INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

GREECE 2002 REVIEW

OECD

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INTERNATIONAL ENERGY AGENCY
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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.

** IEA Member countries: 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 also takes part in the work of the IEA.*

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), the Republic of Korea (12th December 1996) and Slovakia (28th September 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Greece is geographically isolated from other IEA Member countries. It depends heavily on imported energy, especially oil. Lignite is the only major domestic fuel and is extensively used for power generation. Lignite is also a major source of CO_2 emissions and air pollutants. Electricity is expected to be in tight supply over the next three or four years. The Greek government has recognised these problems and is trying to diversify its supply sources. One approach is to increase interconnections of gas, oil and electricity transmission lines with neighbouring countries and the European Union. Another is to increase the use of gas for power generation and other activities. In order to attract investment to meet rapidly growing energy demand, well-designed markets need to be created in both the electricity and gas sectors.

Progress has been made on the institutional framework for market liberalisation. The Regulatory Authority for Energy (RAE) was established in July 2000 as an independent agency, with a mixed advisory and decision-making role. In electricity matters, such as codes, regulations, end-user tariffs and licensing for generation, the RAE gives an opinion. The Ministry of Development makes the final decisions. The RAE has full competence in supervising the Transmission System Operator on third-party access matters, setting end-use natural gas tariffs, unbundling, imposing fines and settling disputes. The RAE is to support the general goals of security of supply, environmental protection and national and regional economic competitiveness. The RAE also provides an opinion on long-term energy planning, which comes under of the Ministry of Development and must be approved by Parliament.

The energy markets in Greece are dominated by highly integrated state-owned enterprises. The government has used this situation to achieve social and economic policy objectives, such as lowering inflation, protecting the competitiveness of energy-intensive industry and indirectly supporting inhabitants in several geographic areas. The aim is achieved through price caps and identical tariffs for all captive electricity consumers. The government has also relied on state-owned enterprises because it lacks the personnel to do detailed planning and to monitor the market. The close relationship between government and the energy companies has resulted in a lack of transparency in the market and in a pattern of discretionary policy actions. Although the situation has improved gradually with market liberalisation and the privatisation of state companies, loosening the ties between the government and state enterprises has become increasingly important to ensure effective competition by new entrants.

In 1995, Greece introduced the "Hellenic Action Plan for the Abatement of CO_2 and Other Greenhouse Gas Emissions". The plan, which aimed to limit the increase in

emissions of CO_2, N_2O and CH_4 from all sources, set a target for the year 2000 of between 12% and 18% above the 1990 level. In 2000, emissions of the three gases were 23.3% above the 1990 level. Under the EU "burden-sharing" agreement to meet the Kyoto Protocol target for 2008-2012, Greece's greenhouse gas emissions target is set at 25% above the 1990 level. CO_2 emissions are expected to grow fast in the future, and so strong additional measures will be needed to meet this target. At present, there is neither a national plan nor an approved package of policies and tools to achieve the target. The first version of a climate change mitigation plan has been completed, but it still needs to be approved by the Minister of Development and the Minister of Environment, Physical Planning and Public Works. This is expected to happen soon, since Greece is moving towards ratification of the Kyoto Protocol. To be effective, however, the plan will need to be supported by an adequate institutional framework and careful monitoring. Greece intends to use the "flexible mechanisms" of the Kyoto Protocol to supplement national measures.

Energy intensity in Greece is a serious concern. It exceeds the IEA Europe average and it is increasing. Significant potential for energy efficiency improvement has been identified. The cost-effectiveness of specific efficiency measures should be taken into account in setting policy priorities. Many specific measures are self-financing and can be taken without relying on subsidies. Measurable targets should be set. The effectiveness of policies should be carefully monitored.

Demand-side measures, to which not much attention has been paid, should be given priority since their energy-saving potential is as great as measures on the supply side. It is commendable that the government is making the effort to use such market-oriented instruments as third-party financing to improve energy efficiency in different sectors. It is also encouraging that the government intends to introduce voluntary agreements with industry as a means to exploit energy-saving potential with demand-side measures. Energy can also be saved in the residential sector. But recently proposed measures, such as tighter building codes and building energy certificates, will only reduce energy consumption in the long term. More immediate results could be achieved by modifying energy prices and taxes and by information campaigns. There has been significant progress in promoting the use of public transport, and the Athens subway system is continuously being expanded. But, efforts need to be strengthened to curb sharply increasing energy demand in this sector, as well as to combat local environmental pollution.

Greek oil demand is forecast to grow by about 40% between 2000 and 2010. The long-term project of building an oil pipeline between Greece and Bulgaria is proceeding, albeit slowly. Although the oil market has been largely liberalised, products may be imported only by refineries, oil marketing companies and a few large oil users. The government justifies this policy by referring to its oil stockholding obligations under the IEA and the European Union. In October 2001, the EU Court of Justice ruled that the existing oil stock regime in Greece was distorting competition. Responding to increasing oil demand in the future will require more stock capacity. For these reasons, Greece is now reviewing its stock management policies. To avoid market distortion and to stimulate competition, direct imports of crude oil and oil products should be allowed, and non-

discriminatory access to oil storage facilities should be ensured. The government has recognised that the oil market is also distorted by tax fraud. It is trying to rectify the situation by new legislation and more effective law enforcement. These problems will be given consideration in a proposed new oil market law. To improve transparency, the management of oil stocks has already been shifted from Hellenic Petroleum S.A. to the government.

Low-quality lignite accounts for 82% of Greece's indigenous energy production and 64% of its electricity supply. While lignite use contributes positively to energy supply security, it also does environmental damage. Programmes are in place to restore the land that has been mined for lignite, and investments have been made to reduce pollutant emissions from lignite-fired power plants. These efforts need to be continued. Even though the government favours the use of gas in power generation, new lignite-fired power plants are licensed, provided they use only state-of-the-art technologies and will not make it more difficult to Greece to meet its greenhouse gas emissions target. The Greek State owns all lignite deposits, and the Public Power Corporation (PPC) had exclusive rights to mine lignite until the electricity market was liberalised and a bidding process was established to lease them. But, as the bidding process was introduced only very recently, there have not yet been any bidders. Today, PPC mines 95% of all lignite in Greece, and uses it in its own lignite-fired power plants.

Greece successfully introduced natural gas into its energy mix in 1996. In 2000, natural gas accounted for 6.1% of primary energy supply, and gas consumption is growing fast. It has already a good footing in power production and has replaced some oil use in the industrial sector. In the future, most growth in gas demand is expected to come in power generation and in the residential and services sectors. The current gas infrastructure is sufficient to meet demand for several years. Considering that an increase in gas demand by a factor of four has been forecast for 2010, the government will be wise to diversify supply sources, to increase liquefied natural gas (LNG) regasification capacity and storage capacity and to build supply links among Greece, Italy and Turkey. The next step should be the liberalisation of the natural gas market, which is still dominated by one incumbent supplier. Under the EU Gas Directive, Greece has a derogation as an emerging market until 2006, but the government is considering opening the market sooner than that date.

The 1995 Climate Action Plan established a target for increasing the share of renewable energy (including large-scale hydro) in primary energy supply to 10% by 2000. The target was not achieved, and the actual renewables share was 5.2% in 2000. A new indicative target has been set to generate 20.1% of electricity by renewables in 2010. The government recognises that the licensing procedures for renewables are still too complex, and it now plans to establish a "one-stop shop" for permits and licences. There is also an effort to identify the potential of new energy sources. The Centre for Renewable Energy Sources investigates their technical and economic aspects. Because of Greece's windy and sunny climate, this potential is significant. Today, renewables are mainly promoted through financial incentives, such as tax breaks, direct subsidies and an attractive feed-in tariff system. The government should explore possibilities of introducing a green certificate system to reduce the cost of promoting renewables.

Electricity supply is forecast to be tight over the coming three or four years, even if all currently planned power plants are in operation. A supply shortage may occur in dry years. Since transmission capacity is limited, imports can play only a marginal role here. It is, therefore, imperative to reform the electricity market promptly so that timely investments can be made by new entrants. Electricity supply is also becoming tight because the summer demand peak is becoming greater and the capacity-utilisation factor of generation is falling. These problems could be abated by tariff adjustments to discourage electricity use in peak times.

Approximately 34% of the Greek electricity market was opened to competition in February 2001. The regulator (RAE) and the Hellenic Transmission System Operator S.A. (HTSO) have been established, and market operators are now required by law to unbundle their accounts. Electricity market regulation thus meets the minimum requirements of the EU Electricity Directive. But much remains to be done to ensure effective competition in the Greek electricity market, which is one of the most concentrated in the European Union. For instance, the state-owned Public Power Corporation (PPC) holds the predominant share of the transmission system operator. When HTSO experienced difficulties in proposing third-party access tariffs, it was because the network owner, PPC, did not provide sufficient cost information. A new set of transmission network tariffs has now been approved by RAE, but it still needs final approval from the Ministry of Development. In the future, the government should ensure that tariffs are adjusted without delay when the network is reinforced.

In the near term, electricity trade with neighbouring countries can have only a very limited direct impact on competition in Greece owing to its limited interconnector capacity and to the higher prices in Italy. Not many new entrants are expected in the near future. Greece's aim to establish a south-east European electricity pool could, however, contribute to increased competition in the long term. The gas-fired power plants that are planned by new entrants will not be commissioned before 2005-2006, and there is a risk that these projects may be delayed. Finding financing for the projects can be difficult in the current climate of high gas prices and low electricity prices. As long as PPC maintains a predominant share in all market segments, the mere separation of its accounts may not be enough to provide a level playing field for new entrants. Additional measures should be taken if sufficient competition does not occur within two to three years.

Electricity prices are distorted. Tariffs in the past were too low to cover the cost of supply, so the government has now announced that it will base tariffs on long-run marginal cost. This may strengthen competition in the market. At the same time, cross-subsidisation should be eliminated for various consumer groups. Electricity prices are uniform throughout the country, including in geographical areas where supply cost is well above the average. Geographical tariff differentiation could promote energy efficiency and provide an incentive to invest in renewables. Aluminium and nickel companies have enjoyed electricity priced well below cost, but such subsidies are to be phased out in 2006 and 2003, respectively. Revenues collected from households have also been slightly lower than the cost of supply, but residential tariffs were increased recently. Agricultural customers are still paying too little compared to cost. Commercial and small industrial consumers pay prices

well above the cost of supply. Specific social policy instruments, not energy prices, should be used to pursue social objectives.

The focus of government research and development programmes on renewables is sensible. More attention may need to be paid to lignite, which continues to play an important role in energy supply. Although Greece participates actively in the European Union's research programmes, there is still room for increasing its participation in IEA Implementing Agreements.

RECOMMENDATIONS

The following are the actions recommended for the Greek government:

General Energy Policy

☐ Continue to diversify energy supply and energy sources, for example by increasing electricity, gas and oil links with other countries.

☐ Enhance efforts to ensure real competition in energy markets; continue the privatisation of energy enterprises, avoid further cross-shareholding in energy companies, and ensure that state involvement in them does not form a barrier for new entrants.

☐ Ensure that the Energy Administration has the resources to carry out its duties; clearly separate the functions of the Energy Administration and the Regulatory Authority for Energy so that regulatory decisions are left to the regulator and policy decisions to the Ministry of Development.

☐ Pursue social objectives by other means than energy taxation and pricing.

☐ Ensure that the objectives of the Operational Programme for Competitiveness are met; the programme should be assessed with measurable criteria.

☐ Continue to make and review supply-demand projections in light of the sharp expected growth in energy demand; improve data collection and processing to provide reliable and timely statistical information to all interested parties.

Energy and the Environment

☐ Complete and implement promptly the "National Programme for Reducing Greenhouse Gas Emissions" and monitor its policies and measures.

☐ Reduce greenhouse gas emissions by putting more focus on demand-side measures.

☐ Ensure that the environmental costs of energy are fully reflected in energy prices.

☐ Carry through with the use of economic instruments, including emissions trading, to reduce greenhouse gas emissions.

☐ Continue efforts to reduce the environmental impact of lignite mining and use.

Energy Efficiency

☐ Formulate a comprehensive and clearly structured policy framework for improving energy efficiency with measurable objectives and targets that can be monitored and verified.

☐ Choose measures based on their cost-effectiveness; give priority to market-oriented instruments. Ensure that government support programmes do not discourage market-oriented approaches.

☐ Give consumers detailed information on their energy use to help them save energy, for instance in connection with energy billing.

☐ Ensure good co-operation with and among all the ministries involved in energy efficiency.

☐ Establish an effective monitoring system to achieve energy efficiency targets; ensure that all programmes are evaluated objectively, preferably by a third party.

Oil

☐ Continue to diversify the sources of oil imports.

☐ Revise oil stock management practices in light of the expected sharp growth in consumption and of the need to stimulate competition; stock management should be revised so that access to stocks is adequate and does not limit import and competition.

☐ Eliminate the remaining price ceiling mechanism and instead develop monitoring of the market.

☐ Develop more effective policies to avoid tax fraud in the oil product market.

☐ Take immediate action with industry to fulfil the IEA emergency reserve obligation.

☐ Submit IEA Monthly Oil Statistics on time.

Natural Gas

☐ Encourage the development of gas infrastructures, including strengthening interconnections and expanding LNG terminal capacity and storage.

☐ Advance its commitment to liberalise the gas markets and encourage private investment; introduce a transparent, cost-effective and non-discriminatory transmission tariff and ensure third-party access.

☐ Allow the construction of private connection pipelines.

☐ Remove the "most favoured customer" contract between the Public Power Corporation (PPC) and the Public Gas Corporation (DEPA).

Renewable Energy

☐ Shift policies for renewables towards a market-oriented approach, including the introduction of portfolio standards and green certificates.

☐ Exploit the cost-effective potential of renewables, paying particular attention to this in the islands.

☐ Speed up the creation of a "one-stop-shop" for licences for renewables.

☐ Ensure that adequate infrastructure is developed in order to exploit fully the potential of renewables in geographically isolated areas.

Electricity and Lignite

☐ Address the problem of capacity margin.

☐ Ensure that, when necessary, third-party access tariffs will be adjusted without delay.

☐ Ensure that electricity prices reflect costs; social pricing and cross-subsidisation should be phased out.

☐ Consider carefully the negative effects of geographically uniform tariffs.

☐ Ensure that the incumbent does not have access to confidential commercial information about new entrants.

☐ Allow the construction of private transmission lines for self-consumption.

☐ Continue efforts to develop the south-east European electricity market.

☐ Prepare to separate distribution and retailing from the other businesses of PPC; as a first step, examine the feasibility of transferring ownership of the transmission network from PPC to HTSO; if competition does not emerge, the government should not preclude splitting PPC's generation assets into several companies with different ownership.

☐ Ensure that captive consumers benefit from the efficiency gains achieved from market liberalisation. Study the benefits of extending market liberalisation to smaller consumers.

☐ With regard to security of supply, the environment and competition, clarify the government position on the future role of coal and lignite in electricity generation.

☐ Improve access to lignite for electricity generators by, for example, ensuring transparency in lignite production costs.

Research and Development

☐ Continue R&D in order to reduce the cost and improve the efficiency of renewables; ensure adequate support for the development and demonstration of clean coal technologies.

☐ Seek opportunities to join international collaboration projects within the European Union and other international organisations, such as the IEA.

☐ Continue to encourage the participation of industry in R&D.

2

ORGANISATION OF THE REVIEW

REVIEW TEAM

The International Energy Agency (IEA) 2002 in-depth review of the energy policies of Greece was undertaken by a team of energy policy specialists drawn from IEA Member countries. The team visited Greece from 19 to 23 November 2001 for discussions with representatives of the Energy Administration and energy industries.

Members of the team were:

Mr Christophe Baulinet (team leader)
Deputy Director-General
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Norway

Mr Manfred Decker
Directorate-General for Energy and Transport
European Commission

Mr Shigetaka Seki
Head, Country Studies Division
International Energy Agency

Ms Lea Gynther
Desk Officer – Greece, Country Studies Division
International Energy Agency

Lea Gynther managed the review and drafted the report. Monica Petit and Bertrand Sadin prepared the figures.

The team consulted with the following organisations:

- The Association of Oil and Petroleum Companies (AOPC)

- Centre for Renewable Energy Sources (CRES)

- Federation of Greek Industries
- Hellenic Petroleum S.A.
- Hellenic Transmission System Operator S.A. (HTSO)
- Managing Authority for the "Operational Programme for Competitiveness"
- Managing Authority for the "Operational Programme for Energy"
- National Observatory of Athens (NOA)
- Prometheus Gas S.A.
- Public Gas Corporation S.A. (DEPA)
- Public Power Corporation S.A. (PPC)
- The Ministry of Development
- The Ministry of Environment, Physical Planning, and Public Works
- The Ministry of Transport
- Regulatory Authority for Energy (RAE)

The assistance and co-operation of all participants in the review are gratefully acknowledged.

REVIEW CRITERIA

The IEA Shared Goals, which were adopted by IEA Ministers at their 4 June 1993 meeting held in Paris, provide the evaluation criteria for in-depth reviews conducted by the Agency. The Shared Goals are set out in Annex B.

3

ENERGY MARKET AND ENERGY POLICY

OVERVIEW

The Greek population numbered 10.6 million in 2000 and is growing moderately. The land area of Greece, which covers 132 000 km^2, consists of a peninsula and 2 000 islands that occupy one-fifth of its territory. This geographical setting with so many isolated islands and mountain areas poses a challenge to energy policy planners. While Greece is quite isolated from other EU markets, its links with south-east European energy markets are stronger.

In 2000, per capita GDP, measured using current purchasing power parities, was €17 400, or almost two-thirds of the OECD and EU averages. This has qualified Greece for EU support, which has been an important source of financing for the development of the Greek energy system. EU-related reforms initiated in the mid-1990s have boosted growth and investment in many sectors. Since then, Greece has made progress in converging with the rest of Europe. Over the last few years, Greece has enjoyed strong economic growth, with the GDP growing at an average 3.5% a year in 1996-2001. Energy use has been growing together with the economy.

ENERGY MARKET

Primary Energy Supply

In 2000, total primary energy supply (TPES) in Greece was 27.8 Mtoe. TPES has grown at an average annual rate of 2.5% over the past decade, but higher growth of 3.8% per year has been forecast by the Greek government for the decade 2000-2010 (Figure 2). Greece's dependence on oil has declined since the early 1970s (77.7% in 1973), but oil still represents 56.1% of all energy. Domestic energy production accounted for 35.9% of TPES in 2000. Although it is expected to increase in volume, indigenous production's share in TPES is expected to fall to 27.5% by 2010. The most important domestic energy source is lignite (Figure 3). Combustible renewables and waste are the second most important domestic energy sources, but much smaller than coal, followed by very small contributions from other renewables and oil.

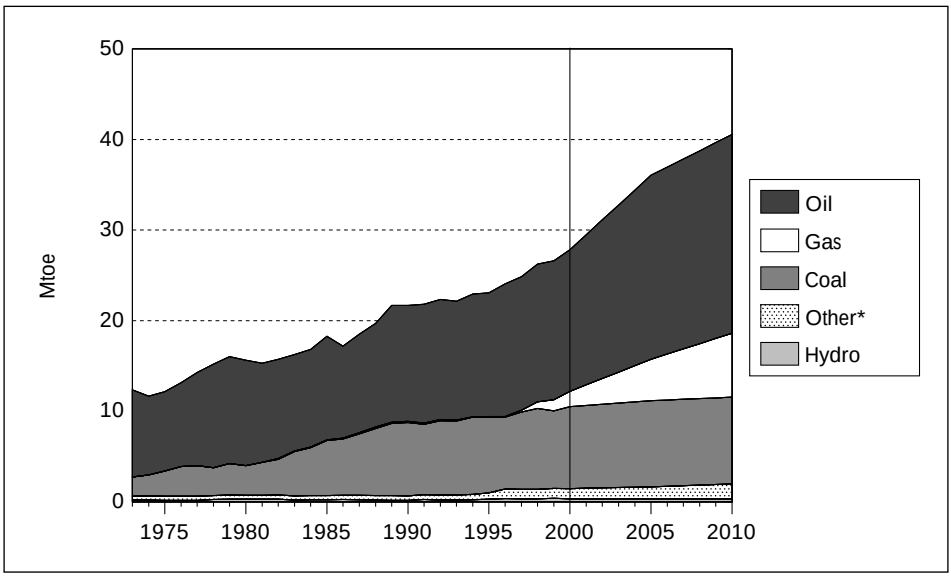
Final Energy Consumption

Total final energy consumption was 19.5 Mtoe in 2000, following average annual increases of 2.6% since 1990, when it was 15 Mtoe. Transport is the largest energy-consuming sector (38%), followed by the residential, services and agricultural sectors (36%) and the industrial sector (27%) (see Figure 5). In 2000, oil accounted

Figure 1
Map of Greece

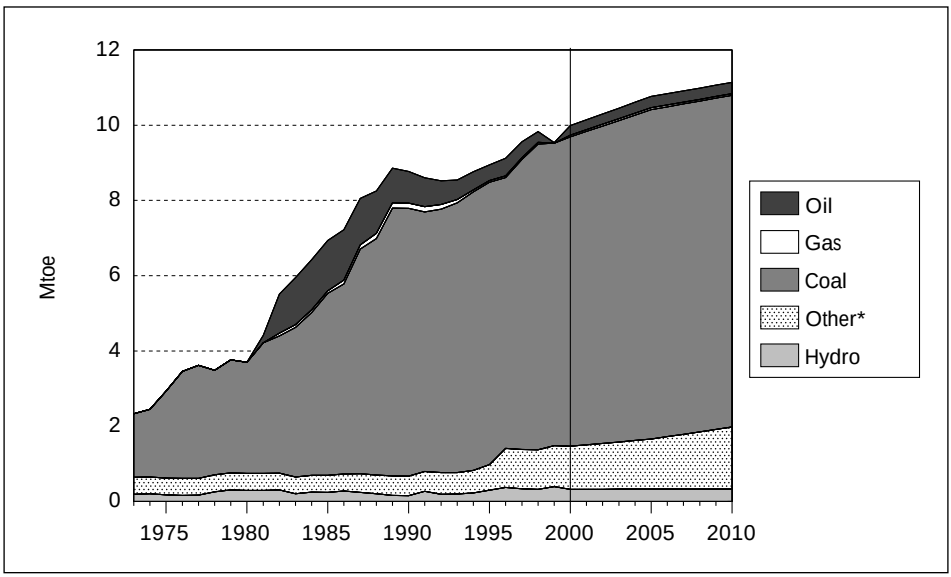
* Former Yugoslavia Republic of Macedonia.

