects, among others on particle physics, astrophysics and molecular biology.

CIEMAT has maintained its research capabilities across all areas of energy production, distribution and use, and runs specific programmes in the areas of nuclear fission and fusion, renewables and fossil fuels. Additionally, it has carried out a wide range of activities in the study of the environmental impact of energy and the socio-economic aspects associated with energy production and use.

CIEMAT's 2004 energy research expenditure was allocated as follows:

- 29% for nuclear and particle fusion
- 24% for environmental impact of energy
- 22% for renewable energy
- 16% for nuclear fission technologies
- 9% for fossil fuel technologies

Apart from being directly attached to the Ministry of Education and Science, CIEMAT also has a close relationship with the Ministry of the Environment, and various regional and local administrations. It also co-operates closely with the CSN and ENRESA, providing technical support on different topics for which these bodies are responsible. CIEMAT's particular focus in 2003 was on the following projects:

- Developing the Centre for the Development of Renewable Energies (CEDER) in Soria, where CIEMAT grouped together all the research it conducts on combustion and gasification plants using biomass. The objective is to turn the CEDER into a reference centre for the treatment of, and energy extraction from, biomass and waste.
- The Fuel Cells and Hydrogen Programme, where CIEMAT is participating actively in the main European initiatives and promotes co-operation between the different Spanish research groups and companies.

- The reactivation of the nuclear technology and safety research capabilities of CIEMAT, developing co-operation with the rest of the nuclear industry, and pushing forward Spain's integration into international initiatives of advanced and 4th generation nuclear systems.

CIEMAT's R&D projects have achieved the following results during the 3rd National Plan's duration:

Nuclear Technology and Radiation Protection

In the field of nuclear fission, research was undertaken aimed at improving the safety of the Spanish nuclear plants and at developing better indicators to help assess the ageing process that currently commissioned nuclear reactors undergo. CIEMAT also participated in the key European projects aimed at obtaining new data on sub-critical systems. Work has also continued on advanced nuclear fuel cycles, where CIEMAT continues its work in the field of radiation protection and management of radioactive waste; the projects in this area are driven by the needs of CSN and ENRESA and by the initiatives of the main international bodies in this field.

Research on the behaviour of materials and processes in a deep geological repository (DGR) of high-level radioactive waste was carried out under ENRESA and European Union R&D programmes. The study of the geological barrier (granite or argillaceous rocks) has provided some important results, confirming the suitability of both types of rocks for establishing a DGR. CIEMAT continues to participate in the main European projects on DGR.

The National Laboratory for Magnetic Containment Fusion at CIEMAT has focused on the scientific and technological operation of the Stellarator TJ-II which is part of the European fusion programme. The laboratory team continued to participate in the operation of the European JET device, and in comparative studies of the Stellarator TJ-II and the Tokamak JET. CIEMAT also continued to participate in the multidisciplinary PhD programme "Plasmas and Nuclear Fusion" in co-operation with various universities. One of the most important projects was the work on the Spanish proposal to locate the ITER fusion reactor project at Vandellós, although this proposed location has now been withdrawn in the competition, and the Spanish government is supporting Cadarache in France over Rokkasho in Japan as a site for the project.

Fossil Fuels and Pollution

Within the combustion and gas technology section, joint projects have started with various private and public organisations aiming to develop and deploy advanced combustion and gas systems. Special emphasis is placed on fluidised bed systems and the treatment, purification and separation of flue gases.

OCEM-CIEMAT has continued to provide technical support to the Ministry of the Economy on the *in situ* follow-up and control of emissions measurement systems of large combustion plants (LCP) of the power industry, and has contributed to the drafting of regulations which will implement the relevant European directive.