Figure 2
Total Primary Energy Supply, 1973 to 2010



* includes geothermal, solar, wind, combustible renewables and waste.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

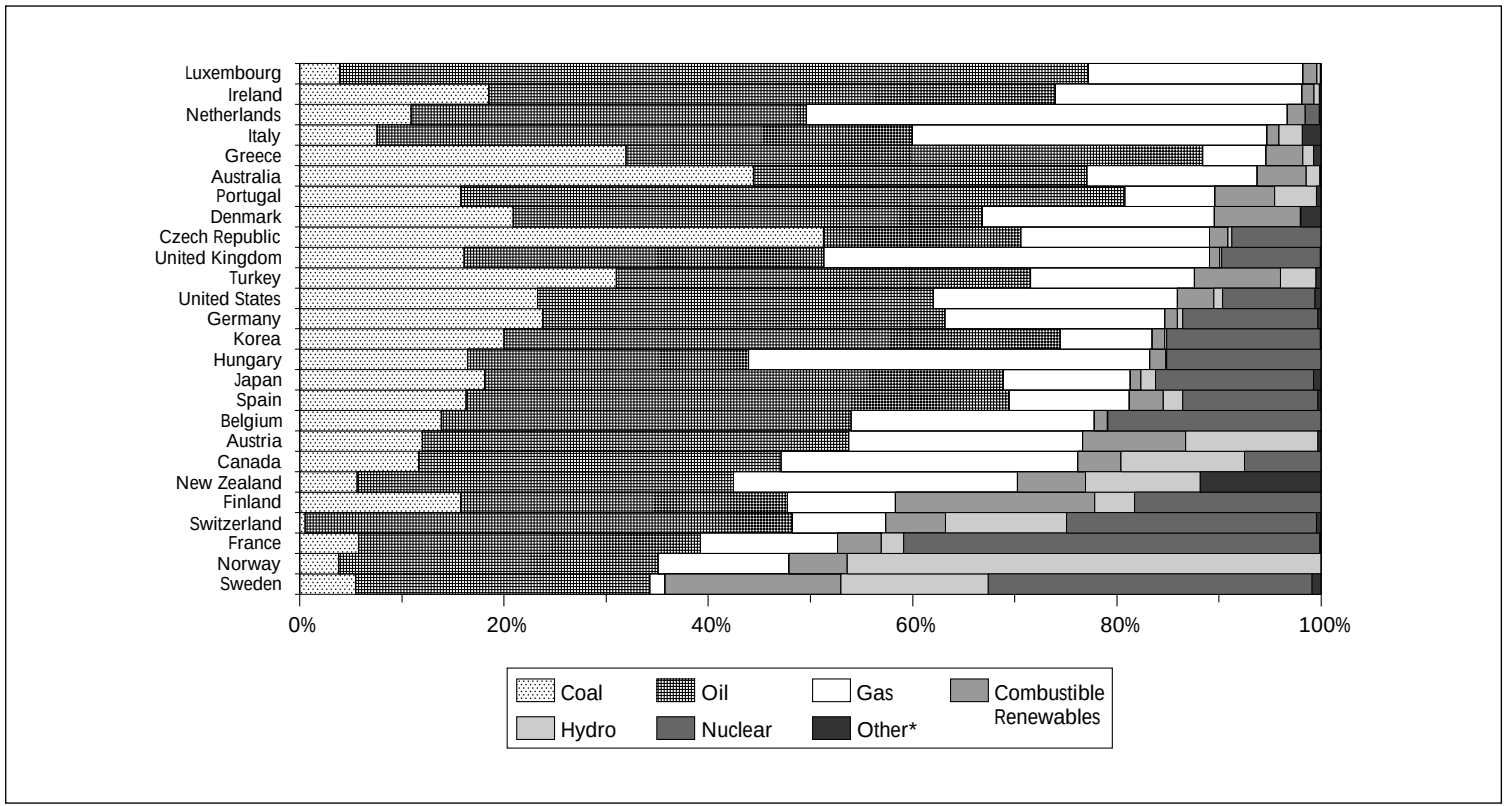
Figure 3
Energy Production by Source, 1973 to 2010



* includes geothermal, solar, wind, combustible renewables and waste.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

Figure 4

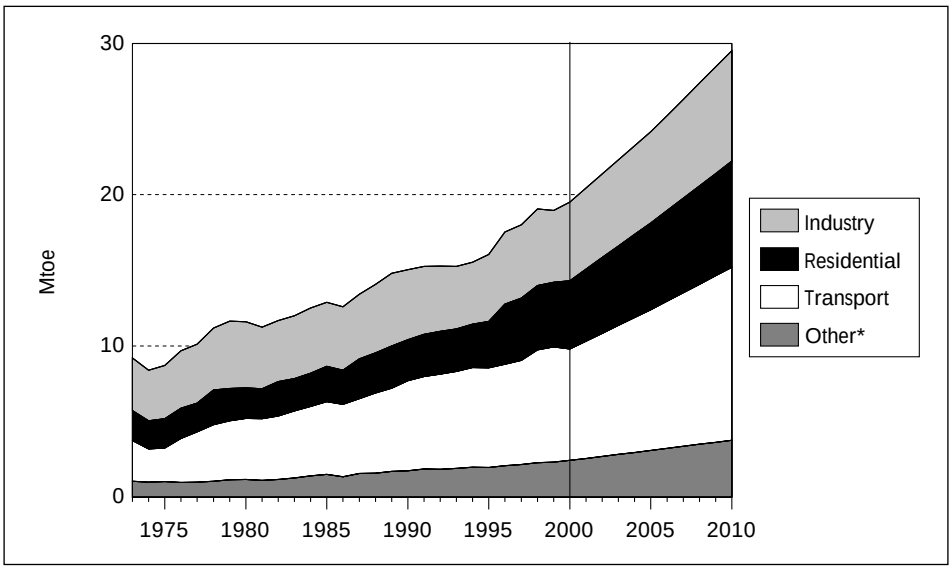
Total Primary Energy Supply in IEA Countries, 2000



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

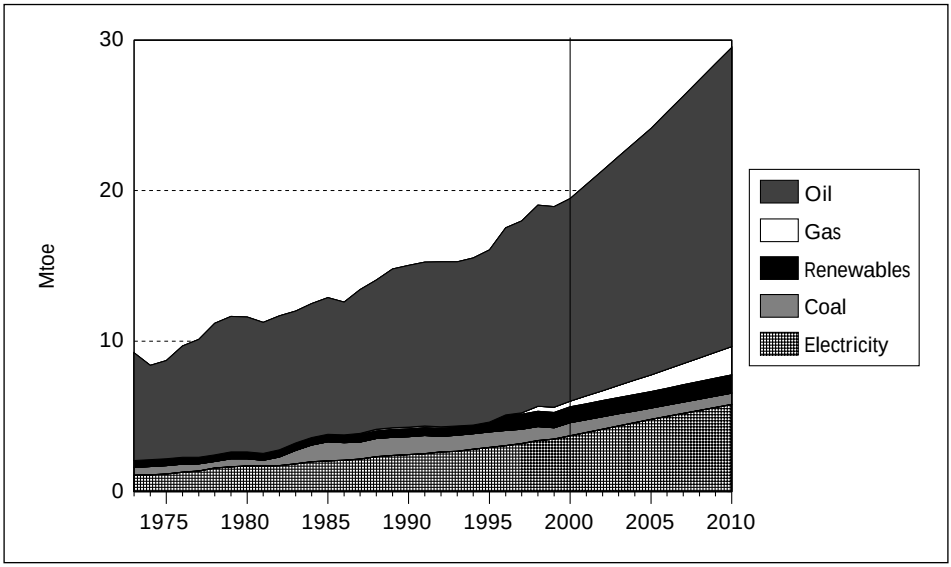
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001.

Figure 5
Total Final Consumption by Sector, 1973 to 2010



* includes commercial, public and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

Figure 6
Total Final Consumption by Source, 1973 to 2010



* includes geothermal, solar, wind, combustible renewables and waste.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

for 69% of final consumption, electricity 19%, combustible renewables and waste 4.9%, coal 4.5%, natural gas 1.9%, other renewables 0.5%, and heat 0.1%. Changes in the proportions of different final energies in the 1990s were small; the shares of coal and oil decreased slightly, whereas those of electricity, gas and renewables increased slightly.

ENERGY POLICY

Energy Policy Objectives

The government's energy policy objectives are defined in its strategy paper "Guidelines of Energy Policy", issued by the Ministry of Development in July 1998. The objectives are:

- Energy security, enhanced by the development of interconnections with neighbouring countries, diversification of energy sources and reduction of dependency on energy imports.
- Introduction of natural gas.
- Increasing the use of indigenous primary energy sources, including renewables.
- Reduction of total final consumption compared to GDP by promoting energy savings and the rational use of energy in all sectors.
- Reduction of CO_2 emissions.
- Energy market reform, including economic restructuring, reduction of the role of the State in the economy, partial liberalisation of the electricity sector and increasing competition in the whole energy sector.
- Research and development on new technologies.
- Stimulating investments in the energy sector.

Energy Policy Institutions

Principal responsibility for energy, including regulation, lies with the Ministry of Development. Within the ministry, energy issues are dealt with by the General Directorate of Energy (hereafter the Energy Administration), which has a specialist

staff of about 20. The Ministry of Environment, Physical Planning and Public Works is responsible for issues related to household energy use and the environmental impact of energy transformation and energy use. The Ministry for Transport is responsible for energy issues related to transport.

An independent Regulatory Authority for Energy (RAE) was established in July 2000 to work as an advisory body to the Ministry of Development. The RAE has some powers of decision, such as imposing fines for violations of electricity market legislation and regulation. It has administrative and economic autonomy, but the Ministry of Development appoints its members and monitors the legality of its decisions. The RAE is composed of a board of five commissioners, including a chair and a vice-chair, each appointed for a 5-year term, which is renewable once. The appointment of the chair and vice-chair requires approval from a parliamentary committee. The members of the RAE cannot be dismissed except in the event of irrevocable conviction for an offence in accordance with the Civil Service Code. The total number of specialist staff in the RAE Secretariat will be 50 once recruitment has been completed; in the meantime, the RAE operates with temporary staff. Its annual budget of approximately €4.4 million is derived from the fixed fees on final electricity, gas and oil charges.

The RAE's responsibilities are principally in the electricity sector. Legislation does not give the RAE a specific role in the oil and gas markets except where actions in these markets have a direct impact on the electricity sector. However, the RAE is fully responsible for issues relating to natural gas distribution and retail sales. A draft decree giving the RAE responsibilities in oil sector regulation is being prepared. The RAE's specific tasks are to:

- Advise the Ministry of Development on the granting of licences.
- Monitor the electricity market and collect information.
- Impose fines for non-compliance.
- Make proposals for the adoption of new measures and regulations.

The RAE also advises the Ministry of Development on energy policy formulation. In this role, it is now preparing a draft report, "Long-Run Energy Plan for Greece". After approval by the ministry, this strategy paper will be submitted for public consultation and will then be subject to parliamentary approval. To support this activity, the RAE carries out energy modelling and forecasting in parallel to similar activities carried out by the ministry.

The 1995 Gas Law required the establishment of an independent "Board of Energy Planning and Control" with a general advisory and information role for energy matters and with special competence in gas issues. The board was to be established by December 1997, but this did not happen because of doubts over its enforcement capacity and independence. The 1999 Electricity Market Law has transferred these tasks to the RAE.

OPERATIONAL PROGRAMMES FOR ENERGY AND COMPETITIVENESS

The EU Community Support Framework[1] has provided financial resources to the Operational Programme for Energy (OPE) and the Operational Programme for Competitiveness (OPC). These programmes have subsidised a number of energy-related projects in Greece, and have also helped to establish the RAE and the electricity Transmission System Operator.

The OPE was launched in January 1994 and continued until the end of 2001. The last contracts under this programme were made at the end of 1999, and some remain to be completed after the end of the programme in 2001. The budget has been used for projects in the following five areas:

- Increasing electricity production capacity (3 PPC projects with a total budget of €561 million).
- Private investment projects in energy conservation and renewable energy sources (332 investments with a total budget of €477 million).
- Development of renewable energy sources, including studies on wind potential and demonstration projects (23 investments with a total budget of €20 million).
- Exploitation of domestic energy sources, including lignite and geothermal energy (48 investments with a total budget of €24 million).
- Development of the National Information System and other projects to support energy policy (10 investments with a total budget of €2.9 million).

The total budget for the programme was €1.1 billion. The EU contributed 33.8%, the Public Power Corporation (PPC) 39.6%, private sources 21%, and the State 5.6%.

The OPE was managed by a separate authority within the Ministry of Development. OPE project proposals were appraised by independent evaluators. The accepted projects were subject to continuous monitoring and energy audits, and a full evaluation of the programme will be completed by the end of 2002. Most, but not all, of the energy objectives set for the programme were achieved in the areas of installed capacity of large-scale electricity generation, co-generation and generation from renewables. But private investments were smaller than originally estimated. The delivery of natural gas was delayed, the introduction of feed-in tariffs for co-generation was too slow and there were licensing problems for renewables and co-generation in Attica (the region surrounding Athens). More information on the targets and achievements of the OPE can be found in the respective chapters of this report.

1. The framework provides funding for EU member States having a per capita national product of less than 90% of the EU average.

The Operational Programme for Competitiveness was launched in 2000 and it will continue until the end of 2006. It applies not only to the energy sector but also to a variety of other economic activities. The four sub-programmes with energy objectives are described in Table 1. Calls for energy project proposals were first launched in 2001: of a total budget of €510 million, €170 million came from EU Community Support Framework grants. So far, the programme has received 310 proposals from the private sector for projects on renewables, co-generation and energy efficiency. For electricity generation project proposals, the prerequisite was either a production licence or a positive recommendation from the RAE to the Ministry of Development.

Table 1
Operational Programme for Competitiveness: Sub-programmes with Energy Objectives

Sub-programmes	*Energy objectives*
Support and encouragement of entrepreneurship	Increased use of renewables and combined heat and power generation (CHP), energy conservation, fuel substitution, environmental protection.
Promotion of excellence in enterprises	Improvement of the quality and management of CHP, renewables and energy conservation technologies; increased competitiveness of Greek energy technology.
Security of energy supply and promotion of liberalised energy markets	Energy infrastructure to support security of electricity supply in the islands and security of gas supply; reinforcement of energy infrastructure to promote more electricity generation from renewables; improved operation of the liberalised electricity market; support for the establishment and operation of the RAE and HTSO; preparation for gas market liberalisation.
Energy and sustainable development	Transmission and use of energy in an environment-friendly manner; rational use of natural resources.

Source: The Managing Authority for the Operational Programme for Competitiveness

Energy Taxation

The government has used energy taxation to influence energy use and pursue social and economic objectives. For instance, to encourage the use of natural gas, the government exempted it from excise taxes until 2010. For public welfare reasons, excise taxes on heating oil are lowered during the winter. At the beginning of 2002, the excise tax on heavy fuel oil was halved to €19 per tonne[2] to increase industrial

2. On average in 2001, US$ 1 = Dr 380.5 or €1.117. (€1 = Dr 340.75, which is the irrevocable conversion rate of 1 January 1999).

Table 2
Energy Taxes in Greece, 2000
(in euros)

Sector/fuel	*Excise tax euro/unit*	*VAT*[4] *%*
Households/electricity	0	8
Households/natural gas	0	8
Households/heating oil (25 April – 14 October)	0.247/litre	13 to 18[1]
Households/heating oil (15 October – 24 April)	0.018/litre	13 to 18[1]
Households/coal	0	18
Non-commercial use/premium leaded gasoline	0.341/litre	13 to 18[1]
Non-commercial use/premium unleaded gasoline	0.301/litre	13 to 18[1]
Non-commercial use/diesel	0.247/litre	13 to 18[1]
Industry/electricity	0	-
Industry/natural gas	0	-
Industry/fuel oil	38.74/tonne[2]	-
Industry/coal	0	-
Industry and commercial use/diesel	0.247/litre[3]	-

[1] VAT on oil products is 18% in the mainland and 13% in some of the islands.
[2] Both light and heavy fuel oil. Both high (1999 data) and low sulphur (2000 data) fuels.
[3] As of 2 December 1999, diesel for electricity production has had an excise tax of €0.12 per litre.
[4] VAT is not shown for industry, electricity generation and automotive diesel for commercial purposes because it is refunded.

Sources: *Energy Prices and Taxes, Third Quarter 2001*, IEA/OECD Paris, 2001, and the Ministry of Development.

competitiveness. While the general rate of value-added tax is 18%, VAT on natural gas has been reduced to 8%, and in 1999 VAT on electricity was also reduced to 8%. On certain islands, VAT on oil supply is 13% (instead of 18%) to lower the social impact of higher fuel prices. Besides taxes set by the central government, municipalities may impose a 2% tax on electricity generation from renewables in their area. The tax was introduced to enhance public acceptance of renewables, mainly wind power, because in some parts of the country there was public opposition to their use. The accumulated funds of the municipal tax are used to benefit the local economy.

ENERGY STATISTICS

With the help of the Centre for Renewable Energy Sources (CRES), the government has developed a National Information System for Energy to improve the availability and quality of energy data. The system was created to assist in monitoring the energy sector, support decision-making in energy policy and planning and provide energy data to all interested parties. It is already in operation and accessible through the Internet. But the system still needs to be improved. For example, energy consumption data are not sufficiently disaggregated to allow effective monitoring and analysis of sectoral trends.

CRITIQUE

Though Greece's dependency on oil has decreased since the early 1970s, it is still higher than that of most other IEA countries. The government has been trying to diversify by introducing natural gas and increasing the supply of renewables. Yet energy demand is rising fast, and the share of oil in TPES may increase even further if the use of gas and renewables does not grow as the government expects. Increasing the production of domestic lignite could reduce dependence on oil but would create additional environmental problems. Security objectives could be achieved by developing interconnections with neighbouring countries for electricity, gas and oil supply, but this would require attracting substantial private investment, and to do so market reform is essential. Energy efficiency improvement is another important area that has not been given sufficient priority in the past.

It is commendable that Greece has steadily reduced direct state involvement in energy supply and has improved the functioning of public energy companies. The state-owned company Hellenic Petroleum has been partially privatised, and the privatisation processes for PPC and DEPA have been launched. The first step has been taken to liberalise the electricity market. An independent regulator and a Transmission System Operator have been put into place. Nevertheless, not much real change can be observed in either the market structure or fuel structure, except for the introduction of gas, whose share in TPES is still very limited. Much remains to be done in energy market reform to attract sustainable investment in energy.

Greece's energy markets are still highly integrated and dominated by state-owned enterprises. Although legislation has been changed to meet the EU Electricity Directive's minimum requirements, these changes are not extensive enough to create true competition. To encourage new entrants, the government should eliminate any possibility for incumbent monopolies to abuse their dominant positions. Further privatisation of state enterprises should be sought. Hellenic Petroleum owns a significant part of the shares of DEPA, the gas monopoly, of which PPC has a standing option to purchase a part. The government should be very careful that such cross-shareholding does not become a barrier to competition. More attention should also be given to the transparency of regulation, as discussed below.

The Energy Administration has a serious problem of understaffing, which is making it difficult to carry out its continuously expanding duties. It has till now depended on human resources from state enterprises, giving rise to concerns that this is creating too close a relationship between government and industry. As the energy market becomes increasingly liberalised and new entrants are encouraged to take part, government needs to keep industry more at arm's length. The Energy Administration also needs to develop its own policy-making capacity. At present, the RAE is acting as a consultant to the government by giving opinions on long-term energy planning. This is a unique situation compared to other countries, where regulators concentrate only on their regulatory function. Since establishing regulations and monitoring the market are very important at the outset of market reform, the government should ensure that the RAE's regulatory function remains unaffected by its consultancy role.

The government also needs to clarify its regulatory role, given that it is still the major owner of influential energy companies. To ensure transparency and fairness of regulation, the government should find a way to transfer to the RAE final regulatory authority for generation and supply authorisation, tariffs and access to transmission and distribution.

The government has used energy pricing and taxation to control inflation and pursue social objectives. This practice has brought uncertainty and distortion to the markets. It may also be discouraging energy efficiency efforts. For instance, lower electricity prices are set for some poorer households. This may be detrimental to energy efficiency, because consumers use energy more rationally if the prices they pay accurately reflect costs. Social objectives could be better addressed by direct support to the needy.

EU financing through the Operational Programmes for Energy and Competitiveness has provided substantial investment subsidies for energy projects in Greece. Progress of the Operational Programme for Energy was carefully monitored, and most of its energy objectives were achieved. But it is not clear whether the objectives were correctly set, as energy efficiency improvement had little weight in the overall assessment of the projects proposed for financing. Likewise, progress under the Operational Programme for Competitiveness should be carefully monitored, and corrective actions taken if it appears that the objectives are not being met. The objectives of the OPC have been clearly defined, but they should be made more measurable.

There are also some problems with energy statistics. In January 2002, the statistics for 2000 were not yet complete and the data not satisfactorily disaggregated for monitoring the market. As markets are progressively liberalised, and policy-makers and potential investors need more timely and accurate information on market development, much still needs to be improved in government energy statistics. The new National Information System is likely to help in this respect. In Greece, both the government and the RAE make future supply-demand projections for all energies, but the responsibility for creating the energy forecast is not clearly defined either for the government or the RAE. Although the RAE needs information on the

development of electricity and gas markets, there is no reason why the RAE should duplicate government work.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Continue to diversify energy supply and energy sources, for example by increasing electricity, gas and oil links with other countries.
- ☐ Enhance efforts to ensure real competition in energy markets; continue the privatisation of energy enterprises, avoid further cross-shareholding in energy companies, and ensure that state involvement in them does not form a barrier for new entrants.
- ☐ Ensure that the Energy Administration has the resources to carry out its duties; clearly separate the functions of the Energy Administration and the Regulatory Authority for Energy so that regulatory decisions are left to the regulator and policy decisions to the Ministry of Development.
- ☐ Pursue social objectives by other means than energy taxation and pricing.
- ☐ Ensure that the objectives of the Operational Programme for Competitiveness are met; the programme should be assessed with measurable criteria.
- ☐ Continue to make and review supply-demand projections in light of the sharp expected growth in energy demand; improve data collection and processing to provide reliable and timely statistical information to all interested parties.

4

ENERGY AND THE ENVIRONMENT

CLIMATE CHANGE

Greenhouse Gas Emissions

To meet its commitment under the Kyoto Protocol to the UN Framework Convention on Climate Change, Greece has agreed – in accordance with the EU "Burden-Sharing Agreement" – not to increase its total greenhouse gas (GHG) emissions by more than 25% above its base year level[3] for the first commitment period of 2008-2012. This means that Greece's GHG emissions, with a base year level of 108.4 Mt of CO_2 equivalent, including "sinks", should not exceed 135.5 Mt of CO_2 equivalent, by the target period.

In 2000, according to the National Observatory of Athens, electricity generation[4] accounted for 50% of total CO_2 emissions (excluding sinks), followed by transport (21%). These sectors have been responsible for most of the growth in CO_2 emissions in the 1990s. Industrial emissions from combustion accounted for 10% of total CO_2 emissions. Emissions from the residential sector have increased significantly, but their share remains relatively small (7%). About 3% of CO_2 emissions come from other energy industries and 1% from the service and other sectors. An additional 8% of the GHG emissions are produced by non-energy sector activities.

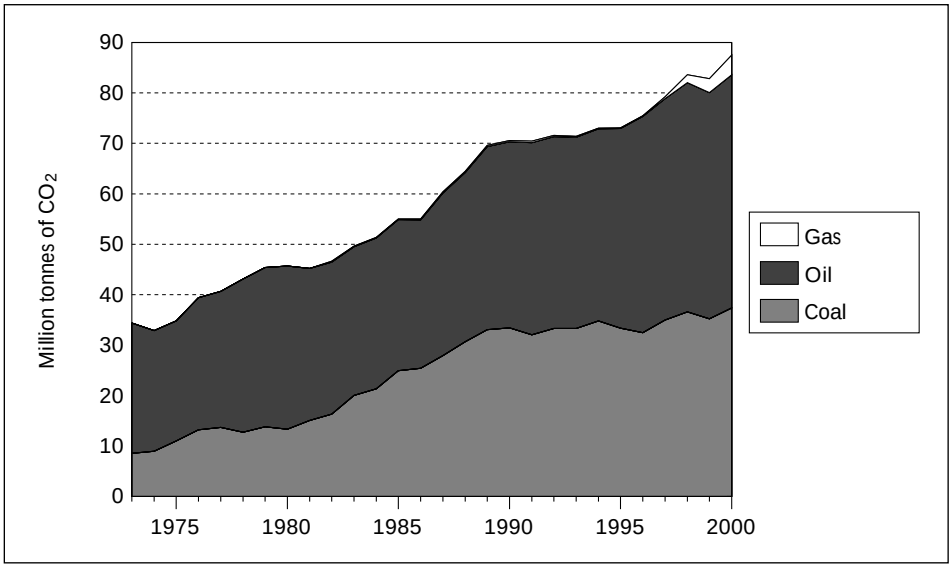
Abatement Programmes and Institutions

Greece developed the "Hellenic Action Plan for the Abatement of CO_2 and Other Greenhouse Gas Emissions" in 1995. The government's objective set out in the plan was to restrict the increase in GHG emissions, namely CO_2, N_2O and CH_4, from all sources in 2000 to no more than 15% ± 3% (or 15.7 Mt ± 3.1 Mt) from 1990 levels. The margin of 3% was adopted to allow for unpredictable domestic or international developments and relevant EU policy actions. As the emissions of the three gases were 23.3% above 1990 levels in 2000, the target was not achieved.

The most important measures under the Action Plan were aimed at changing the fuel mix in electricity generation so that more natural gas, wind and biomass would be used. In the industrial, residential and commercial sectors, the emphasis was on increasing energy end-use efficiency and fuel substitution by natural gas. In the

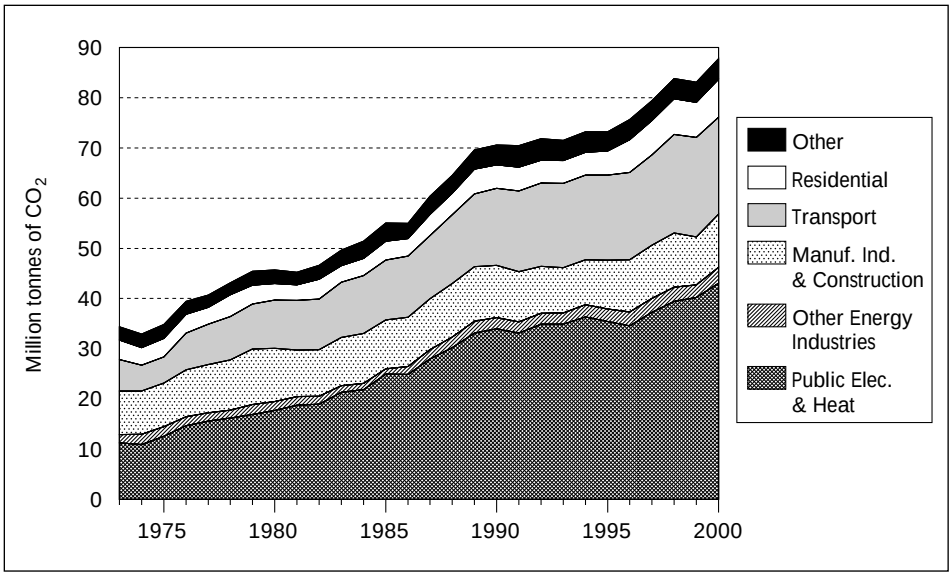
3. The Burden-Sharing Agreement covers CO_2, CH_4 and N_2O for which the base year is 1990, and PFCs, HFCs and SF_6 for which the base year is 1995.
4. In 2000, 64.2% of electricity was generated from lignite, followed by oil (16.6%), natural gas (11.1%), hydropower (6.9%), wind power (0.8%) and biomass and waste (0.3%).

Figure 7
CO_2 Emissions by Fuel*, 1973 to 2000



* estimated using the IPPC Sectoral Approach.
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2001.

Figure 8
CO_2 Emissions by Sector*, 1973 to 2000

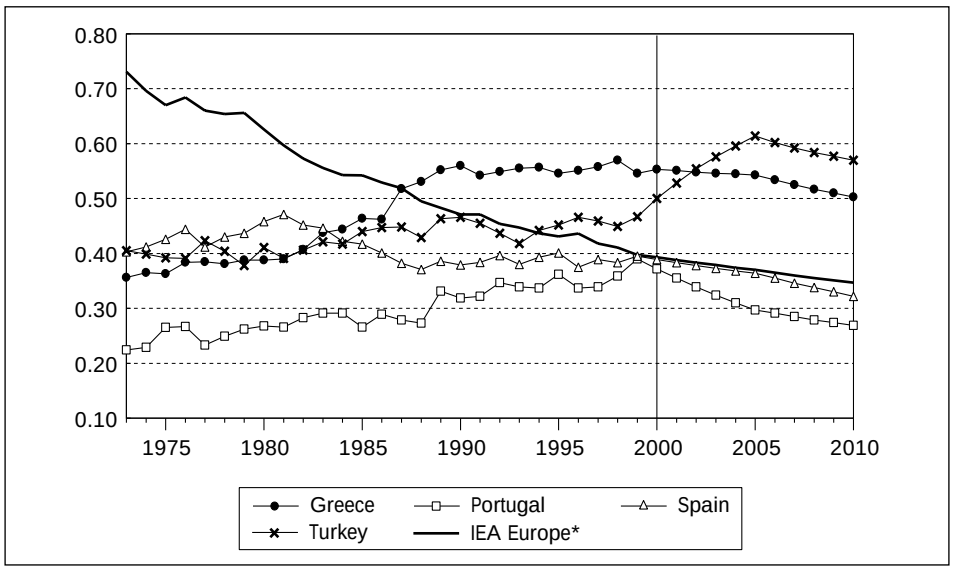


* estimated using the IPPC Sectoral Approach.
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2001.

Figure 9

Energy-related CO_2 Emissions per GDP in Greece and in Other Selected IEA Countries, 1973 to 2010

(CO_2 emissions/GDP using 1995 prices and purchasing power parities)



* excluding Norway from 2000 to 2010.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001; *National Accounts of OECD Countries*, OECD Paris, 2001, and country submissions.

The National Observatory of Athens

The National Observatory of Athens (NOA) operates under the supervision of the General Secretariat for Research and Technology in the Ministry of Development. One of the four institutes of the NOA is the Institute for Environmental Research and Sustainable Development (IERSD). It is responsible for environmental and climate change issues related to energy transformation and use. The IERSD receives financing from the government and domestic and international research programmes, and it provides commercial services. Its permanent specialist staff of 11 is supported by additional project staff. The Institute's activities cover environmental studies, meteorology and climatology, physics of the atmospheric environment, air and water pollution, solar and wind energy, climate change, resource management, sustainable development and hydrology.

transport sector, it was on improving the transport infrastructure, fuel use and vehicle technology. In this sector, the key actions were the extension of the Athens subway system and the deployment of natural gas buses and LPG taxis in Athens, and encouraging the use of public transportation and energy-efficient vehicles. Attention was also given to transport management and the evaluation of biofuels. Vehicle taxation (Law 2682/99) was differentiated according to engine size and

Table 3

Energy Conservation and GHG Emissions Abatement Potential in Greece by the Year 2010

Measures		*Thermal energy conservation (ktoe)*	*Electricity conservation (ktoe)*	*GHG emissions (kt CO_2-eq)*
Residential and Services Sector		**27**	**333**	**4 066**
R1	Insulation of buildings in the residential sector	30		95
R2	Insulation of buildings in the tertiary sector	2	1	11
R3	Maintenance of central boiler systems	41		130
R4	Replacement of old boiler systems	19		61
R5	External shading, ventilation, etc.		5	57
R6	Promotion of high-efficiency air-conditioning systems		11	116
R7	Promotion of high-efficiency electric devices		26	291
R8	Replacement of incandescent light bulbs with low-energy bulbs		134	1 467
R9	Automated lighting systems		2	23
R10	Solar systems for water heating		115	1 258
R11	Solar systems for space and water heating	6	2	44
R12	Photovoltaic systems (roof-top)		1	8
R13	District heating with biomass	3	9	318
R14	Promotion of natural gas for space heating	11		82
R15	Promotion of air-conditioning systems with natural gas	-84	28	106
Transport Sector		**142**		**916**
T1	Maintenance of private cars and light trucks	25		76
T2	Promotion of buses using natural gas	0		2
T3	Improvements in road signalling	19		58
T4	Development of public transport	98		461
T5	Non-technical measures	N.E.	N.E.	N.E.
T6	Promotion of biofuels			319
Industrial Sector		**134**	**14**	**786**
I1	Promotion of natural gas in thermal uses	6		163
I2	Promotion of solar energy	103		340
I3	Promotion of biomass in thermal uses	-1		46
I4	Various energy conservation measures	26	14	238
Electricity Generation Sector		**-22**	**21**	**7 599**
E1	Promotion of renewable energy sources			4 027
1	Wind energy			1 850
2	Small hydroelectric power plants			1 033
3	Central photovoltaic units			21
4	High enthalpy geothermal energy			50
5	Biomass power plants			1 074
E2	Operation of gas power plants as baseload units			3 350
E3	CHP plants with natural gas in the industrial and tertiary sectors	-22	21	222
Agriculture				**92**
A1	Manure management systems			62
A2	Promotion of organic farming			30
Waste				**98**
W1	Flaring of landfill gas			98
Industrial Processes				**4 651**
IP1	Restructuring of chemical industry			3 744
IP2	HFCs recycling from stationary and mobile refrigeration equipment			907
Total		**282**	**368**	**18 208**

N.E. not estimated.

Source: The National Observatory of Athens.

environmental performance. Legislation was put in place to promote renewables (see Chapter 8); renewable energy generators now have better access to the electricity grid thanks to laws 2244/94 and 2773/99 which cover, for example, feed-in tariffs and use of the grid for transmission. The government expects that with the increased use of renewables, CO_2 emissions in 2010 will be reduced by 1 Mt.

The Action Plan expired in 2000 and Greece is planning to introduce a new "National Programme for Reducing Greenhouse Gas Emissions 2000-2010". This programme was elaborated by NOA under the supervision of the Ministry of Environment, Physical Planning and Public Works and the Ministry of Development. The first version was completed in early 2002 but still has to be approved by the two ministers. The need for rapid implementation was taken into account in the design of the programme, and the government plans to establish a Special Action Unit to monitor and assess progress in implementation. The programme's guiding principles include sustainable development, fair burden-sharing by all economic sectors, economic development and economic efficiency.

A background study was prepared by NOA in January 2002 to help in the development of the new national programme. NOA estimated that under a business-as-usual scenario, GHG emissions in 2010 would be 36% above base year level, while CO_2 emissions from the energy sector (in 2010) would be 45% above the 1990 (base year) level.

A number of potential emissions reduction measures were identified and their cost-effectiveness was analysed. The total reduction potential for thermal energy was estimated at 0.3 Mtoe, and for electricity at 0.4 Mtoe. The associated GHG emissions reduction potential was estimated at 18.2 Mt (see Table 3), with the emission reduction potential in the residential and services sectors estimated at 4.1 Mt (22%); in electricity generation, 7.6 Mt (42%); industry, 0.8 Mt (4%); transport, 0.9 Mt (5%); and non-energy sectors, 4.8 Mt (27%). It was estimated that with the implementation of all the measures, by 2010 the increase of GHG emissions would be limited to 19% above base year levels (see Figure 10). Implementing only measures with zero or negative marginal cost (so-called "win-win" measures) would result in an increase in GHG emissions of 29.6% above base year levels. The discount rate used in this analysis was 6% and the cost estimates included full investment, operation and maintenance costs of each measure without subsidies (see Figure 10 and Table 4). The results (see Table 4) were ranked according to their cost-effectiveness. Measures that were identified as effective include fairly easy actions such as improved ventilation, further penetration of natural gas, etc.

Since the assumption that all GHG mitigating potential will be fully exploited is not realistic, NOA made another estimation of energy saving and emissions reduction assuming that only 70% of the potential of each measure would be realised, with a few exceptions; these include measures in industrial processes, namely IP1 and IP2 (see Table 3), whose potential is assumed to be fully realised. NOA also took into consideration possible interactions between the measures. Based on this more pragmatic approach, the increase of GHG emissions is estimated at 24.5% compared to base year emissions.

Table 4
Cost of GHG Emissions Abatement Measures

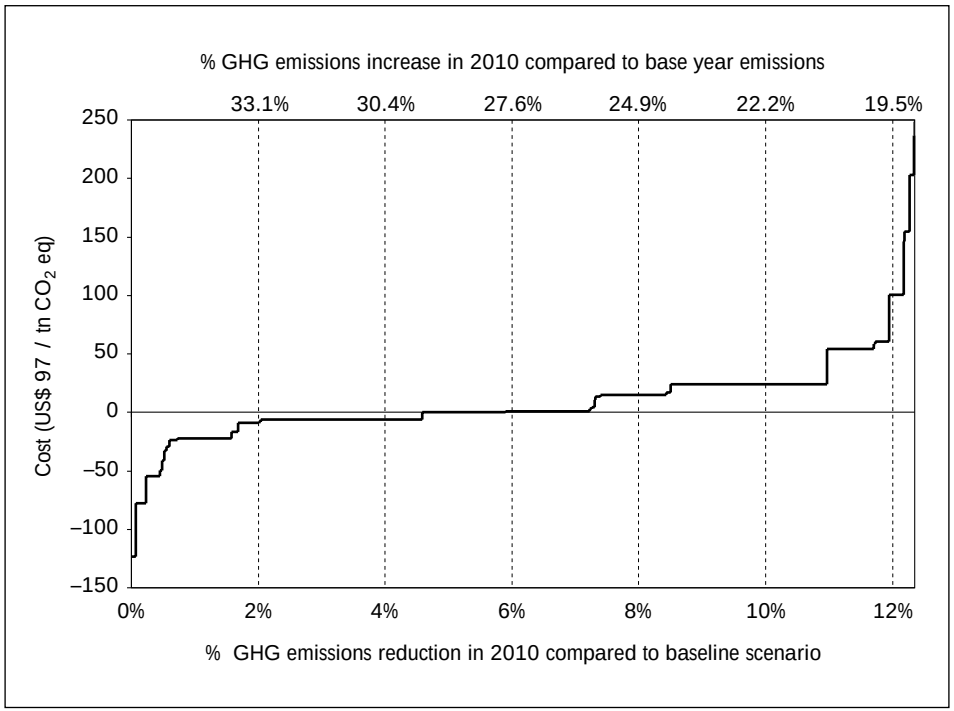
Measures		*Sector*	*Cost ($/t CO_2 eq)*	*GHG reductions (kt CO_2 eq)*	*Implementation cost (million $)*
R14	Promotion of natural gas for space heating	Res./Serv.	-123.50	82	112
R9	Automated lighting systems	Services	-77.80	23	4
I4	Various energy conservation measures	Industry	-54.22	238	21
R13	District heating with biomass	Residential	-49.40	318	173
E3.2	CHP plants with natural gas in the tertiary sector	Power	-41.10	49	15
T3	Improvements in road signalling	Transport	-32.74	58	47
I3	Promotion of biomass in thermal uses	Industry	-29.33	46	23
T1	Maintenance of private cars and light trucks	Transport	-23.53	76	130
E3.1	CHP plants with natural gas in industrial sectors				
R10	Solar systems for water heating	Residential	-16.72	1 258	1 015
I1	Promotion of natural gas in thermal uses	Industry	-8.61	163	55
T4	Development of public transport	Transport	-8.06	461	995
R5	External shading, ventilation, etc.	Services	-6.24	57	52
IP1	Restructuring of chemical industry	Industry	0.00	3 744	N.E.
IP2	HFCs recycling from stationary and mobile refrigeration equipment	Industry	0.02	907	0.13
E1.2	Small hydroelectric power plants	Power	0.58	1 033	350
E1.1	Wind energy	Power	3.09	1 850	640
R1	Insulation of buildings in the residential sector	Residential	4.58	95	206
A1	Manure management systems	Agriculture	10.58	62	1
R4	Replacement of old boiler systems	Res./Serv.	13.16	61	110
R2	Insulation of buildings in the tertiary sector	Services	14.87	11	23
R3	Maintenance of central boiler systems	Res./Serv.	14.91	130	135
R8	Replacement of incandescent light bulbs with low-energy bulbs	Res./Serv.	15.18	1 467	720
E1.4	High enthalpy geothermal energy	Power	17.15	50	25
W1	Flaring of landfill gas	Waste	23.79	98	3
H2	Operation of gas power plants as baseload units	Power	24.11	3 350	0
R7	Promotion of high-efficiency electric devices	Residential	28.61	291	400
T2	Promotion of buses using natural gas	Transport	54.51	2	21
E1.5	Biomass power plants	Power	58.47	1 074	400
R11	Solar systems for space and water heating	Residential	60.28	44	84
T6	Promotion of biofuels	Transport	100.60	319	0
I2	Promotion of solar energy	Industry	145.88	340	1 141
E1.3	Central photovoltaic units	Power	154.32	21	45
R6	Promotion of high-efficiency air-conditioning systems	Services	202.87	116	376
R15	Promotion of air-conditioning systems with natural gas	Services	236.51	106	327
R12	Photovoltaic systems (roof-top)	Services	248.43	8	33
T5	Non-technical measures	Transport	N.E.	N.E.	N.E.
A2	Promotion of organic farming	Agriculture	N.E.	30	N.E.
Total				**18 208**	**> 7 709**

N.E. not estimated.