Hydrogen and Fuel Cells

In the field of fuel cells (FC) research, projects on polymer exchange membrane (PEM), molten carbonate (MC) and solid oxide (SO) fuel cells were carried out. For PEMFC new electro-catalysts are being developed. Advances have been made in developing cathode materials that are more resistant to corrosion in the very hot working conditions of the MCFC and development has begun on new materials for SOFC. CIEMAT also took part in a project aiming to develop a city bus driven by a PEMFC using hydrogen as fuel. CIEMAT is also participating in the main European initiatives promoting hydrogen technologies and fuel cells and the IEA Hydrogen Co-ordinating Group (HCG).

Studies on hydrogen began with the building and running of a demonstrator integrating photovoltaic panels, an electrolyser for the production of hydrogen and metal hydrides for storage. Another project for solar production of hydrogen and synthesis gas from heavy waste oil was carried out at the Almería Solar Platform. This initiative is a move towards the development of "solar fuels". Agreements to further progress in this field of research have been signed between CIEMAT and Petróleos de Venezuela and the Mexican Petroleum Institute.

Renewable Energy

CIEMAT has maintained its RD&D activity on renewable energy in the areas of biomass, wind, solar photovoltaic and solar thermal in the centres of Madrid, Soria and Almería, and through its participation in the National Centre for Renewable Energies (CENER).

Within the biomass sector, work has continued on the evaluation of the potential of biomass resources, the standardisation of solid biofuels and the techniques of pre-treatment required for their use either in stand-alone or in combined applications with other carbon or waste product streams. The energy balance of the first 1 500 hectare harvest of energy crops of Brassica Carinata is also currently evaluated. This project represents the first commercial demonstration of an energy crop in Spain. As technological support to industry, an analysis has been made of the characteristics of 200 samples from 19 companies working in the sector. There has also been participation in the drawing-up of national and European technical specifications and regulations relating to biomass.

Following the strategy for developing the CEDER biomass research centre, special attention has been paid to projects for the treatment and harnessing of waste in energy production. A plant for the production of biogas from circulating fluidised bed combustion is being finished. New plants are being set up in co-operation with the private sector. These are aimed at developing pre-treatment and combustion methods for biomass, and treatment methods for sewage sludge or other waste flows.

Research has continued into the potential for the improvement of wind energy generation systems, focusing on systems isolated from the electricity grid. Monitoring is also taking place on the installation of a wind (10 kW), photovoltaic (5 kW), and diesel (10 kW) hybrid system with energy storage using batteries and controlled by a modular control and management system developed by a Spanish company.

In solar photovoltaic energy, CIEMAT has focused its research on the development of basic technology for thin layer photovoltaic devices, as well as on the improvement of the performance and reliability of photovoltaic components and systems to enhance the competitiveness of this type of electricity production in various applications.

The Almería Solar Platform (PSA) continues to be the most important European installation in the field of the concentrating solar energy. In addition to its own projects and training activities, the PSA actively participates as a technological advisor in the development of the first three projects for commercial demonstration promoted by different consortia of companies in Spain.

Other Activities

CIEMAT has continued to work on technological innovation evaluation in the energy sector through its activity in the Observatory of Technological and Industrial Prospection (OPTI). A book called *Technological Development 2002* has been published with results from these evaluation activities.

The economic assessment of externalities from generation and consumption of electricity and transport has continued, and CIEMAT has begun activity in the field of energy modelling. A study using the EXTERN-E methodology has been undertaken to evaluate the externalities of future thermonuclear fusion plants for electricity generation. CIEMAT has also undertaken a financial assessment based on scenario modelling of the environmental and health effects of urban air pollution in Madrid and neighbouring provinces. An analysis of the lifecycle impact of biofuels (bioethanol and biodiesel) is currently under way in co-operation with the Ministry of the Environment, aiming to quantify the environmental impacts of these fuels across their lifecycle.

A co-operation agreement has been signed between the Department of Universities, Research and Information Society of the Generalitat de Catalunya (Catalan regional government), CIEMAT, the Autonomous University of Barcelona, and the IFAE of Barcelona to establish a science and technology centre called Scientific Information Gateway (PIC).