Source: The National Observatory of Athens.

Figure 10

Marginal Abatement Cost Curve for GHG Emissions in the Energy Sector



Source: The National Observatory of Athens.

Greece intends to use the Kyoto "flexible mechanisms"[5] as supplementary tools to fulfil its commitment. Their use will depend on the international market price of emission credits and the marginal cost of domestic measures. Based on the assumption that all the "win-win" measures (see Table 4) and measures with a cost of less than US$ 3 per tonne of CO_2eq will be implemented, the NOA has estimated the potential contribution of the Kyoto "flexible mechanisms". This contribution could reach 30% of the required GHG emissions reduction.

The potential contribution of the "flexible mechanisms" may seem significant, but domestic measures could make a very important contribution without incurring substantial costs (see Table 4). However, implementation costs could be very different from the estimates, especially when the indirect costs of domestic measures (*e.g.* infrastructure cost, establishment and operation of an agency

5. The Kyoto Protocol allows Annex I Parties to acquire and transfer any part of their emissions commitment through international emissions trading (Article 17), Joint Implementation (Article 6) and the Clean Development Mechanism (Article 12). The "flexible mechanisms" of the Kyoto Protocol, which implicitly recognise that circumstances differ from one country to the next, offer certain flexibility in choosing the least costly approach to reducing emissions.

responsible for implementing and monitoring the measures, *etc.*), are taken into account. If these costs are high, then the potential of "win-win" measures is lower than estimated and the relative attractiveness of the "flexible mechanisms" increases.

ENVIRONMENTAL PROBLEMS RELATED TO LIGNITE MINING AND USE

Large lignite reserves of 1.2 billion tonnes have been exploited in the Ptolemais-Amyndeon area (West Macedonia in northern Greece) since the 1950s, and in the Megalopolis area (Peloponnese, southern Greece) since the 1970s. All lignite mines in Greece are opencast. Lignite mining requires huge excavations that result in extensive dumping of overburden material. The amount of such material varies from 2 m^3 per tonne of lignite in the Megalopolis mines to 3.84 m^3 in the Ptolemais-Amyndeon mining area. In 2000, about 220 million m^3 of overburden material was removed from the two lignite mining areas.

According to the Public Power Corporation (PPC), some 28 square kilometres (2 800 ha) of mined land have been reclaimed in the Ptolemais-Amyndeon area and some 5 square kilometres (500 ha) in the Megalopolis area. In 2000, restoration and reclamation efforts covered some 220 ha, while only 120 ha of new land were affected by mining operations. This restoration of land is financed through a 0.4% levy on PPC's revenues. In 2000, the tax revenue from the levy was €10.3 million.

The quality of lignite is poor, given its 55-60% water and 15-18% ash content. Sulphur content in the western Macedonia deposits is relatively low at 0.5%, and it is rich in lime, which is a natural sulphur absorbent in combustion. Lignite mined at Megalopolis has 1.5% sulphur content and low natural lime content. In 2000, lignite combustion for power generation accounted for about 72% of sulphur dioxide and 73% of nitrogen oxide emissions. The total emissions of both sulphur dioxide and nitrogen oxides from lignite combustion grew by 26-27% between 1990 and 2000, mostly because capacities in some lignite-fired power plants have increased. Specific emissions of SO_2 and ash have grown in some lignite-fired power plants, specific emissions of particles have decreased in all such plants and specific emissions of NO_x have decreased in most of the plants. In addition to technical changes, specific emissions are affected by variations of lignite quality (see Table 5).

At present, the lignite power plants in Greece comply with the EU Large Combustion Plant Directive (88/609/EEC). However, new stricter requirements in the future may lead to changes in the operation order of power plants; some lignite-fired plants may become back-up power plants. The Public Power Corporation, which is the operator of the lignite-fired power plants, runs a programme for upgrading the emissions control equipment, such as replacing old electrostatic precipitators at most of the plants. In 2000, a flue gas desulphurisation plant began operating at unit IV of the Megalopolis power plant. The new power plant in Meliti-Achlada (in Florina) will be equipped with a desulphurisation plant, and provisions

Table 5
Pollutant Emissions from Lignite-Fired Power Plants, 1998 to 2000

Plant name	*Year*	*Capacity*	*SO_2*	*NO_x*	*Particles*	*Ash*
		MW_e	(g/GJ)	(g/GJ)	(g/GJ)	(tonne/ MW-year)
St. Dimitrios	1998	1 595	124	121	79	1 871
	1999	1 595	137	90	75	1 830
	2000	1 595	160	148	66	2 297
Kardia	1998	1 225	120	150	119	1 813
	1999	1 225	129	117	87	1 775
	2000	1 225	160	134	54	1 797
Ptolemais	1998	620	162	147	47	2 179
	1999	620	198	139	44	1 787
	2000	620	178	32	36	2 030
Amyndeon	1998	600	692	88	44	2 244
	1999	600	649	77	38	2 626
	2000	600	588	75	33	2 640
Megalopolis	1998	850	3 810	125	246	2 530
	1999	850	3 278	109	200	2 779
	2000[1]	850	2 621	115	159	2 650
Total emissions	1998		331.7 kt	44.7 kt	37.7 kt	..
	1999		296.1 kt	39.9 kt	35.6 kt	..
	2000		249.8 kt	47.1 kt	28.2 kt	..

[1]. Desulphurisation plant in Megalopolis started operation in 2000.

Source: Ministry of Development.

have been made for retrofitting unit III of the Megalopolis plant with a desulphurisation plant. PPC also monitors the air quality near the power plants in order to meet the requirements of its environmental permits.

URBAN AIR POLLUTION

Urban air pollution is a serious problem in Greece. The problem is worst in Athens, where one-third of the country's population lives; however, other major cities, such as Thessaloniki, also have serious air quality problems. Air pollution is principally

caused by emissions from transport, but also by emissions from heating and industry. Climatic conditions increase the formation of some pollutants, such as ozone.

SO_2 concentrations in major cities (*e.g.* Athens and Thessaloniki) have declined by about 23% since 1990, reaching levels clearly lower than recommended limits. This is mainly due to the relocation of industries to city outskirts, substitution of heavy residual oil by LPG or light fuel oil in the industrial and residential/services sectors, and reductions in the sulphur content of diesel from 0.3 to 0.2% by weight. NO_2 concentrations in Athens have stabilised in recent years near the ambient air quality limits, and in Thessaloniki they are well below limit values. In Athens, ambient concentrations of smoke exceed the standard in the city centre but not in other areas, while concentrations of total suspended particles (TPS) and ground-level ozone have consistently exceeded the limit. However, carbon monoxide (CO) concentrations show a decreasing trend and the cases when they exceed the recommended value are becoming less frequent. CO concentrations are nonetheless higher in Athens than in Thessaloniki. Ambient levels of lead measured in Athens and Thessaloniki have continuously decreased over the last decade, as use of unleaded gasoline in motor vehicles has expanded. Ambient standards for SO_2, NO_2, ozone, TPS and lead have been transposed to Greek law from EU directives, while the World Health Organisation's recommended guideline is applied for CO.

The general energy policy objectives of increasing the use of natural gas and increasing energy efficiency can help to reduce local pollution. Some examples of specific measures that have been taken to reduce air pollution include:

- Expansion of the Athens subway system.

- Fuel standards, *e.g.* for lead in gasoline and sulphur in diesel and heavy fuel oil, have become stricter following the EU norms.

- Since the mid-1980s, an alternate licence plate system has restricted the use of passenger cars in central Athens. During busiest hours, cars with odd-numbered plates may be used only on odd-numbered days and cars with even-numbered plates only on even-numbered days. It is not clear, however, what the impact of the measure has been, given that car users may have second cars with a different licence plate number.

- A retirement plan for old vehicles was introduced in 1991 to replace the motor vehicles fleet with new cars equipped with catalytic converters. In effect, 350 000 cars were retired, but the programme was discontinued because scrapyards were selling the old cars.

- Since 1994, pollutants in exhaust gases are controlled once a year for private vehicles and twice a year for taxis and light trucks.

- Since 1995, all types of motor vehicles (including taxis and motorcycles, but excluding public buses) are banned from the commercial centre of Athens.

- Introduction of natural gas-fuelled buses and LPG-fuelled taxis in Athens.

- Rescheduling and re-routing of buses to accommodate distant neighbourhoods or to link neighbourhoods by means of efficient routing.

- Dedicated bus lanes to improve driving conditions. In effect, the average speed of a bus has increased from 16 km/h to 30 km/h.

- In the event that meteorological conditions may lead to excessively high pollution concentrations, full banning of traffic is applied in the centre of Athens.

The "Athens 2004 Air Quality Study" was an international study launched by the committee responsible for Athens' bid to host the Olympic Games in 2004. The objective of the study was to analyse air quality changes in Athens until 2004. Dispersion models were used to study the impact of different policies on air quality. The results were compared with air quality in 1990, and the analyses show that air quality will significantly improve by 2004. The study also indicates that the most effective measures appear to be renewing the car fleet and prohibiting the most polluting passenger cars from circulating inside the outer city ring.

CRITIQUE

Greece is facing a challenge to meet its Kyoto target. A recent forecast estimates that, under a business-as-usual scenario, CO_2 emissions from energy transformation and use will increase by 42% from the 1990 levels by 2008-2012; however, Greece's Kyoto target for CO_2 emissions is not to exceed the 1990 levels by more than 25%.

Studies indicate that there is significant potential for reducing CO_2 emissions and specific measures have been identified. The next step is to implement them. In this regard, the preparation of a new National Programme to meet the Kyoto target is progressing well. The programme is to set emissions reduction targets for each sector and to recommend a set of measures based on their cost-effectiveness. Since achieving these goals will be difficult, the government should complete the programme and start implementation as promptly as possible. It should monitor the performance of each measure to ensure that resources are most effectively and efficiently used. Also, informing the public and industry about the plans as early as possible would help in timely implementation.

In the past, policy emphasis has been on supply-side measures. However, as disclosed in the NOA's findings, many demand-side measures are very cost-effective and many of them have significant emissions reduction potential. As NOA recommends, the government should pay more attention to demand-side measures. It also appears that a few important potential emissions reduction measures in the transport sector were not included in the analysis. For instance, the analysis included the use of alternative transport fuels but not modal changes; the efficiency improvements in the car fleet were assumed to have been achieved through better

maintenance. The use of lighter cars and the agreements between the European Union and the car industries to reduce fuel consumption and CO_2 emissions were included in the analysis, but not the impact of energy-efficient driving habits; consumers with growing income levels tend to buy bigger and heavier cars. Finally, enforcing better maintenance of private vehicles is not an easy task and the costs associated with the enforcement of such a measure were also not included in the analysis.

Prudently, Greece intends to combine the use of domestic measures and the Kyoto "flexible mechanisms" to meet its emissions reduction target, and estimates on their likely contribution have already been made. It is important for the government to regularly monitor the performance of domestic measures, follow their effectiveness and consider how the country wants to use the "flexible mechanisms" to meet the Kyoto target. In this regard, the government should ensure that it has the resources and expertise to do all this. Further, an intensive exchange of information with industry is necessary to ensure effective implementation of the measures.

Although there is a heavy reliance on subsidy programmes, NOA has estimated that numerous measures could be undertaken without subsidies. The government should avoid giving subsidies to industrial projects that could be implemented without them. In addition, heavy reliance on EU financing may inhibit the development of domestic financing mechanisms. Instead, the government is encouraged to provide reliable information to industry and the public on the energy-saving potential and true cost of energy so that private investors can find ways to save energy and resources (details are discussed in the following chapter on energy efficiency).

The prevailing energy taxes have been set only for fiscal purposes and do not appear to fully reflect the externalities of fuels, especially the environmental externalities. The government does not consider taxing energy a viable tool to control GHG emissions given concerns about loss of competitiveness and increases in inflation. Since most energies are cheaper in Greece than the EU average, a CO_2 emissions tax should not be excluded. The approach could be to allow power generators and other large industrial users of energy to enter cap-and-trade regimes. This would allow entities with higher marginal abatement costs to meet their CO_2 targets by acquiring CO_2 units from another entity with lower marginal abatement cost. Moreover, cap-and-trade might be particularly interesting in the case of liberalised energy markets, where companies may not have sufficient resources to comply with CO_2 objectives by domestic means. A tax could then be applied to smaller energy users, such as in the transport, residential and commercial sectors.

Lignite mining has caused local environmental problems. Programmes are in place to reduce this impact by restoring the used land and, at present, the rate of restoration is more rapid than the rate of exploitation of new land. Significant investments have been made to reduce the emissions from lignite-fired power plants and PPC has a programme for further improvement. Not only the total emissions but also the specific emissions of some pollutants have fluctuated in the 1990s, partly owing to variation of lignite quality.

The concentrations of some pollutants have started to decrease as relevant policies have been applied. The current energy policy objectives, such as promoting the use of natural gas, are in line with the need to reduce urban air pollution. Energy conservation in the transport sector is not only important in meeting the climate objectives, but also crucial in terms of improving local air quality.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Complete and implement promptly the "National Programme for Reducing Greenhouse Gas Emissions" and monitor its policies and measures.
- ☐ Reduce greenhouse gas emissions by putting more focus on demand-side measures.
- ☐ Ensure that the environmental costs of energy are fully reflected in energy prices.
- ☐ Carry through with the use of economic instruments, including emissions trading, to reduce GHG emissions.
- ☐ Continue efforts to reduce the environmental impact of lignite mining and use.

5

ENERGY EFFICIENCY

END-USE EFFICIENCY TRENDS

Total final energy consumption (TFC) was 19.5 Mtoe in 2000, up by 30% from 1990. Transport had the biggest share (37.8%), followed by industry (26.6%)[6], the residential sector (23.2%), the services sector (6.7%) and other, mainly agricultural, uses (5.7%).

TFC of the transport sector grew by 24% in 1990-2000, with an average annual growth rate of 2.1%. An increase of 55% is forecast by the government for 2010. This growth in energy consumption is explained mainly by the development of road transport, which accounted for 70% of total energy consumption in the transport sector in 1999. The number of vehicles and mileage have grown considerably, and the average age of the car fleet (over ten years) is the oldest within the EU. Compared to 1.7 million[7] in 1990, there were 2.9 million passenger cars in Greece in 1999 (with a government estimate of 3.2 million for 2000), and their number is forecast to grow further. Passenger-kilometres in inland transport have grown from 74 billion in 1990 to 109 billion in 1999. On the other hand, greater use of public transport (buses and metros) in Greece has slowed the growth of energy consumption. In 1997, about 25% of all passenger-kilometres were travelled in public transport compared to the 9% EU average. This is because the scheduled traffic intensity of public transport in Greece is high and fares are low. The volume of goods transported by road in national transport grew from 10.9 billion tonne-kilometres in 1990 to 17.7 billion tonne-kilometres in 1999.

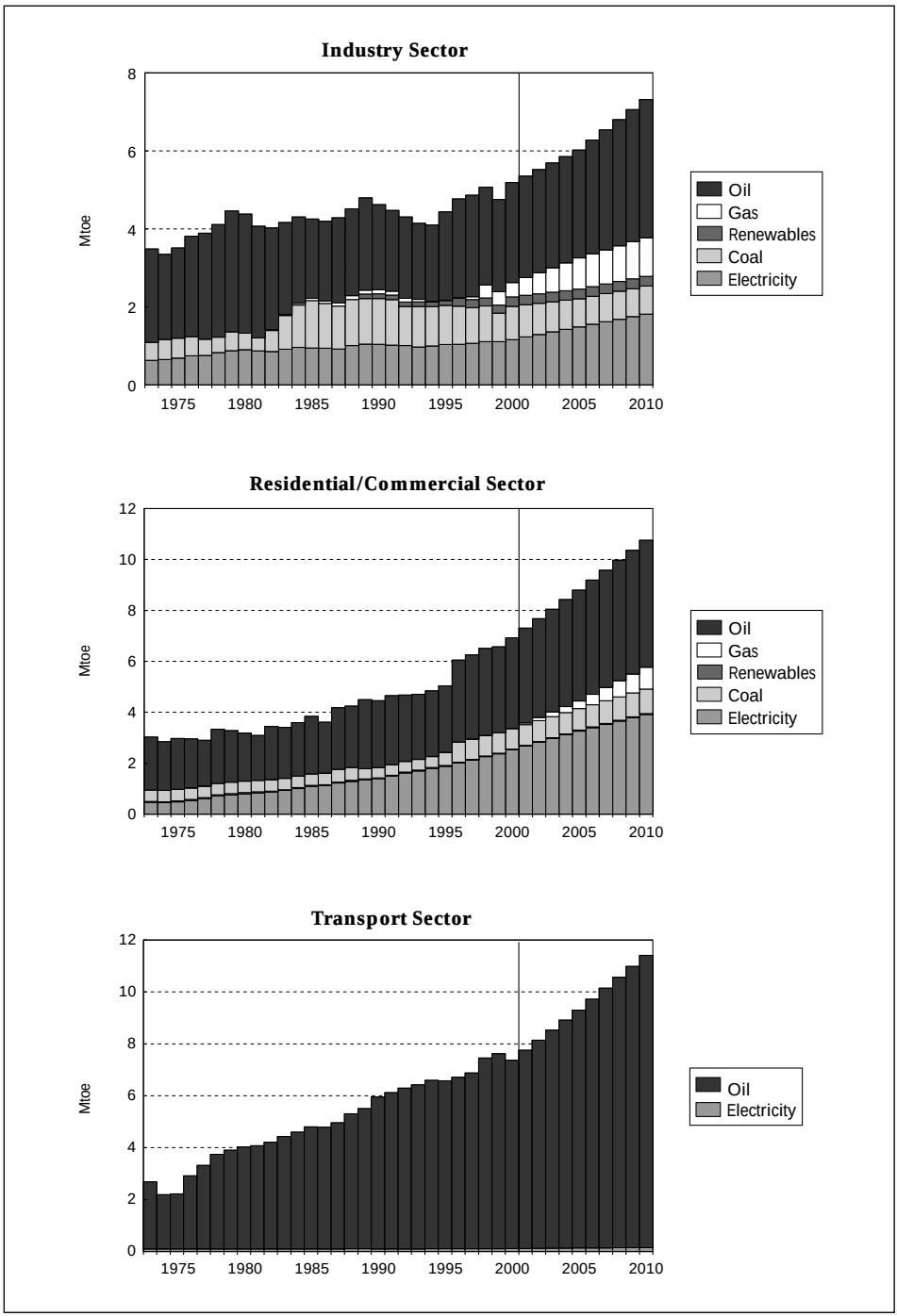
In the industrial sector, energy consumption grew moderately by 12% between 1990 and 2000, whilst a 41% increase, i.e. 3.5% per year, is forecast by the government by 2010. The government bases this estimate for growth in TFC on estimated growth in GDP (4% per year), and not in industrial production. Between 1995 and 2000, the average annual growth rate in TFC was 2.9% as compared to 2.8% in industrial production. The largest energy-consuming industries are the non-metallic minerals industry (which represents 28% of all industrial consumption), the non-ferrous minerals industry (with an 18% share) and the food industry (with a 14% share).

TFC growth was strong in the residential sector – 66% between 1990 and 2000 – but it was even stronger in the services sector, where the increase was 102% over the same period. Essentially driven by a rise in household income levels, increased energy consumption in the residential sector is due for the most part to a greater use of air-conditioning. In the services sector, rapid economic growth has largely contributed to the increase in energy consumption, as has a wider use of air-

6. Including non-energy use of 0.56 Mtoe.
7. The transport statistics quoted here are from the European Commission, Directorate-General for Energy and Transport.

Figure 11

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

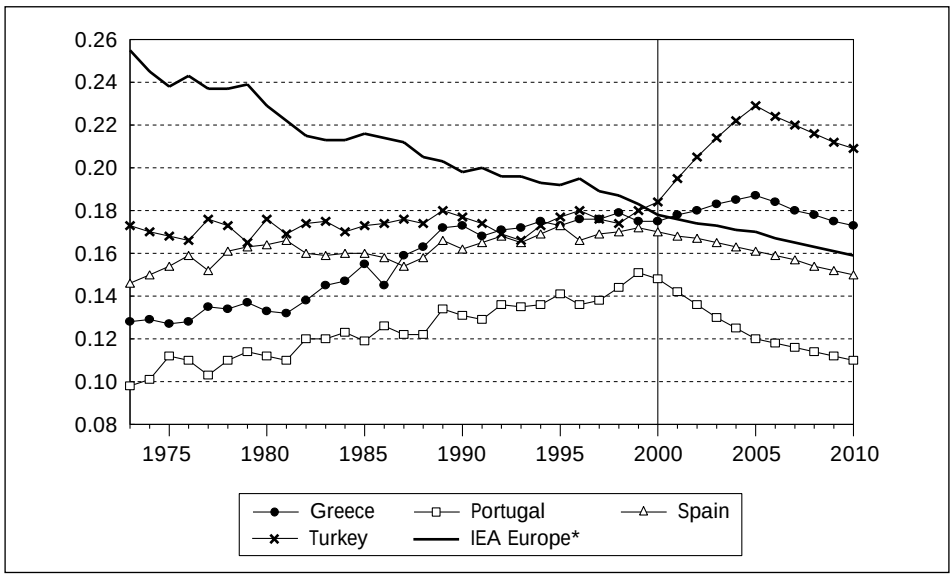


Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

conditioning. The government estimates that TFC in these sectors will grow by about 55% by 2010.

The total primary energy supply (TPES) grew by 28%, i.e. 2.5% per year, between 1990 and 2000. Greece's energy intensity (TPES per unit of GDP) has been slowly rising over the past ten years, so that the energy intensity of Greece is converging with the average of IEA Europe; in 1999, Greece exceeded that average. In the future, energy intensity in Greece is projected to grow slightly.

Figure 12
Energy Intensity in Greece and in Other Selected IEA Countries, 1973 to 2010
(toe per thousand US$ at 1995 prices and purchasing power parities)



* excluding Norway from 2000 to 2010.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001; *National Accounts of OECD Countries*, OECD Paris, 2001, and country submissions.

ENERGY EFFICIENCY INSTITUTIONS AND INSTRUMENTS

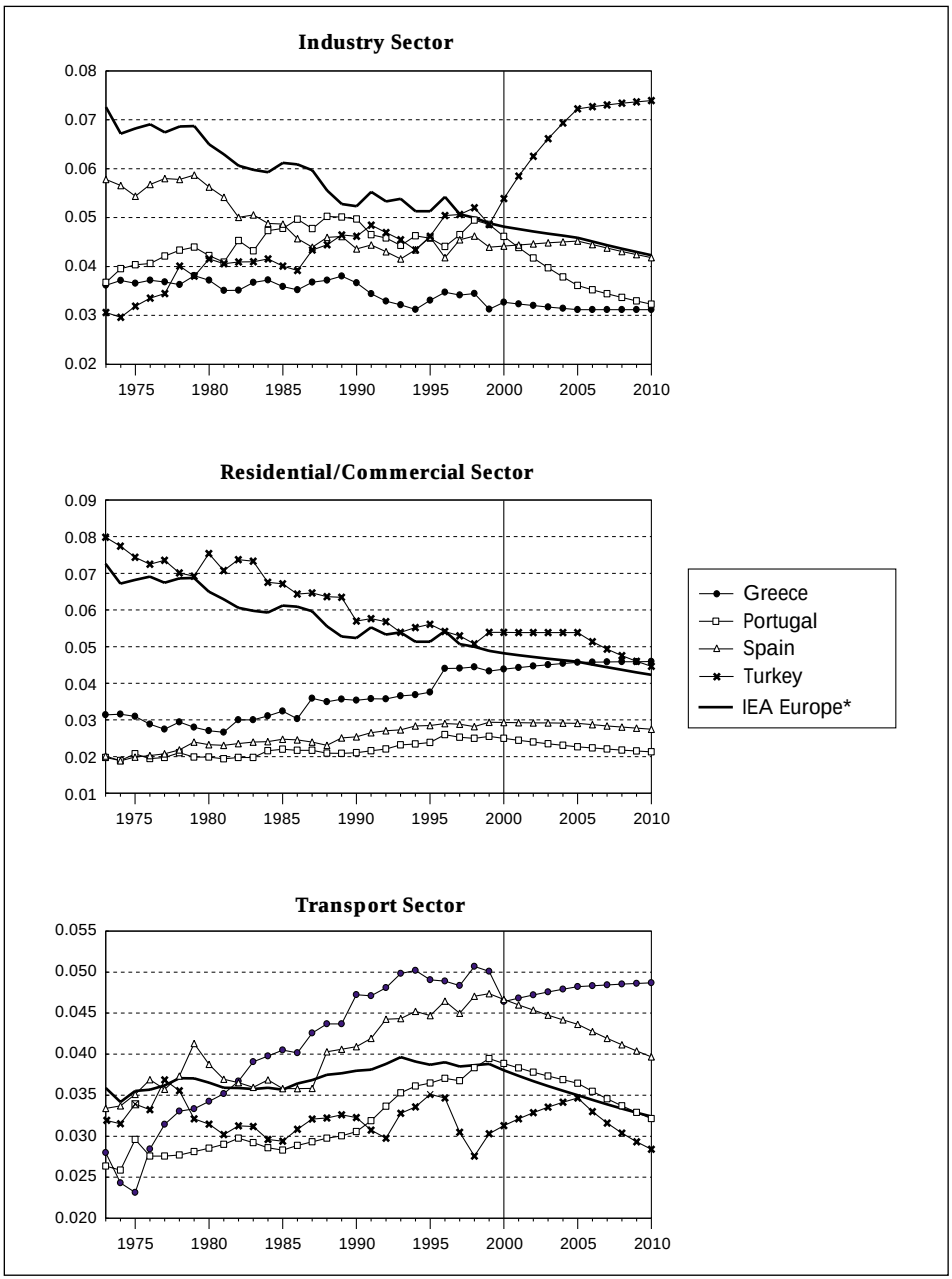
Institutions

Formulating energy policies is within the competence of the Ministry of Development; however, the Ministry of Environment is responsible for policies on energy use in buildings and the Ministry of Transport is greatly involved in policies concerning energy use in transport. At present, there is no clearly structured policy, comprehensive programme or target for energy efficiency. However, elements of energy efficiency policy can be found in the policy statement "Guidelines of Energy Policy" issued by the Ministry of Development in July 1998. These elements include

Figure 13

Energy Intensity by Sector in Greece and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand US$ at 1995 prices and purchasing power parities)



* excluding Norway from 2000 to 2010.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001; *National Accounts of OECD Countries*, OECD Paris, 2001, and country submissions.

improved efficiency of electricity production, transmission and distribution; energy saving in all sectors with an emphasis on buildings and the transport sector; promotion of CHP; consumer awareness; and new financial instruments, such as third-party financing. The government believes that a recent study ("Planning of national actions for the next decade in the energy sector in compliance with the Kyoto Protocol national commitments"), which was conducted by the National Observatory of Athens in April 2000, will help in specifying energy efficiency policy and strategy. The study includes specific recommendations on energy conservation measures in all sectors, with estimates of their costs and a classification according to their cost-effectiveness (see Chapter 4).

Centre for Renewable Energy Sources (CRES)

The CRES was established in 1987 as a public entity with significant financial and administrative independence, supervised by the General Secretariat of Research and Technology of the Ministry of Development. Its principal goal is to use applied research, pilot projects, technical assistance and information dissemination to promote – both nationally and internationally – new technologies related to renewables and energy efficiency. The CRES also acts as an official consultant to the Greek government for national policy, strategy and planning in renewables and energy efficiency. Funding for the centre is provided mainly through competitive programmes of the European Union, the Ministry of Development and other ministries, and industry. It has a specialist staff of over 120.

The Centre for Renewable Energy Sources (CRES) is the national centre in Greece dedicated to renewable energy, rational use of energy and energy saving (see box). It plays an important role in implementing and co-ordinating programmes and activities for the promotion of energy efficiency and renewables.

Financing Sources

Energy efficiency projects are subsidised under the framework of Greek development laws and operational programmes for energy and competitiveness (see Chapter 3). The Development Law 2601/1998 (replacing Development Law 1982/1990) stipulates that the government provide subsidies for improving energy efficiency and promoting renewables in the industrial and services sectors and for electricity generation by co-generation or renewables. Subsidies can cover 15 to 40% of the investment, depending on the geographical location. Loans at reduced interest rates and tax credits are available to investors as an alternative to subsidies. However, the Development Law in force has been inefficient. Practically no investments in energy efficiency have been made under it because the subsidies are less generous than under the 1990 law, and investors prefer the subsidies offered

through operational programmes. The results of the 1990 Development Law were assessed by the Directorate of Renewable Energy and Energy Saving in the Ministry of Development. It was found that between 1993 and 1998 the subsidy scheme had reduced primary energy consumption by 26.3 ktoe/year, and that the substitution of electricity and oil by gas and biomass had resulted in energy savings of 37.4 ktoe/year.

One of the five sub-programmes of the Operational Programme for Energy (OPE) (see Chapter 3) was on energy conservation to increase energy efficiency in the industry and services sectors. It was designed to provide subsidies of up to 45% of energy conservation investments made in these sectors. The projects that were approved for this programme had a total budget of €127 million of private investments to be used on energy end-use efficiency, and they were implemented between 1997 and 2001. The Operational Programme for Competitiveness 2000-2006 (OPC) continues to subsidise energy conservation investments. Both of these programmes offer subsidies not only to promote efficient energy in end-use but also to promote co-generation and fuel substitution. Under OPE, the total budget used for these three activities was €168 million, and the estimated primary energy savings achieved are 280 ktoe/year.

Outside the operational programmes, energy efficiency projects in Greece have received significant financial support from the EU. During 1997-2000, the EU SAVE, THERMIE and ENERGIE programmes have financed projects with a total budget of €20.4 million (of which about 40% were EU contributions).

Sectoral Measures

The measures to improve energy efficiency in transport are the same as those used for reducing GHG emissions, *i.e.* promoting public transport, better maintenance, inspections, and vehicle taxation (see Chapter 4). The energy saving potential of measures in transport and other sectors is shown in Table 3.

Energy efficiency measures that are in place in industry include energy audits, promotion of co-generation and fuel substitution. The CRES conducts energy audits. By November 2001, a total of 119 energy audits had been performed on industrial processes. Investment subsidies and attractive feed-in tariffs are used to promote co-generation in the sector (see Chapter 9), and fuel substitution by natural gas is covered by the operational programmes. The government is in favour of third-party financing for energy efficiency projects, but no such schemes have been established in the industrial sector yet. The government intends to introduce mandatory energy inspections and controls for industries and businesses that are big energy consumers, but so far no legislation has been passed to implement these measures. The government is also considering voluntary agreements, but has announced no specific plans to implement these.

Energy consumption in buildings is growing very fast. Despite the mild climate, energy use for heating accounts for 63% of energy consumption in the domestic sector. Energy use for air-conditioning is also increasing rapidly. The main framework for energy efficiency measures in buildings is the action plan "Energy 2001", which was prepared in 1994 by a joint scientific committee under the co-ordination of CRES and the supervision of the Ministry of Environment. Its aim was to implement energy efficiency programmes for buildings so that the requirements of the EU SAVE Directive (93/76/EEC) on reducing carbon dioxide emissions could be met. A key action of "Energy 2001" was the elaboration of a new national building energy code, *i.e.* the "Regulation for the Rational Use of Energy in Buildings (KOXEE)" which will replace the existing thermal insulation regulation[8]. In 1999, the CRES was given the task of developing the new code under the supervision of the Ministry of Environment. It is now at an advanced stage. However, the Ministry of Environment is waiting for the completion of the planned EU directive[9] on energy performance in buildings before introducing the new regulation. Other actions of "Energy 2001" included reorgansing energy management procedures in the public building sector. All public buildings have been required to assign an energy officer to deal with energy management, and many of these managers have already been appointed. Pilot projects and information dissemination activities (analysis, demonstration and training, seminars and workshops, exhibitions) have also received much attention. Following "Energy 2001" recommendations, the Ministry of Environment has entrusted the CRES with a study to prepare an action programme (to be financed under the OPC) for promoting investments in energy efficiency and renewables in public building projects.

"Energy 2001" has been supported by legislative initiatives. A draft presidential decree was prepared to establish financial incentives for energy-saving measures in buildings. The Ministerial Decision 21475/4707/98 was passed to improve energy efficiency in buildings in order to limit their contribution to CO_2 emissions. It introduced a variety of new measures in the building sector, including energy certification and energy audits of buildings, energy billing based on actual consumption, regular inspection of boilers, and third-party financing of energy conservation and renewables projects in public buildings. As of 2000, new public buildings – and as of 2004, all public buildings, including existing ones – will be required to have an energy certificate, *i.e.* an energy identity card, stating the energy performance of the building based on an energy audit. For the Greater Athens area, the cost of this instrument is estimated at €1 130 million by 2010, with estimated energy savings of 0.14 Mtoe/year and a reduction of CO_2 emissions of 0.53 Mt/year. A proposal for the methodology and procedures for energy certificates has been prepared under the EU SAVE II Programme, but the final details still have to be set down by the Ministry of Environment. The certificate system will be launched together with the new code for energy use in buildings. However, the revision of energy billing and third-party financing measures in public buildings are still only in the planning phase.

8. The thermal insulation regulation in force in Greece was introduced in 1979.
9. The directive will, for example, establish a common methodology for minimum energy efficiency standards for buildings, and give guidelines for the establishment of energy certification schemes.

Several measures have been introduced outside the "Energy 2001" framework. The EU directives on energy labelling of domestic appliances (92/75/EEC and 96/57/EEC) and on the efficiency of domestic hot water boilers (92/42/EEC) have been fully transposed to Greek legislation. Since 1995 (Law 2364/95), both households and operators in the services sector have received a 75% reduction on their taxable income for investments in appliances using natural gas or renewables. Up to now, third-party financing has been used little in the private sector and is actually forbidden in the public sector. A few projects have been established with third-party financing in private hospitals, despite the more favourable financing terms offered by OPE. A draft law, which will shortly be presented to Parliament, will create the necessary legal frame for encouraging the use of third-party financing in the private sector. Another draft law, which will permit third-party financing in the public sector, is under preparation. PPC runs some voluntary programmes, and subsidises the price of energy-efficient light bulbs in some islands and of boiler substitution in Ptolemais.

CRITIQUE

Energy intensity (TPES per unit of GDP) in Greece has been growing steadily, and final energy consumption has increased dramatically in the transport, residential and services sectors in the 1990s. The situation has been different in the industrial sector, where energy intensity decreased slightly and final energy consumption grew moderately over the past decade. However, the government expects energy consumption to increase rapidly in all sectors in the future owing to estimated high GDP growth. The government attributes most of the past increase to growing income levels but recognises that there is significant room for energy efficiency improvement. It also considers that slowing down the growth of energy consumption and improving energy efficiency are important measures to reduce CO_2 emissions.

Three ministries and one implementing agency are responsible for energy efficiency. An essential condition for ensuring effectiveness of energy efficiency policy is to ensure coherence in policy actions taken by all these bodies. A well-structured framework for national energy efficiency policies would help in this respect. Dialogue between governmental organisations and industry is vital for identifying the necessary policy tools and cost-effective measures to promote energy savings. Priority should also be given to improving statistical information and analysis.

Though there are measures to improve energy efficiency in many areas, there has not been a well-framed and comprehensive policy or plan. The development of such a policy, possibly supported by a plan, should be sought for consistency and effectiveness among measures. The development of measurable objectives is important to assess the performance of various policy measures and to make adjustments to improve the effectiveness of policies. Preferably, an independent evaluator should carry out the performance assessment. Related analysis has already

been conducted in connection with the preparation of the Kyoto Implementation Plan. The study identified a significant number of measures, which would not only reduce energy consumption and emissions, but would also have zero or negative marginal cost. These measures should be given priority. It is encouraging to see that the government is seeking market-oriented instruments, such as third-party financing. Currently, the government depends heavily on subsidies under the frameworks of the development laws and operational programmes. However, many of the projects appear to be effective without subsidies. Moreover, clear and measurable targets for energy efficiency gain do not seem to have been set for many of the projects. The government is therefore strongly encouraged to scrutinise existing programmes, especially those relating to industry.

Industry has managed to keep the growth of energy consumption modest and there has been no shift towards increased electricity consumption. Until the late 1990s, there were only a few policy measures in place in the residential and services sectors. The National Observatory of Athens has estimated that many trivial improvements – such as better ventilation, more efficient electrical appliances and maintenance, and replacement of boilers – can significantly reduce energy consumption in buildings. The potential related to these measures should be actively exploited. The impact of energy efficiency measures in the transport sector has been modest. As many of the measures in the different sectors were introduced recently, or will be in the near future, they can curb the growth of energy consumption only in the mid or long term.

The government has already recognised the need to introduce voluntary agreements and to promote third-party financing in the industrial sector. It has also recognised the need for raising public awareness of energy efficiency. The consumers in the residential sector could benefit from informative energy bills to help them to follow their consumption and to take measures to use energy more efficiently. The planned introduction of new regulations requiring individual measurement of energy use and individual billing is commendable in this respect. In connection with the billing, consumers could also get detailed information on how to save energy. Third-party financing is also considered effective in the services sector, and there is no reason why it should not be allowed in the public sector. Voluntary agreements could be used in the services sector as well. In the transport sector, public transport could be developed further and used more.

A concern in the transport sector is that the cars in Greece are the oldest in the EU, and thus their fuel efficiency is poor. The high prices of new cars after tax discourage car owners from replacing their old cars with new ones that are much more energy-efficient. The government is encouraged to study carefully how taxes and other government policies affect the behaviour of consumers in purchasing cars, and to adjust policies to promote the replacement of old cars.

Some energy prices, such as lower electricity prices for some consumer groups and lower taxes on diesel during the heating season, may lead to inefficient use of energy. The government should ensure that tariffs and taxation encourage efficient energy use.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Formulate a comprehensive and clearly structured policy framework for improving energy efficiency with measurable objectives and targets that can be monitored and verified.

- ☐ Choose measures based on their cost-effectiveness; give priority to market-oriented instruments. Ensure that government support programmes do not discourage market-oriented approaches.

- ☐ Give consumers detailed information on their energy use to help them save energy, for instance in connection with energy billing.

- ☐ Ensure good co-operation with and among all the ministries involved in energy efficiency.

- ☐ Establish an effective monitoring system to achieve energy efficiency targets; ensure that all programmes are evaluated objectively, preferably by a third party.

6

OIL

INDUSTRY STRUCTURE

The main player in the Greek oil market, Hellenic Petroleum S.A., operates in all of the market's segments. In November 2001, the company's shareholding structure was as follows: the Hellenic Republic 58.4%, state-owned Hellenic Finance 9.6%, and free-floating shares 32%. In 2001, the government announced that 23% of Hellenic Petroleum's shares that are currently held by the State would be sold to a strategic partner, with whom it would create a strategic alliance in order to further expand the company's activities in south-eastern Europe. By law, direct state ownership of the company cannot be less than 35%. Its market share in refining is 57% and in marketing and retailing it is 26%. The market share in retailing includes both direct sales to consumers and distribution through filling stations.

Table 6
Companies Involved in Oil Market Segments

Upstream	*Refining and Chemicals*	*Trading, Distribution, and Retail*
Hellenic Petroleum	*Refining:* Hellenic Petroleum	Hellenic Petroleum (EKO-ELDA)
Kavala Oil	(Aspropyrgos and	Avin Oil
Enterprise Oil Consortium	Thessaloniki refineries)	BP/Mobil
Triton Energy	Motor Oil Hellas	Shell/Texaco
	Petrola	Others
	Chemicals: EKO Chemicals	
	Shell	
	BP	

Source: Ministry of Development.

The exploration and development of hydrocarbon deposits in Greece is stipulated by the Hydrocarbons Exploration Law (2289/95). While ownership of hydrocarbons is vested in the Greek State, it administers these rights through Hellenic Petroleum, which has exclusive rights for the exploration and exploitation of hydrocarbon resources in Greece. These rights cover 54 000 km^2. However, the company can lease exploration and production areas to third parties through competitive bidding. Within this framework, Hellenic Petroleum participates in consortia with Enterprise Oil and Triton Energy, to whom the Greek State granted exploration and production licences in western Greece in 1997. The total area of these concessions is 6 555 km^2.