CRITIQUE

Spain's energy R&D is now conducted under the 4th National Plan for Energy RD&D (2004-2007) programme. The funding of the 4th National Plan is EUR 42-44m over three years. The total budget has been increased from EUR 34m in the 3rd National Plan. This is encouraging given that the R&D activities of the private energy sector could be reduced as a result of further market liberalisation in Spain. Nevertheless, the Spanish energy R&D budget per thousand units of GDP in 2003 was 0.07, still lower than other European countries (*e.g.* 0.12 for Germany, 0.23 for Italy) and other IEA countries (*e.g.* 0.25 for the US). Sustained budgetary support to R&D should be continued and further strengthened.

Research activities funded by the government should attempt to bring in private partners where appropriate in order to enhance the cost-effectiveness of public research spending. Spanish energy industry players believe that the public-private co-operation in the field of energy RD&D is not strong enough, and that this co-operation should be further strengthened.

The target of the 4th National Plan is to guarantee environment-friendly energy supply through cleaner and more efficient energy uses and increasing renewable energy. The Ministry of Industry, Tourism and Trade is managing this programme, even though CIEMAT (Centre for Energy, Environmental and Technological Research), the public research institute, is the main implementing body of the programme. Because the control of CIEMAT has recently been shifted from the Ministry of Industry, Tourism and Trade to the Ministry of Science and Education, it should be ensured that this shift will not weaken the close links and the consistency that currently exists between the activities of CIEMAT and the national energy policy.

While CIEMAT was originally a nuclear research body, its current portfolio is reasonably well diversified (nuclear fission 15%, fossil fuel 8%, fusion 27%, renewables 21%, environmental impact 22%, etc.). This portfolio seems to reflect well the current priorities of the Spanish energy policy.

Currently, Spain is actively participating in the energy research programme under the European Union. It is also participating in twelve Implementing Agreements of the IEA. Such participation in international technology collaboration is commendable. The Spanish authorities are currently reconsidering their participation in Implementing Agreements. This

reconsideration should be in line with the strategy of the 4th National Energy RD&D Plan. Recent reviews of international energy technology collaboration might provide good references for this matter.

RECOMMENDATIONS

The government of Spain should:

- *Continue and further strengthen a sustained support to energy RD&D.*
- *Ensure close co-ordination between the Ministry of Education and Science and the Ministry of Industry, Tourism and Trade in the implementation of the national energy RD&D programme.*
- *Further enhance public-private co-operation.*
- *Continue and deepen the evaluation of the performance of the energy R&D programme.*

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2002	2003	2010	2020	2030
TOTAL PRODUCTION		**11.3**	**34.6**	**31.8**	**33.0**	**..**	**..**	**..**
Coal[1]		6.5	11.7	7.5	7.0	..	..	..
Oil		0.7	1.2	0.3	0.3	..	..	..
Gas		0.0	1.3	0.5	0.2	..	..	..
Comb. Renewables & Waste[2]		0.0	4.1	4.3	4.7	..	..	..
Nuclear		1.7	14.1	16.4	16.1	..	..	..
Hydro		2.5	2.2	2.0	3.5	..	..	..
Geothermal		–	–	0.0	0.0	..	..	..
Solar/Wind/Other		–	0.0	0.8	1.1	..	..	..
TOTAL NET IMPORTS[3]		**42.5**	**56.6**	**101.9**	**102.7**	**..**	**..**	**..**
Coal[1]	Exports	0.0	0.0	0.5	0.5	..	..	..
	Imports	2.2	7.1	14.8	13.3	..	..	..
	Net Imports	2.2	7.1	14.4	12.7	..	..	..
Oil	Exports	4.3	12.3	6.2	7.0	..	..	..
	Imports	45.3	61.8	81.2	82.7	..	..	..
	Bunkers	1.4	3.7	6.8	7.0	..	..	..
	Net Imports	39.6	45.9	68.1	68.7	..	..	..
Gas	Exports	–	–	–	–	–	..	..
	Imports	0.9	3.7	18.9	21.2	..	..	..
	Net Imports	0.9	3.7	18.9	21.2	..	..	..
Electricity	Exports	0.2	0.3	0.6	0.7	..	..	..
	Imports	0.0	0.3	1.1	0.8	..	..	..
	Net Imports	–0.2	–0.0	0.5	0.1	..	..	..
TOTAL STOCK CHANGES		**–1.5**	**–0.1**	**–2.1**	**0.4**	**..**	**..**	**..**
TOTAL SUPPLY (TPES)		**52.4**	**91.1**	**131.6**	**136.1**	**170.2**	**..**	**..**
Coal[1]		9.0	19.3	21.6	20.1	15.1	..	..
Oil		38.4	46.5	67.3	69.0	81.6	..	..
Gas		0.9	5.0	18.7	21.3	37.0	..	..
Comb. Renewables & Waste[2]		0.0	4.1	4.3	4.7	13.4	..	..
Nuclear		1.7	14.1	16.4	16.1	16.5	..	..
Hydro		2.5	2.2	2.0	3.5	3.3	..	..
Geothermal		–	–	0.0	0.0	0.0	..	..
Solar/Wind/Other		–	0.0	0.8	1.1	2.8	..	..
Electricity Trade[4]		–0.2	–0.0	0.5	0.1	0.4	..	..
Shares (%)								
Coal		*17.2*	*21.2*	*16.4*	*14.8*	*8.9*	..	..
Oil		*73.3*	*51.0*	*51.1*	*50.7*	*48.0*	..	..
Gas		*1.8*	*5.5*	*14.2*	*15.7*	*21.8*	..	..
Comb. Renewables & Waste		*–*	*4.5*	*3.3*	*3.5*	*7.8*	..	..
Nuclear		*3.3*	*15.5*	*12.5*	*11.8*	*9.7*	..	..
Hydro		*4.7*	*2.4*	*1.5*	*2.6*	*2.0*	..	..
Geothermal		*–*	*–*	*–*	*–*	*–*	..	..
Solar/Wind/Other		*–*	*–*	*0.6*	*0.8*	*1.6*	..	..
Electricity Trade		*-0.3*	*–*	*0.3*	*0.1*	*0.2*	..	..

0 is negligible, – is nil, .. is not available.