Greece has four refineries, which are all located in different parts of the peninsula (see Table 7). Their total refining capacity is 21 million metric tonnes per year, split almost equally between the two Hellenic Petroleum-owned refineries (Aspropyrgos

Table 7
Refineries in Greece

	ELDA	*EKO*	*Motor Oil Hellas*	*Petrola*
Ownership	Hellenic Petroleum	Hellenic Petroleum	50% Vardinoyannis Group (Greek) 50% Saudi Aramco	Petrola Refinery S.A. (private Greek company)
Location	Aspropyrgos (Athens area)	Thessaloniki	Ag. Theodori (Corinth area)	Elefsis (Athens area)
Distillation capacity				
Mt/year	6.8	3.5	5.0	5.0
thousand bbl/day	135	75	100	100
Refinery type	highly complex: catalytic, thermal, and hydro-cracking; MTBE production, vacuum distillation	hydroskimming; vacuum distillation; isomerisation; reforming	complex: catalytic and thermal cracking; isomerisation; MTBE production, vacuum distillation	topping: atmospheric distillation only; no vacuum distillation, reforming or desulphurisation
Year established	1958	1966	1972	1972

MTBE: methyl tertiary butyl ether.
Source: Ministry of Development.

and Thessaloniki) and the two privately-owned refineries (Motor Oil Hellas and Petrola). In addition to its domestic refining capacity, Hellenic Petroleum acquired a 63% interest in EL PET Valkaniki S.A in 1999, which owns 69.5% of the OKTA refinery in Skopje, in the former Yugoslavia Republic of Macedonia (FYROM). Through this acquisition, Hellenic Petroleum secured management control of the OKTA refinery. The refinery will be connected with the port of Thessaloniki by an oil pipeline, which started operation earlier this year.

Compared to the OECD average, the refinery output in Greece concentrates more on heavy products; for example, heavy fuel oil accounts for 34% of refined oil products, while the OECD average is 13%. However, Hellenic Petroleum will increase light product yields in its refineries over the next five years. Present production of all Greek refineries is in full compliance with Auto Oil I specifications for 2000, and the investments required to meet the Auto Oil II specifications for 2005 are already planned. The use of leaded gasoline has been forbidden since the beginning of 2002.

In the Greek oil industry, marketing companies have to be legally separate from refining operations. They are allowed to import and export oil products and sell

them to final consumers, directly or through filling stations. Direct imports and direct purchases from refineries are allowed for only four final consumers: the Greek Army, the Public Power Corporation, Olympic Airways and Hellas Aluminium. A new "oil market law" is being prepared and is expected to be introduced in 2002. The new law will allow all companies to import oil products directly provided that they can meet stockholding obligations (see below the section on Emergency Response Measures).

In 2000, the market shares[10] held by marketing and distribution companies were Hellenic Petroleum (EKO-ELDA and Mamidakis), 21.2%; BP Hellas, 21.1%; Shell/Texaco, 17.4%; Avin Oil, 8.1%; Jet Oil, 7.2%; Elinoil, 4.4%; and 13 other companies, 20.6%. In 1999, there were 7 310 filling stations, of which about 90% were owned by dealers. Greece is the only other country in the EU besides Spain where the number of filling stations is increasing. According to the European Commission, however, gasoline sales per service station in Greece are the lowest among the EU countries, with 680 m^3 being sold per year, which is less than half of the European average.

SUPPLY, DEMAND AND TRADE

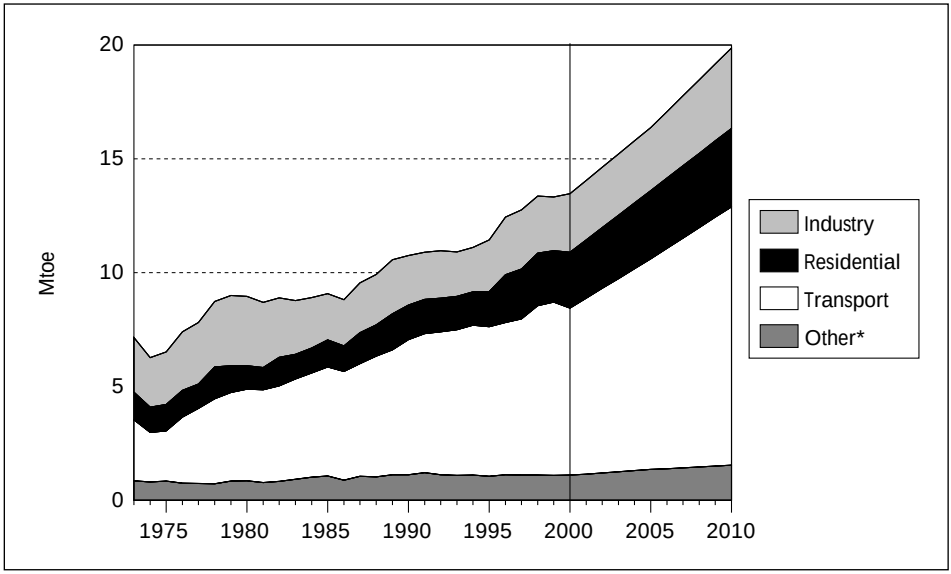
Between 1973 and 1990, the share of oil in total primary energy supply decreased from 77.7% to 58.9%, but has remained at about the same level during the 1990s, reaching 56.1% in 2000. However, from 1990 to 2000, oil supply grew from 12.8 to 15.6 Mtoe (*i.e.* by 22%). The government expects total oil demand to grow significantly – by some 40% – between 2000 and 2010, with an increase in oil consumption expected in all of the end-use sectors (see Figure 14). While use of oil in power generation will also grow over the next five years, it is expected to decrease thereafter.

The share of oil in total final energy consumption remained quite steady in the 1990s, amounting to 69% in 2000. Transport, the major oil consuming sector, accounted for 55% of final oil consumption in 2000; industry (including non-energy use) for 19%; and the other sectors for 26%. Between 1990 and 2000, final oil consumption grew by 35% in both the residential and commercial sectors, by 24% in the transport sector, and by 18% in industry.

The liquid petroleum gas market in Greece is small. LPG is used principally in the industrial sector, and bottled LPG is used in the domestic and food services sectors for cooking and heating, as well as in taxis for fuel. Until recently, using LPG in bulk for heating in the residential sector or for fuel in private cars was prohibited, mainly because of a risk of explosion. Then Law 2919/01 was passed, permitting the use of LPG in the residential sector for central heating, and the Electricity Market Law (2773/99) has made it possible to use it in the transport sector. As the necessary

10. Including sales of gasoline, diesel and heating oil. The shares exclude sales to consumers who are allowed to import or to buy directly from the refineries.

Figure 14
Final Consumption of Oil by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

regulations are being elaborated, it is expected that LPG use for central heating will be introduced later in 2002. The number of companies currently operating in the Greek LPG market is 17.

Almost all of the oil in Greece is imported. Indigenous production decreased from 5.4% of total refinery intake in 1990 to 1.3% in 2000. The Prinos field in the northern Aegean Sea, off the coast of Kavala, is at present the only indigenous source of crude oil. In February 2001, a new oilfield was found offshore the Aegean island of Thassos (also near Kavala). Production from this oilfield is expected to be 7 000 to 7 500 barrels per day, which is under 2% of the annual refinery intake.

In 2000, 19.4 million metric tonnes of crude oil were imported, mostly from Iran, Saudi Arabia, the former Soviet Union, Iraq and Libya. Greece has managed to diversify slightly its sources of crude oil by increasing imports from the former Soviet Union, but supplies from the Middle East still account for 72% of the total.

Greece is a net exporter of oil products and these exports have been increasing rapidly. In 2000, 3.9 million metric tonnes of oil products were exported, mainly to Turkey, the United States and to non-OECD Europe. Greece also imports oil products. In 2000, oil products accounted for 14% (3.3 million metric tonnes) of total oil imports. These imports came from diverse sources, the largest being the former Soviet Union, followed by Italy, the United States and Libya.

The Greek, Bulgarian and Russian governments signed a protocol in 1994 to co-operate on the construction and operation of a pipeline that could potentially provide an alternative route for exporting Caspian Sea Oil. The planned pipeline would connect Burgas (Bulgaria) and Alexandroupolis (Greece). A basic study on the pipeline project was completed in December 2001. While the results of the study were favourable to the project, ownership, financing and tariff issues need to be resolved before the project can proceed.

PRICES

Petroleum product prices have been set freely in the market since 1992. The State nevertheless retains the right to introduce price ceilings on gasoline in areas where it believes monopolistic markets may be distorting prices. Until 1995, these ceilings were invoked a few times during demand peaks in tourist areas, but they have not been used since then.

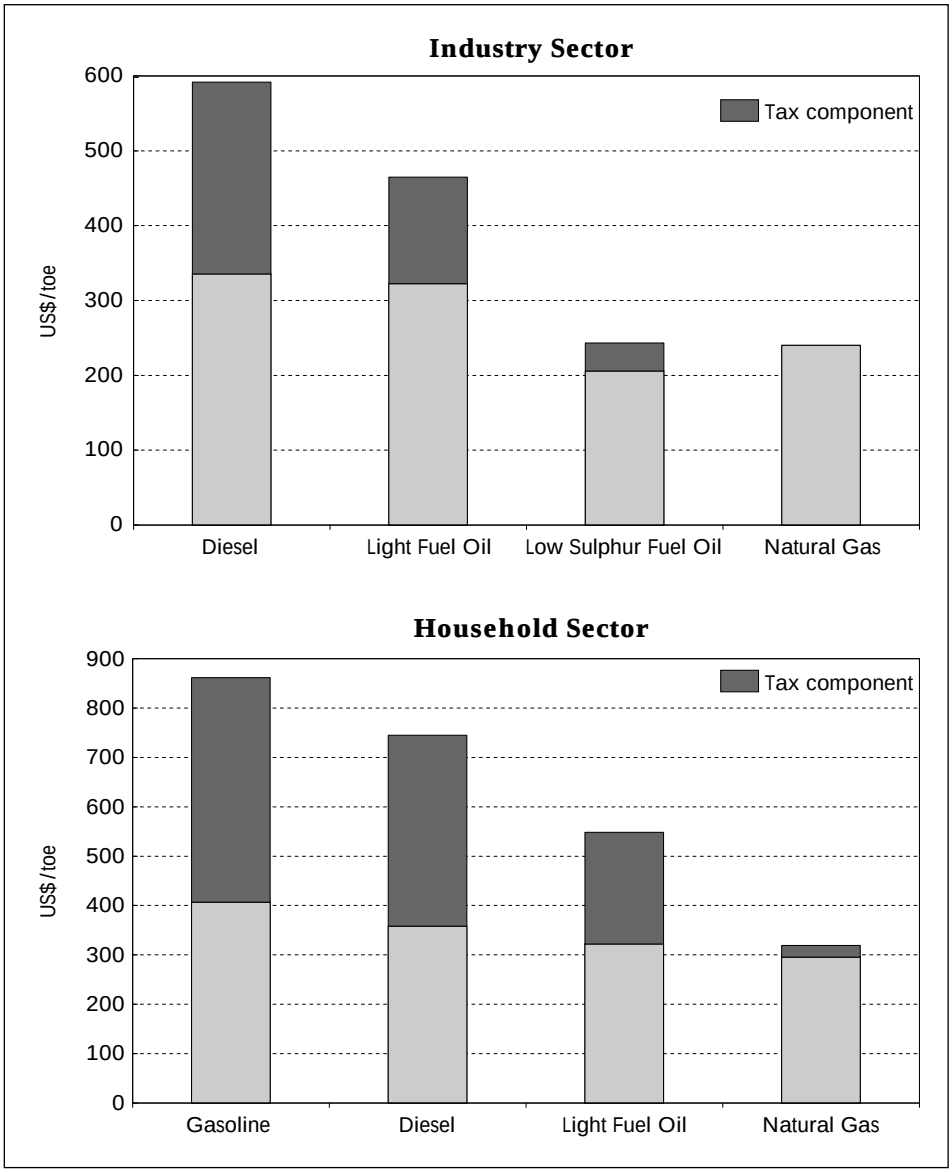
Figures 16 and 17 show the prices of unleaded gasoline and automotive diesel in Greece in relation to prices for these products in other OECD countries. The Greek average diesel price is the lowest whilst the average gasoline price is the second lowest in OECD Europe. These low prices in Greece are mainly due to lower taxes, for the pre-tax prices are not low when compared to other European OECD countries. The excise taxes for diesel and light fuel oil are the same for household and industrial/commercial use. The excise tax for heavy fuel oil (€38.15 per tonne) was decreased by half (to €19 per tonne) in the beginning of 2002 to increase the competitiveness of Greek industries, especially those operating in regions without natural gas supply.

Because of Law 2127/93, the government can reduce the excise tax on light fuel oil used for space heating between October and April, which it regularly does during these months. According to the Association of Oil and Petroleum Companies (AOPC), diesel sales are significantly lower during the heating season, which suggests that a part of heating oil (with lower taxes) is illegally used for transport fuel to escape higher taxes on diesel. The Ministry of Finance and the Ministry of Development, in co-operation with local authorities, are monitoring the market to avoid such tax fraud. More effective measures will be introduced in the new "oil market law", such as having specialist control groups carry out spot checks. For a limited time, each group will be constituted with specialists from a new registry in the Ministry of Development. Non-compliance with product standards will be subject to fines of €15 000 to 1 500 000, temporary or permanent loss of licence, or temporary closure. The measure was tested in 2000 and proved effective.

EMERGENCY RESPONSE MEASURES

The Civil Emergency Planning Law 17/74, which deals with civil emergency situations of any kind, and the Oil Law 1571/85 (as subsequently amended) provide the legal framework for Greek participation in IEA emergency response measures.

Figure 15
Fuel Prices, 2000



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2001.

Under the Prime Minister's authority, the Ministry of Development issues the relevant decision imposing controls on imports and exports of petroleum products. Law 15/74 provides for oil company compliance with government emergency actions.

Law 2289/95 and Ministerial Decision D1/FA3/11264/367/95 oblige oil companies to maintain – in accordance with EU regulations – three categories of product stocks,

corresponding to 90 days of their sales in the internal market during the previous calendar year. Greek legislation is designed to meet the EU obligations, but makes no reference to IEA obligations. In particular, it does not require a 10% deduction for unavailable stocks.

In August 2000, the Ministry of Development decided to take direct responsibility for oil and gas data collection and monitoring, and for the supervision of stocks through intensive controls, including on-site inspections and imposition of fines. Previous to this decision, the Hellenic Petroleum company, under the supervision of the ministry, collected such information. The Ministry of Development is also conducting a study for establishing an efficient stockholding regime.

Oil traders and distributors – *i.e.* the so-called oil marketing companies – are obliged to comply with EU stockholding regulations. New companies entering the market must keep stocks equivalent to their sales prospects for the next three months. In practice, most oil marketers meet the requirement by holding stocks at the refineries: the stock obligation is transferred from the trader or distributor to a refinery under provision of a supply contract.

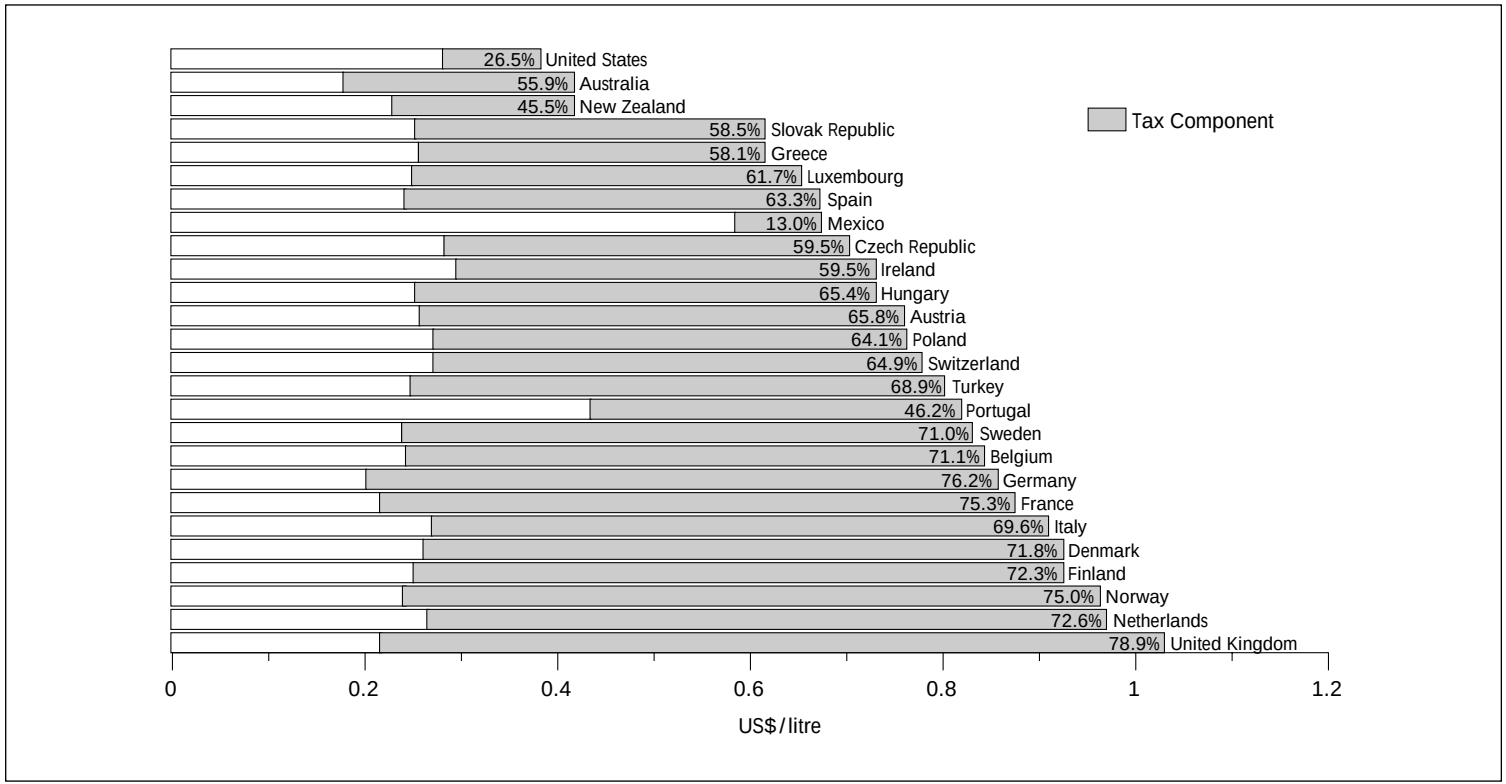
In October 2001, the EU Court of Justice ruled that the existing oil stock regime in Greece was distorting competition. The decision did not criticise storage at refineries as such, but took the view that the system was favouring Greek refineries by encouraging marketing companies to obtain supplies from national refineries that could offer them storage facilities; further, these facilities could be used only for the quantity of supplies that the marketing companies had purchased from the refinery. This problem will be addressed with the proposed "oil market law", which has been designed to change the technical details of stock obligations and stock management. Importers and refineries will be responsible for keeping oil stocks corresponding to 85 days of their sales, and marketing companies 5 days of their sales. If marketers or end-users want to import oil, they will have to comply with the 90-day obligation for the imported quantity. They can do so by building their own stocks or by renting stocks from refineries following a commercial agreement and paying a regulated third-party access tariff.

For several years Greece failed to meet its IEA International Energy Program stockholding obligations. Then, between 1998 and late 1999, it met these obligations, but in the fourth quarter of 1999, the emergency reserves fell substantially below the 90-day minimum. For much of their crude oil needs, Greek refineries rely on long-term supply contracts with suppliers from OPEC countries. Following OPEC decisions to reduce crude oil production, they were faced with reduced oil supplies, and were discouraged from building stocks by high spot oil prices and backwardation in the market. Penalties may be applied to companies that do not fulfil their obligations (Law 2289/95); however, in practice, the relevant provisions of the law are not strictly enforced.

In order to improve this situation, the Ministry of Development decided in August 2000 to take over certain responsibilities from the Hellenic Petroleum company, such as direct responsibility for oil and gas data collection and monitoring, and the

Figure 16

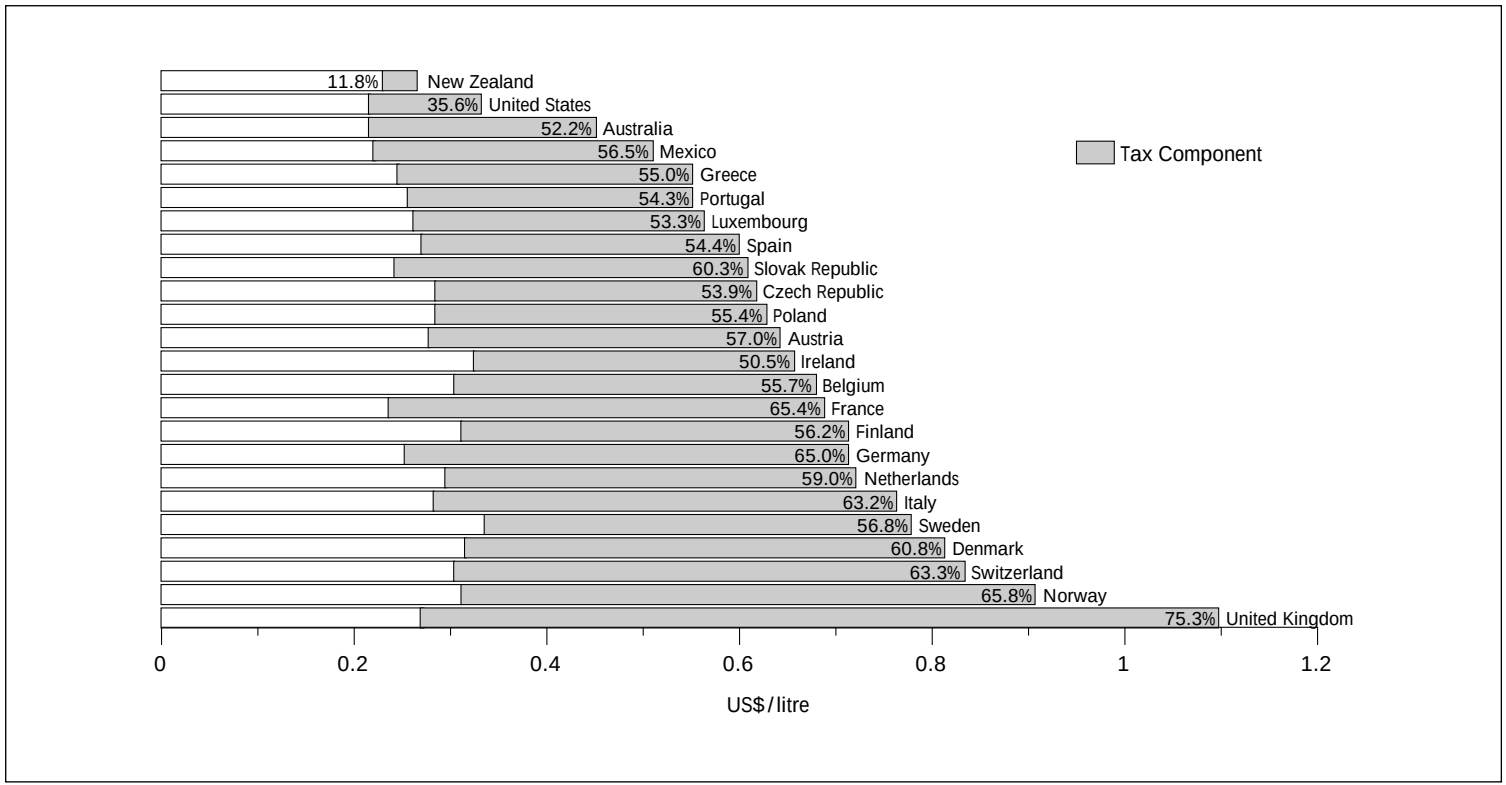
OECD Unleaded Gasoline Prices and Taxes, Fourth Quarter 2001



Note: Data not available for Canada and Japan.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2002.

Figure 17

OECD Automotive Diesel Prices and Taxes, Fourth Quarter 2001



Note: Data not available for Canada, Hungary, Japan and Turkey.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2002

supervision of stocks through intensive controls, including on-site inspections and imposition of fines. The new oil data system is now in operation. Despite these efforts, Greek stock levels have been substantially below their IEA obligation since the last quarter of 1999. Furthermore, the Ministry of Development has consistently failed to report monthly oil data in a timely manner. As of 1 February 2002, the latest monthly oil statistics submitted to the IEA by Greece were for June 2001.

CRITIQUE

Oil accounts for 56% of TPES and virtually all crude oil is imported. While Greece has diversified its supply sources, the main bulk of crude oil is still imported from Middle East and Russia. Greece should continue diversifying supply sources and maintain good relations with oil suppliers, as it has been strategically doing in the past.

Significant investments are needed to adapt the refineries to meet the new, stricter standards of 2005. It is not clear yet what impact the new product standards will have on the European and Greek refining industries. The oil companies may choose to invest in new technology for some of the refineries while closing others, typically the smaller units. Given the small size of Greek refineries, it may be that Greece will import higher-quality gasoline and export gasoline to countries where fuel standards are not as strict as in Europe.

The Greek oil markets were liberalised in 1992 and competition has evolved in the retail sector. However, competition in the other sectors is still limited. Several policies have created barriers to competition. For example, most consumers and retailers still cannot import petroleum products directly, and the current emergency stockholding obligation practically forces importers to hold stock in the existing four refineries. The government has recognised these problems and has proposed a new "oil market law" to address them. With the new law, users will be able to import oil products directly if they can meet stock obligations, and access to stock capacity will be arranged by a regulated third-party access tariff.

While gasoline prices have been liberalised, the government retains the right to set price ceilings during peak demand periods if it considers that the market is not functioning well. Since 1995, the government has not set price ceilings in any region in Greece. Such a mechanism has become completely obsolete in areas where many filling stations compete with each other. Also, price ceilings encourage consumption during peak demand periods, leading to reduced energy efficiency and environmental problems. Although the small size and isolation of some of the markets are important factors, the government could take other actions to encourage the development of competitive conditions there. For instance, it could carefully monitor the evolution of prices in these areas, and ensure that filling station operators do not abuse of their monopolistic position.

The current taxation system for heating oil has created two problems. One is that the government adjusts the tax in winter, reducing the transparency of price-setting.

Such a practice can easily discourage consumer efforts to achieve energy efficiency. The other problem is that the difference in tax on heating oil during winter has encouraged tax fraud by which heating oil is illegally diverted for diesel use. According to the AOPC, laws have not been effectively enforced to avoid such tax fraud. While the government has taken action to monitor the markets more carefully, it recognises that more effective measures are needed. Those proposed in the new "oil market law" are likely to reduce violations provided that spot checks are carried out frequently enough.

It is commendable that the Greek Energy Administration has taken direct responsibility for data collection to improve monitoring and data transparency. Yet, despite these actions, oil stockholding levels continue to fall far below Greece's IEA stockholding obligation. The Energy Administration argues that Greece's oil security is better than it appears since all stocks should be considered available, and not just 90%, as defined by IEA rules. However, according to the most recent IEA Monthly Oil Statistics data submission from Greece, stock coverage still falls well below the IEA 90-day stockholding obligation, even if the IEA 10% exclusion for unavailable stocks is not taken into account. Moreover, IEA Monthly Oil Statistics continue to be reported extremely late. This is a serious concern as all IEA emergency calculations and country contributions to any co-ordinated emergency response action would be based on the most recent monthly oil statistics available. To remedy the situation, the Greek government is aiming to include in the new "oil market law" provisions that are specifically designed to deal with these problems.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Continue to diversify the sources of oil imports.
- ☐ Revise oil stock management practices in light of the expected sharp growth in consumption and of the need to stimulate competition; stock management should be revised so that access to stocks is adequate and does not limit import and competition.
- ☐ Eliminate the remaining price ceiling mechanism and instead develop monitoring of the market.
- ☐ Develop more effective policies to avoid tax fraud in the oil product market.
- ☐ Take immediate action with industry to fulfil the IEA emergency reserve obligation.
- ☐ Submit IEA Monthly Oil Statistics on time.

7

NATURAL GAS

INDUSTRY STRUCTURE

The Greek Public Gas Corporation (DEPA) was established in 1988 as a vertically integrated company in the Greek gas sector. It has exclusive rights to import, transport and supply large customers, such as power plants. Other companies will be able to import gas after April 2007, provided that they agree with DEPA on the network access fee and they obtain a licence issued by the State. They can then sell the imported gas only to DEPA or to customers established in areas where DEPA does not intend to extend the national transmission network. DEPA is owned directly by the State, except for a blocking 35% owned by Hellenic Petroleum, which itself is 68% state-owned. In June 2000, the Inter-ministerial Committee for Privatisation decided that private investors would be allowed to own a part of DEPA, and a search for a strategic partnership was initiated in October 2001. Current legislation also allows the Public Power Corporation (PPC) to buy part of DEPA's shares if it so wishes. Prometheus Gas – which is a joint venture between Gazexport Ltd (a subsidiary of the Russian gas supply company Gazprom) and the private Greek company Copelouzos Group – can by law import gas and use DEPA's transmission grid, but only if DEPA has sold all of its contracted gas, *i.e.* 3.2 bcm[11]. This condition does not apply in cases where the imported gas is used to generate electricity destined for export. In any case, Prometheus (or any other Gazexport venture) must agree with DEPA on the access fee.

In 1995, DEPA established distribution companies (EDAs) in Thessaloniki, Thessalias and Attica. These three EDAs then established, jointly with private investors, three corresponding gas supply companies (EPAs). Each EPA is licensed to operate for 30 years. In May 2000, Italy's Italgas won a tender to become the operator and 49%-shareholder of the first two EPAs. The remaining 51% equity is held by the EDAs, which also own the networks constructed and operated by the EPAs. Similar operation and ownership arrangements were agreed for the gas distribution network in Attica (the greater Athens region), where a consortium of US Cinergy and Royal Dutch/Shell won the 30-year concession in November 2000. EDA Attica is the largest natural gas distribution company in Greece, with 8 000 customers. DEPA has an exclusive contract to supply the three EPAs until 2016. Two or three additional distribution companies will be established through partial private investments – one in Sterea and Euvoia (Evia), and one or two in east Macedonia and Thrace.

DEMAND AND SUPPLY

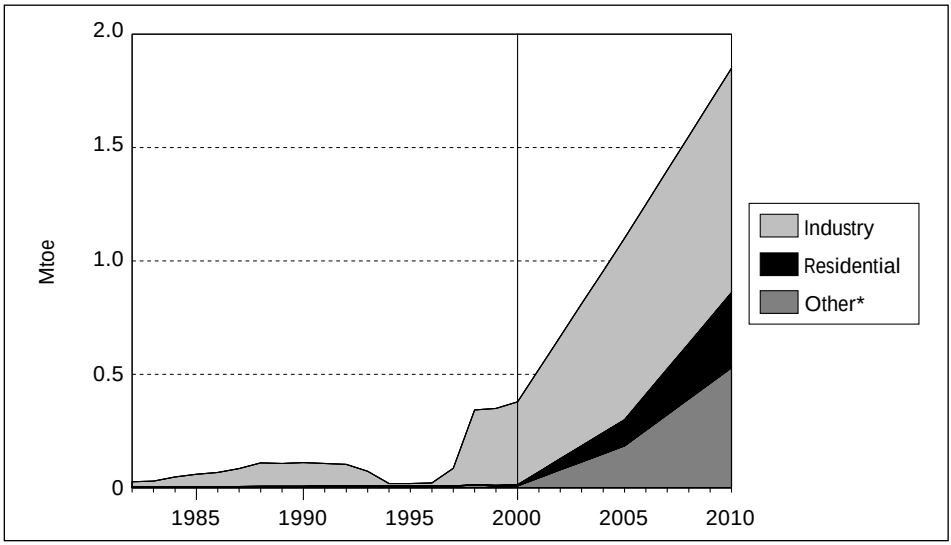
Demand

The Greek natural gas market is young and under development. Gas consumption began to increase with the first imports of natural gas from Russia in the mid-1990s.

11. DEPA's sales of Russian gas reached 2 bcm in 2000.

Between 1990 and 2000, the proportion of natural gas in the total primary energy supply grew from 0.14 Mtoe (0.6%) to 1.7 Mtoe (6.1%). Gas consumption reached 2 bcm in 2000, of which about 78% was consumed in electricity generation and the industrial sector accounted for the rest. The share of the residential and commercial sectors in gas consumption was negligible, which is common in developing markets; however, the government expects consumption in these sectors to rise after the EPAs have been partially privatised. Between 2000 and 2010, the government estimates gas use in electricity production to grow almost by a factor of four, and gas consumption by industry is expected to almost triple, from 0.37 Mtoe to 0.99 Mtoe. The smaller consumers are expected to use about 0.86 Mtoe of gas by 2010. According to government projections, gas will account for 17.4% of total primary energy supply by 2010.

Figure 18
Final Consumption of Natural Gas by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

Supply

Greece's small domestic natural gas reserves were depleted in 1995. These reserves were the sole supply source of gas during the 1980s and the first half of the 1990s.

Natural gas imports began in September 1996, when the first deliveries of Russian gas were made via a new high-pressure pipeline from Bulgaria. Imports of liquefied natural gas (LNG) from Algeria began in February 2000 after a LNG terminal in Revithousa near Athens started operation in November 1999. In 2000, Russian imports totalled 1.54 bcm and Algerian imports 0.51 bcm. DEPA has two long-term import contracts, both with a take-or-pay clause; one is with Gazexport

Figure 19
Natural Gas Infrastructure

Source: *Natural Gas Information 2001*, IEA/OECD Paris, 2001.

for pipeline gas until 2016 (up to 2.8 bcm/year) and one is with Sonatach for LNG until 2020 (0.51 to 0.68 bcm/year).

DEPA's import contracts cover Greek consumption up to 2005. It is currently investigating different supply options, such as increasing supply through new interconnections or increasing LNG capacity. There are five alternatives, namely:

- Increasing imports *via* pipeline from Russia.

- Building a transmission pipeline between Turkey and Greece under the Interstate Oil & Gas Transmission Network (INOGATE), the European framework agreement. A feasibility study on the pipeline comprising 80 km of lines in Greece and 200 km in Turkey was launched in October 2001. The capacity of the pipeline would be 1.5 bmc/year, of which 0.5 bcm would be consumed in Greece and the rest would be for transit. A memorandum of understanding has been signed between DEPA and BOTAS (of Turkey) for developing the project.

- Building a transmission pipeline between Italy and Greece. A feasibility study has been completed. The length of the onshore pipeline would be 210 km and of the offshore pipeline 224 km, with an annual transport capacity of 3.5 bcm.

- Increasing LNG storage and emission capacities in the Revithousa terminal.

- Building a new LNG terminal.

The Greek natural gas system comprises 961 km of high-pressure pipelines, 385 km of medium-pressure pipelines and approximately 1 460 km of low-pressure pipelines. Total capacity of the two tanks at the LNG terminal is 130 000 m^3 and the regasification capacity is 220 000 m^3 of gas per hour. Storage with 0.4 bcm capacity is planned in a depleted gas deposit in Kavala. DEPA's initial plan was to build 6 500 km of low-pressure networks. To date, it has constructed 1 000 km and the remaining 5 500 km will be constructed by the EPAs. For example, EPA Attica plans to invest €230 million to add 3 350 km to the network in order to reach 55% of the region's 4 million people. City gas distribution networks will also be expanded in Thessaloniki and Thessaly.

The natural gas project has been, and continues to be, financed by the Greek State (through the Public Investment Programme) and the European Union. Greece has benefited from financing under the Community Support Frameworks I, II and III, and the EU initiatives REGEN[12] and INTERREG[13]. Two other important sources of financing are the European Investment Bank, which has granted soft loans, and the

12. REGEN has provided financing for priority gas infrastructure projects in the EU. The principal aim of REGEN has been to assist in the development of peripheral regions by opening up their energy markets and enhancing their security of energy supply.
13. INTERREG assists both internal and external border areas of the EU in overcoming the special development problems that arise from their relative isolation within national economies and within the Union as a whole.

European Coal and Steel Community. They both support the development of natural gas in Greece in the context of a European policy to promote trans-European networks. Investments made by the EPAs will be the first private investments in the Greek gas sector.

LEGISLATIVE AND REGULATORY FRAMEWORK

Given that Greece is an emergent gas market, it has a derogation from the EU Gas Directive until November 2006, with a possible extension past that date. The reasons for this are that the Greek natural gas system is not directly connected to the European grid and it has one dominant non-EU supplier with a market share of more than 75%. However, the government has announced that it will liberalise the gas wholesale market as of 2004.

The 1995 Gas Law (2364/95) provides the basic legal framework for the development of the gas supply system. Its main articles govern import, transmission, trading, and distribution of natural gas; privileges, formation, and ownership of gas distribution companies; miscellaneous tax and commercial provisions. The Gas Law has been modified and complemented by several secondary laws, ministerial decisions and presidential decrees. Law 2528/97 amended the Gas Law by, among other things, cancelling the obligation for equal end-user prices for sales in the residential and commercial sectors throughout the country. The Presidential Decrees 367/96 and 10/98 defined the procedures to be followed in the international tender for the selection of investors for the three initial EPAs. The Ministerial Decision 4241/796 of February 2000, which prohibited the use of oil for space and water heating and cooking in the "historical centre of Athens"[14] from February 2001, favours the use of gas in this area.

Some legislative action has been taken to prepare for market liberalisation. Law 2837/00, issued in accordance with the provisions of the EU Directive 98/30, required accounting unbundling in all natural gas companies. Consequently, DEPA has unbundled its accounts in 2001. The Electricity Market Law (2773/99) established the Regulatory Authority for Energy (RAE) that covers both electricity and gas markets. It took over most of the competence of the Board of Energy Planning and Control, established by the 1995 Gas Law, *e.g.* to carry out some regulatory functions in the gas market. In contrast to the electricity sector, the RAE has the final powers of decision in many issues related to natural gas distribution, including pricing by the EPAs. The RAE is studying what would be the most appropriate legislative and institutional framework for opening the gas market. The proposal will be submitted to government by mid-2002.

A third-party access (TPA) tariff has been prepared by DEPA and was presented to the RAE in September 2001. The fundamental assumptions, tariff structure and the

14. The "historic centre of Athens" includes approximately 26 000 apartments, 4 000 houses and 40 000 offices and shops.

revision procedure followed in transmission tariff-setting are now:

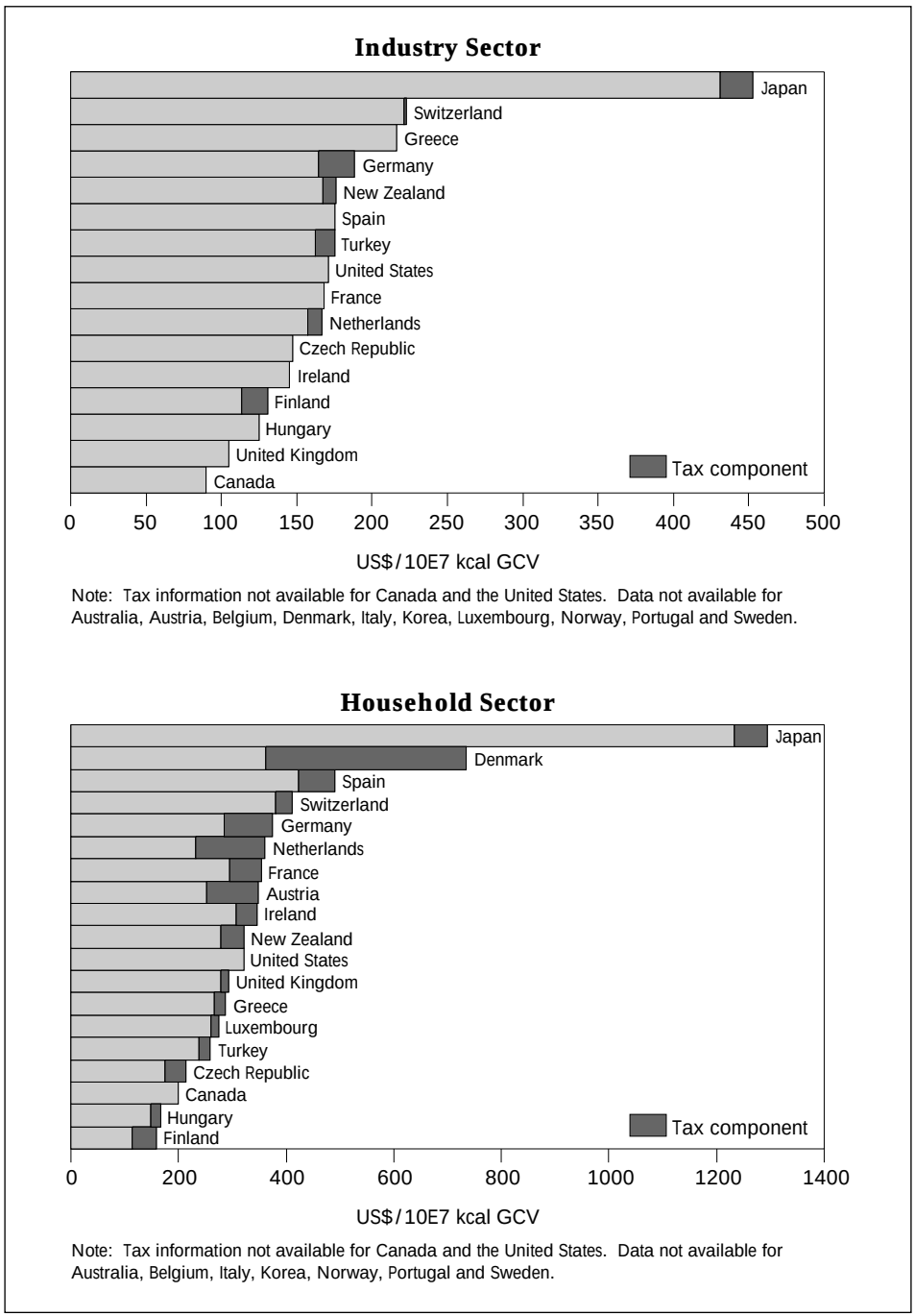
- The tariff will be based on recovery of cost, not on market value.
- Recovery of cost is based on the Regulated Asset Base[15] (RAB) and the Weighted Average Cost of Capital[16] (WACC).
- The depreciation period based on the economic lifetime of equipment is approximately 35 years.
- The regulated tariff will be identical throughout the system, without geographical differentiation.
- The tariff will comprise two parts: a fixed part related to transmission capacity (90% of the total tariff) and a variable part that is dependent on the volume of transferred gas (10% of the total tariff).
- There are separate tariffs for transmission and the use of LNG terminals. The indicative value of the proposed transmission tariff with a 70% load factor is €2.5 per MWh, and for the use of the LNG terminal it is €3.2 per MWh (including transmission).
- The tariff will be constant in nominal terms.
- The initial investments in the system have been heavy and consumption is emerging at a slower pace. Therefore, the first consumers to join the network will not be charged the full investment costs and there will be a 15-year adjustment period to level the cost burden.
- The tariff will be reviewed every five years; however, there will be two reviews in the first 5-year period.