Please note: The forecast data for 2010 have been estimated by the IEA Secretariat based on the official 2011 Spanish forecasts, assuming a linear growth between 2003 and 2011.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2002	2003	2010	2020	2030
TFC	**39.9**	**62.5**	**94.6**	**100.2**	**127.7**	**..**	**..**
Coal[1]	4.0	3.2	1.5	1.6	2.2	..	..
Oil	30.1	39.9	57.7	60.2	73.8	..	..
Gas	0.7	4.6	14.2	15.8	22.9	..	..
Comb. Renewables & Waste[2]	–	3.9	3.5	3.8	4.9	..	..
Geothermal	–	–	0.0	0.0	0.0	..	..
Solar/Wind/Other	–	–	0.0	0.0	0.3	..	..
Electricity	5.1	10.8	17.7	18.7	23.6	..	..
Heat	–	0.0	–	–	–	..	..
Shares (%)							
Coal	*9.9*	*5.2*	*1.6*	*1.6*	*1.8*	..	..
Oil	*75.6*	*63.9*	*61.0*	*60.1*	*57.8*	..	..
Gas	*1.8*	*7.4*	*15.0*	*15.8*	*17.9*	..	..
Comb. Renewables & Waste	–	*6.3*	*3.7*	*3.8*	*3.8*	..	..
Geothermal	–	–	–	–	–	..	..
Solar/Wind/Other	–	–	–	–	*0.3*	..	..
Electricity	*12.7*	*17.3*	*18.7*	*18.7*	*18.5*	..	..
Heat	–	–	–	–	–	..	..
TOTAL INDUSTRY[5]	**20.7**	**25.3**	**36.4**	**38.4**	**46.6**	**..**	**..**
Coal[1]	3.6	2.9	1.4	1.5	2.1	..	..
Oil	13.4	11.3	14.9	15.0	16.0	..	..
Gas	0.4	3.8	10.8	12.1	17.2	..	..
Comb. Renewables & Waste[2]	–	1.8	1.3	1.5	2.3	..	..
Geothermal	–	–	–	–	–	..	..
Solar/Wind/Other	–	–	–	0.0	–	..	..
Electricity	3.3	5.4	7.9	8.3	8.9	..	..
Heat	–	–	–	–	–	..	..
Shares (%)							
Coal	*17.5*	*11.6*	*3.9*	*3.9*	*4.6*	..	..
Oil	*64.7*	*44.6*	*41.0*	*39.1*	*34.4*	..	..
Gas	*2.0*	*14.9*	*29.7*	*31.5*	*36.9*	..	..
Comb. Renewables & Waste	–	*7.3*	*3.7*	*4.0*	*4.9*	..	..
Geothermal	–	–	–	–	–	..	..
Solar/Wind/Other	–	–	–	–	–	..	..
Electricity	*15.8*	*21.5*	*21.7*	*21.6*	*19.2*	..	..
Heat	–	–	–	–	–	..	..
TRANSPORT[6]	**11.9**	**22.8**	**35.7**	**37.6**	**48.8**	**..**	**..**
TOTAL OTHER SECTORS[7]	**7.2**	**14.4**	**22.6**	**24.2**	**32.3**	**..**	**..**
Coal[1]	0.3	0.3	0.1	0.1	0.1	..	..
Oil	4.9	6.1	7.7	8.2	10.7	..	..
Gas	0.3	0.8	3.4	3.7	5.7	..	..
Comb. Renewables & Waste[2]	–	2.1	2.1	2.1	2.1	..	..
Geothermal	–	–	0.0	0.0	0.0	..	..
Solar/Wind/Other	–	–	0.0	0.0	0.3	..	..
Electricity	1.7	5.1	9.4	10.0	13.4	..	..
Heat	–	0.0	–	–	–	..	..
Shares (%)							
Coal	*4.3*	*2.1*	*0.3*	*0.3*	*0.3*	..	..
Oil	*68.2*	*42.4*	*33.9*	*34.0*	*33.2*	..	..
Gas	*4.1*	*5.8*	*15.0*	*15.4*	*17.5*	..	..
Comb. Renewables & Waste	–	*14.4*	*9.1*	*8.7*	*6.4*	..	..
Geothermal	–	–	–	–	–	..	..
Solar/Wind/Other	–	–	*0.2*	*0.2*	*1.0*	..	..
Electricity	*23.4*	*35.2*	*41.5*	*41.3*	*41.5*	..	..
Heat	–	–	–	–	–	..	..

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2002	2003	2010	2020	2030
ELECTRICITY GENERATION[8]							
INPUT (Mtoe)	**12.6**	**33.0**	**48.9**	**49.4**	**61.1**	**..**	**..**
OUTPUT (Mtoe)	**6.5**	**13.0**	**20.8**	**22.2**	**27.4**	**..**	**..**
(TWh gross)	75.7	151.2	241.6	257.9	319.1	..	..
Output Shares (%)							
Coal	*18.9*	*40.1*	*34.1*	*29.5*	*16.4*	..	..
Oil	*33.2*	*5.7*	*11.8*	*9.3*	*4.6*	..	..
Gas	*1.0*	*1.0*	*13.4*	*15.3*	*31.3*	..	..
Comb. Renewables & Waste	*0.1*	*0.4*	*1.2*	*1.4*	*7.1*	..	..
Nuclear	*8.7*	*35.9*	*26.1*	*24.0*	*19.9*	..	..
Hydro	*38.2*	*16.8*	*9.5*	*15.9*	*12.2*	..	..
Geothermal	–	–	–	–	–	..	..
Solar/Wind/Other	–	*0.0*	*3.9*	*4.7*	*8.5*	..	..
TOTAL LOSSES	**13.4**	**28.4**	**37.0**	**36.7**	**42.4**	**..**	**..**
of which:							
Electricity and Heat Generation[9]	6.1	20.0	28.1	27.2	33.7	..	..
Other Transformation	3.6	2.3	1.2	1.3	..	..	..
Own Use and Losses[10]	3.7	6.1	7.7	8.2	8.7	..	..
Statistical Differences	**–0.9**	**0.2**	**–0.0**	**–0.8**	**–**	**..**	**..**

INDICATORS

	1973	1990	2002	2003	2010	2020	2030
GDP (billion 2000 USD)	276.03	431.41	591.13	605.90	736.06	..	..
Population (millions)	34.81	38.85	40.55	40.81	42.44	..	..
TPES/GDP[11]	0.19	0.21	0.22	0.22	0.23	..	..
Energy Production/TPES	0.22	0.38	0.24	0.24	..	..	..
Per Capita TPES[12]	1.50	2.34	3.25	3.34	4.01	..	..
Oil Supply/GDP[11]	0.14	0.11	0.11	0.11	0.11	..	..
TFC/GDP[11]	0.14	0.14	0.16	0.17	0.17	..	..
Per Capita TFC[12]	1.15	1.61	2.33	2.46	3.01	..	..
Energy-related CO_2 Emissions (Mt CO_2)[13]	141.6	206.7	302.8	313.2	365.3	..	..
CO_2 Emissions from Bunkers (Mt CO_2)	7.0	15.0	30.0	30.8	30.8	..	..

GROWTH RATES (% per year)

	73–79	79–90	90–02	02–03	03–10	10–20	20–30
TPES	4.1	2.9	3.1	3.4	3.2	..	..
Coal	3.0	5.4	0.9	–6.8	–4.0	..	..
Oil	4.1	–0.5	3.1	2.6	2.4	..	..
Gas	6.7	12.3	11.7	13.9	8.2	..	..
Comb. Renewables & Waste	24.8	49.4	0.5	10.4	15.9	..	..
Nuclear	0.4	20.9	1.3	–1.8	0.4	..	..
Hydro	8.2	–5.3	–0.9	79.1	–0.8	..	..
Geothermal	–	–	–	–	–9.4	..	..
Solar/Wind/Other	–	–	65.5	28.5	14.4	..	..
TFC	4.1	1.9	3.5	5.9	3.5	..	..
Electricity Consumption	6.4	3.6	4.2	6.0	3.4	..	..
Energy Production	5.5	7.5	–0.7	3.8	..	..	..
Net Oil Imports	3.2	–0.4	3.3	0.9	..	..	..
GDP	2.3	2.9	2.7	2.5	2.8	..	..
Growth in the TPES/GDP Ratio	1.8	–0.0	0.4	0.9	0.4	..	..
Growth in the TFC/GDP Ratio	1.8	–0.9	0.8	3.3	0.7	..	..

Please note: Rounding may cause totals to differ from the sum of the elements.

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Includes lignite.
2. Comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Total net imports include combustible renewables and waste.
4. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
5. Includes non-energy use.
6. Includes less than 1% non-oil fuels.
7. Includes residential, commercial, public service and agricultural sectors.
8. Inputs to electricity generation include inputs to electricity and CHP. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear and 100% for hydro.
10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Toe per thousand US dollars at 2000 prices and exchange rates.
12. Toe per person.
13. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2003 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

Member countries* of the IEA seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a 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

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. **Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are 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 realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. **Co-operation among all energy market participants** helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention and subsequently abbreviated, this glossary provides a quick and central reference for many of the abbreviations used.

bcm	billion cubic metres.
BWR	boiling water reactor.
CCGT	combined-cycle gas turbine.
CCPO	Spanish Climate Change Prevention Office.
CDM	Clean Development Mechanisms.
CHP/CCP	combined production of heat cooling and power; sometimes when referring to industrial CHP, the term "co-generation" is used.
CIEMAT	Centre for Energy, Environmental and Technological Research.
CLH	Compañia Logistica de Hidrocarburos.
CNC	National Climate Council.
CNE	National Energy Commission.
CNPCE	National Civil Emergency Planning Committee.
CORES	Strategic Reserves Corporation.
CSN	Nuclear Safety Council.
CSRE	National Energy Resources Committee.
CTC	cost of transition to competition.
DGR	deep geological repository.
E4	Spanish government Energy Efficiency Strategy.
EC	European Commission.

ECSC	European Coal and Steel Community.
ELV	Emission Limit Values.
ENRESA	National Radioactive Waste Corporation.
ENUSA	Empresa Nacional de Uranio.
ETS	Emissions Trading Scheme.
EU	The European Union.
GDP	gross domestic product.
GHG	greenhouse gases.
GW	gigawatt, or 1 watt $\times 10^9$.
GWh	gigawatt-hour = 1 gigawatt $\times$ 1 hour.
IDAE	Institute for Energy Diversification and Saving.
IEA	International Energy Agency.
JI	Joint Implementation.
kt	thousand tonnes.
ktoe	thousand tonnes of oil equivalent.
kV	kilovolt, or 1 volt $\times 10^3$.
kWh	kilowatt-hour = 1 kilowatt $\times$ 1 hour.
LED	light-emitting diode.
LNG	liquefied natural gas.
LPG	liquefied petroleum gas.
LUCF	Land Use Change and Forestry.
m^3	cubic metre.
MOU	memorandum of understanding.
Mt	million tonnes.
Mtce	million tonnes of coal equivalent (1 Mtce = 0.7 Mtoe).
Mtoe	million tonnes of oil equivalent; see toe.

MW	megawatt, or 1 watt $\times$ 10^6.
MW_e	megawatt of electrical capacity.
MWh	megawatt-hour = 1 megawatt $\times$ 1 hour.
MWp	megawatt peak.
NAP	National Allocation Plan.
NESO	National Emergency Sharing Organisation.
NERP	National Emission Reduction Plan.
NO_x	nitrogen oxides.
OCI	Research Co-ordination Organisation.
OECC	Spanish Office of Climate Change.
OECD	Organisation for Economic Co-operation and Development.
OMEL	Compañia Operadora del Mercado Español de Electricidad, S.A.; electricity market operator.
OPEC	Organization of the Petroleum Exporting Countries.
PAEE	Energy Saving and Efficiency Plan.
PEN	National Energy Plan.
PFER	Plan for the Promotion of Renewable Energy in Spain.
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between different countries.
PROFIT-Energia	National Energy Programme.
PWR	pressurised water reactor.
REE	Red Electrica de España.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
RES	renewable energy system.
RMUC	Raw Material Unit Cost.

SME	small and medium-sized enterprises.
SO_2	sulphur dioxide.
TEIDE	Technological Programme for Energy R&D.
TFC	total final consumption of energy.
TJ	terajoule, or 1 joule $\times 10^{12}$.
toe	tonnes of oil equivalent, defined as 10^7 kcal.
TPA	third-party access.
TPES	total primary energy supply.
TSO	transmission system operator.
TWh	terawatt-hour =1 terawatt $\times$ 1 hour.
UNFCCC	United Nations Framework Convention on Climate Change.
VAT	value-added tax.
VOCs	volatile organic compounds.

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