PRICING AND TARIFFS

Compared to other IEA countries, the price of natural gas in Greece is among the highest for industry and about average for households (see Figure 20)[17]. In March

15. Typically, a sectoral regulator estimates the asset value on which it is appropriate for investors to receive a return in the case of price regulated utilities. This base is known as the Regulatory Asset Base, or RAB.
16. Every company has a capital structure – a general understanding of what percentage of debt comes from retained earnings, common stocks, preferred stocks, and bonds. By taking a weighted average, we can see how much interest the company has to pay for any amount it borrows. This is the Weighted Average Cost of Capital (WACC).
17. It should be noted that data are not available for all IEA countries and so a comprehensive comparison could not be made.

Figure 20
Gas Prices in IEA Countries, 2000



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2001.

2001, a long dispute between Gazexport and DEPA over contract pricing was settled. DEPA and Gazexport agreed on a 6% price increase and both sides agreed not to seek a revision of pricing terms until the end of 2003. According to DEPA, the transmission tariff currently accounts for some 15-20% of the final gas price and appears to be at the high end of the European tariffs. The main reason for this is that capital cost remains high given that only 6.3% of investment in gas infrastructure has been amortised.

There is a "most favoured customer" contract between DEPA and the PPC. According to this contract, if any other customer negotiates lower prices or better terms than PPC for power generation, then PPC must be given the same or better price or terms. According to DEPA, this contract was a commercial decision to give discounts to their largest client. If any other client's purchases should exceed those of PPC, then that client would also get a "favoured customer" contract.

CRITIQUE

Greece is actively developing a gas market to diversify its energy supply and to reduce the environmental impacts of electricity generation. Progress in the 1990s was remarkable; the share of gas in the constantly growing TPES increased from negligible to 6.1% in 2000. The current gas infrastructure can accommodate an increase in supply for several years, and projects to increase LNG and storage capacity are well under way. An increase in LNG capacity would help in the diversification of supply sources, as would the planned projects to build links between Greece, Italy and Turkey.

Greece is an emergent gas market. To promote gas use, the government has followed some policies that should be reviewed when the market matures. Gas is exempted from excise taxes until the end of 2010, which may distort inter-fuel competition. The government has been playing a key role in the gas sector as the major owner of DEPA. It has justified this heavy-handed approach for national energy security reasons. However, such an approach is not coherent with the government's intention to introduce competition by market liberalisation.

The incumbent supplier has overwhelmingly dominated the gas market from upstream to retail. It is commendable that the government has announced its intention to bring forward gas sector liberalisation from 2006 to 2004. It is also commendable that steps have already been taken to establish regulatory responsibilities for the sector with the Regulatory Authority for Energy and that account unbundling in gas activities is now required. The next step is to develop a transparent and non-discriminatory TPA tariff for all gas infrastructures. The government also needs to make the schedule of liberalisation clear so that both the consumers and potential investors can be prepared. The tariffs need to be set urgently. It is encouraging to see that DEPA has made a first proposal for the tariff. Furthermore, Greece should allow gas users to build their own connection lines, as this could reduce transmission costs. This is forbidden until May 2004 under

current legislation and thereafter will be allowed only in areas where DEPA has not expressed an interest in extending its system.

Cross-ownership of the energy companies is a concern, making it difficult to ensure competition under the liberalised markets. Hellenic Petroleum, the principal oil supplier, owns a significant share of DEPA, and current legislation allows the electricity incumbent PPC to purchase part of DEPA's shares. A risk of these arrangements could be that they create a barrier to inter-fuel competition. PPC's involvement could strengthen PPC's position as the most favoured client and reduce its interest to look for alternative, competing supply sources that, in turn, could trigger new entry. The "most favoured customer" contract between PPC and DEPA is a potentially discriminatory practice towards other consumers.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Encourage the development of gas infrastructures, including strengthening interconnections and expanding LNG terminal capacity and storage.
- ☐ Advance its commitment to liberalise the gas markets and encourage private investment; introduce a transparent, cost-effective and non-discriminatory transmission tariff and ensure third-party access.
- ☐ Allow the construction of private connection pipelines.
- ☐ Remove the "most favoured customer" contract between PPC and DEPA.

8

RENEWABLE ENERGY

SUPPLY

In 2000, energy from renewable sources (including waste) amounted to 1.47 Mtoe, of which 0.32 Mtoe was hydropower. This represents a slight increase from 1990, when energy from renewables totalled 0.7 Mtoe, with 0.15 Mtoe coming from hydropower. The contribution of renewables to total primary energy supply (TPES) was 5.2 % in 2000. The government estimates that the energy supply of renewables and wastes will grow by 35% between 2000 and 2010, but that their share of total energy demand will drop to 4.9%. However, these estimates were made under the current policies and the new intensified efforts to mitigate climate change could lead to stronger growth in the use of renewables.

Electricity production from renewables was 4.3 TWh, representing 8.1% of total gross generation in 2000. Hydropower contributed 3.7 TWh (with pumped storage), and wind and solar power 0.45 TWh. Hydropower generation fluctuated and was influenced by weather conditions from year to year. Production from wind and solar increased in the 1990s. At the end of 1999, the installed capacity of combustible renewables and waste was 7.47 GW; hydropower, 2.96 GW (of which 0.62 GW is pumped storage); and wind power, 0.09 GW. Wind power capacity doubled during 2000, reaching 0.23 GW.

Most of the wind power is installed in the islands: Crete currently has 10 wind energy parks producing 10% of the island's electricity, with another 14 wind parks to follow. Mannheim ABB and German Windsolar signed an agreement in March 2001 to develop wind power stations in Greece. In June 2001, Gemesa of Spain signed an agreement with the Hellenic Energy and Development Company to invest €420 million to develop wind power plants with a total capacity of 460 MW by 2005.

Solar energy is principally used for hot water production, with 20% of Greek households using solar water-heaters. Greece is the leading country in solar energy use in the EU, with a 2.75 million m^2 collector area. A few small photovoltaic power plants are in operation, particularly in the smallest inhabited islands. Energy Photovoltaics (a German-Italian-American consortium) announced in July 2001 that it will build a 15 MW photovoltaic power plant in Kilkis. A 50 MW solar thermal plant is under construction in Crete.

The current policies promote biomass use for combined heat and power production. However, the number or biomass-fired CHP plants that can be built is now limited. The potential for geothermal energy in northern Greece is estimated at 200 MW of heat, of which about 70 MW are currently exploited for heating greenhouses and other agricultural purposes, spas, and space heating.

There are no comprehensive estimates for the future potential of renewables in Greece. In practice there are certain limitations. For instance, only a few large

hydropower plants can be installed. Although there is significant unused wind power potential in the mountain areas and islands, there is not yet adequate infrastructure to use this potential. The same applies to small-scale hydro. Environmental and other considerations, such as the number of archeologically important sites, also limit the use of renewables.

The Public Power Corporation (PPC) has been the principal investor in renewables, and its operations in renewables are organised under its subsidiary PPC Renewables S.A. PPC's programme for the development of renewable energy sources covers wind, photovoltaics, geothermal energy and small and large-scale hydropower. It is included in PPC's 10-year Development Plan for the period 1994-2003, which has established capacity targets of 306 MW for large hydro, 17 MW for small hydro and 37 MW for wind power by 2003. As described above, other companies are now penetrating the market for renewables in Greece.

Between February and August 2001, the Regulatory Authority for Energy (RAE) awarded licences for new power plants running on renewable energy sources, representing a combined total capacity of 1 155 MW. All the licences were given to new market entrants. New wind energy installations account for 912 MW, of which 591 MW are destined for the integrated network encompassing Attica, Euvoia, Cyclades islands and South Lakonia. Wind farms in Thrace will make up 200 MW, but their construction will have to wait until transmission lines have been built. The remaining 121 MW will be produced by new plants in various islands. In addition to wind, small hydro will make up 179 MW, biomass 63 MW, and photovoltaic 1 MW. By November 2001, the total capacity of licensed new plants running on renewables was already 1 565 MW.

Large-scale hydropower is subject to licensing procedures that are different from other renewables. RAE has recommended to the Ministry of Development that four licences for large hydroelectric units, with a total output of 272 MW, be awarded to Michaniki, Terna and Aegek, which are all construction companies. Michaniki plans to build a 93 MW power plant in Aghios Nikolauos, Arta; Terna a 60 MW plant on the Acheloos River; and Aegek a 93 MW plant in Vovousa (Ioannina), and another 26 MW plant on the Kalamas River.

POLICY

The Centre for Renewable Energy Sources (CRES) plays a key role in co-ordinating the government's activities in renewable energy development and research. It plans, implements and executes applied R&D projects, provides technical support and disseminates information. It also investigates the technical and economic potential for renewables. Law 2702/99 appointed CRES as the national co-ordinating agency for all activities related to renewables, and it operates under the supervision of the Ministry of Development.

In the 1995 Climate Action Plan, the government established a target to increase the share of renewables to 10% of the primary energy supply by 2000. This target was

not achieved, and was lowered to a 6% share by 2000 and an 8% share by 2010. The revised 2000 target was not achieved as renewables accounted for only 5.2% of TPES. In September 2001, the EU adopted a new directive (2001/77/EC) to promote electricity production from renewables. Following the directive, Greece adopted an indicative target to generate 20.1% of its electricity from renewables, including large-scale hydro, by 2010. This means that Greece should more than double its generation of electricity by renewables between 2000 and 2010.

Law 2244/94 was issued in 1994 to encourage power generation from renewables by others than PPC, and to establish electricity feed-in prices for that purpose. This is in contrast to the previous Law 1559/85, which had delegated this matter to a ministerial decision. Law 2244/94 also covers the conditions under which renewable energy generators can have access to the electricity grid, length of contracts and administrative measures. However, it does not provide for direct access to the transmission network owing to the monopoly status that PPC had until 1999.

Law 2773/99, which succeeds the 1994 law, stipulates a new feed-in tariff regime for electricity produced from renewables. The feed-in tariff regime is almost the same for the interconnected and non-interconnected networks. In the interconnected network, including the islands connected to the mainland grid, the Transmission System Operator pays the generator a price, which is composed of energy and capacity charges, but no capacity reimbursement is paid to autoproducers. The energy charge represents 90% of the energy part of the medium-voltage domestic monthly end-use tariff. The capacity charge is 50% of the capacity part of the same tariff, and is multiplied with a constant coefficient of 0.50 for wind and solar energy plants, 0.70 for small-scale hydro and 0.90 for geothermal and biomass plants. In the non-interconnected islands, PPC in its capacity as the Network Operator, pays 90% of the low-voltage monthly end-use tariff for renewable energy generation, including co-generators using renewable energy. Capacity is not reimbursed and Law 2773/99 abolishes the net-power metering compensation[18] provided under the previous regime. Autoproducers are paid 70% of the low-voltage monthly end-use tariff whereas independent power producers receive 90%. This provision was introduced because the autoproducers generate electricity primarily to meet their own requirements and only secondly sell their surplus to the Network Operator. Consequently, the viability of their investments rests only marginally on electricity sales. In 2001, the average feed-in tariff was €0.0731 per kWh in both the interconnected system and the non-interconnected islands.

Law 2491/01 has simplified licensing procedures but a number of licences and permits are still required before renewable power generation facilities can be

18. Net-power metering compensation, which was applied under the 1994 law, was designed to define – in the case of an autoproducer that generates and consumes electricity in different locations but within the area of one transmission network – the amount of electricity generated in one location that would be compensated for the electricity consumed in another location. The law defined the percentage of compensation at 80%; with the exception of local governments, their enterprises and farmers' co-operatives, for whom the compensation was 90%.

installed. According to Law 2773/99, generation authorisation must be acquired from the Ministry of Development based on a recommendation submitted by RAE to the ministry. The government estimates that the process will take 4-12 months. Law 2244/94 covers installation and operation permits issued by the regions. The installation permit is required to kick off a construction project, and involves a number of approvals from various authorities, including siting approval and environmental impact assessment, and approvals from the Forest Management Services, Archaeological Services, the Ministry of National Defence, radio and television broadcasting authorities, and the Civil Aviation Authority. Obtaining all the approvals preceding the installation permit usually takes an average of 19 months.

Law 2773/99 gives renewables priority in network dispatching if the installed capacity does not exceed 50 MW or, in the case of hydropower, 10 MW. The surplus of autoproducers is given the same priority within the same capacity limits. The law also obliges the Transmission System Operator and the Public Power Corporation to provide connection to new generators; however, in practice, the development of wind power in some mountain and island areas is slowed down by the need to simultaneously extend the transmission networks.

To maximise market penetration, subsidies are given to all schemes involving renewables. As with energy efficiency and co-generation, the two principal funding sources for subsidies are the Development Law 2601/98 (replacing the previous Law 1892/90), and the Operational Programmes for Energy and Competitiveness (see Chapter 3). There are two subsidy mechanisms for renewables: a maximum 35% investment subsidy for power generation, and a maximum 75% deduction from taxable income for the use of solar heating systems in the residential and services sectors. Greece does not intend to establish a green certificate system in the near future, but considers it a viable option for later on.

Renewables could be competitive without subsidies in some isolated geographical areas, such as Crete, southern Euvoia and Lakonia, and mountainous areas in the north. According to the Ministry of Development, the cost of electricity generated by wind (with a 6 m/s annual mean wind speed) is approximately €0.047/kWh, whereas the fuel cost of diesel in medium and smallish islands is approximately €0.06 to 0.07/kWh. It should be noted, however, that the average annual wind speed in the Aegean Sea islands and the mountain areas is considerably higher (9 m/s) than the figure cited above, and conditions for wind power are even more favourable in the smallest islands.

Given the strong environmental opposition towards wind power installations in some regions of the country, the government introduced a 2% tax on renewables in July 2001. As local governments tax the generators and use the revenue for local projects, it is hoped that these actions will lead to greater public acceptance of wind power.

CRITIQUE

Although Greece has tried to increase the share of renewables in primary energy supply, their share is decreasing. The share of renewables in electricity production,

however, is slowly increasing. Progress should be monitored closely and policies should be adjusted so that the challenging targets that have been set for renewables – 20.1% of electricity generation by 2010 – can be met. In 2000, that share was 9.2%, including large-scale hydro. While the economic, unused potential for renewables is limited, the technical potential is large for both wind and solar energy. Unfortunately, there are not yet any comprehensive resource mappings for renewables in Greece. At present, it seems that there are few possibilities to develop large-scale hydro, the availability of biomass is limited and, although wind power has considerable potential, there are many environmental and other constraints.

Greece promotes renewables mainly by providing subsidies, setting attractive feed-in tariffs, priority dispatching and R&D. After market liberalisation, there were more licence applications for power generation by renewables, implying that current policies will lead to an increase in electricity generated by these energy sources. Whereas subsidies may be necessary for some immature technologies, careful consideration is needed to ensure that subsidy programmes will not penalise cost-effective alternatives. When subsidies are given to renewables, it is not certain that the most economical projects will be implemented. Creating competition between different renewables could help to reduce costs. This objective could be pursued by adopting a more market-based approach, *e.g.* by introducing portfolio standards together with a green certificate system.

According to an analysis by the Ministry of Development, renewables could be competitive without subsidies in geographically isolated areas where there is no access to the national grid and the generation cost by diesel generators is high. However, renewables may need an adequate local infrastructure in order for their potential to be exploited. Renewables are already used in such local systems but are nevertheless supported by subsidies. Geographically differentiated end-use tariffs, based on the cost of supply, would be an incentive for the generators and would reduce the need for subsidies. Renewables are also burdened by the 2% tax that, while increasing their public acceptance, reduces their competitiveness.

The licensing and permitting procedures for renewables have been simplified in 2001 but are still cumbersome and time-consuming. It is commendable that the government has recognised the problem and has set an objective to develop a "one-stop-shop" for licences.

RECOMMENDATIONS

The Government of Greece should:

- ☐ Shift policies for renewables towards a market-oriented approach, including the introduction of portfolio standards and green certificates.

☐ Exploit the cost-effective potential of renewables, paying particular attention to this in the islands.

☐ Speed up the creation of a "one-stop-shop" for licences for renewables.

☐ Ensure that adequate infrastructure is developed in order to exploit fully the potential of renewables in geographically isolated areas.

9

ELECTRICITY AND LIGNITE

INDUSTRY STRUCTURE

The Public Power Corporation (PPC) – one of the largest companies in Greece – is a state-owned utility responsible for generation, transmission and distribution of electricity throughout the country. It accounts for 97% of both total generation and total capacity. The company also operates a telecommunications business and mines lignite for power generation. Following market liberalisation, PPC is no longer a monopoly by law. However, in practice, it will maintain its dominant market position for at least a few years until independent power producers start operating in the newly liberalised markets. There are also a number of autoproducers, primarily industrial companies operating co-generation systems, with some increasingly using renewables (see Table 8).

Table 8
Major Electricity Autoproducers, 2000

Company	*Type*	*Electric capacity* MW_e
Hellenic Aspropyrgos Refinery	CHP	50.0
Hellenic Sugar	CHP	56.0
Motor Oil Hellas	CHP	23.0
North Aegean Petroleum Company	CHP	16.5
Phosphoric Fertilisers Co.	CHP	25.0
Northern Greece Chemical Industries (fertilisers)	CHP	10.5
ETMA (textiles)	CHP	13.1
Aluminium de Grèce	CHP	11.6
Various systems operating with renewables	wind + hydro	200.0
Various	CHP	7.8
Total		**413**

Source: Ministry of Development.

Following the market liberalisation process, PPC's operations have been restructured and privatisation has been initiated. The accounts for mining, generation, transmission and distribution operations have been separated. Three subsidiaries have been established, one for renewables, one for co-generation and one for telecommunications. In the beginning of 2001, PPC was transformed into a *Société Anonyme* and in December 2001, 16% of PPC's shares became available to investors.

PPC did not apply for new licences in 2001, but nine new generation licences were granted to independent power producers in the competitive markets (Table 9). One of the licensed plants is a large-scale hydropower plant and eight will use natural gas. Enelco, Terna-GEK, Alfa Alfa Holdings, Mytilinaios Group, ELPE (Greek Petroleum Group), EDF/HED and CINERGY will develop the gas-fired plants. As it takes approximately 3-4 years from the start of a feasibility study to the commissioning of a combined cycle power plant, the newly licensed gas-fired plants will not be commissioned until 2005-2006 at the very earliest. Most likely it will be later, since most of the licence applicants have not yet started to conduct the feasibility studies.

Table 9
Generation Licences Awarded by November 2001

Technology	*Capacity MW*
Combined cycle natural gas (8 plants)	2 600
Open cycle gas turbines (1 plant)	150
CHP plants by autoproducers	260
Large hydropower (1 plant)	300
Total, large power plants	**3 310**
Renewables	1 565
Small CHP	140
Total, renewables and small CHP	**1 706**
Total	**5 016**

Source: Regulatory Authority for Energy.

The Hellenic Transmission System Operator S.A. (HTSO) was established in December 2000 to manage the high-voltage (400 kV and 150 kV) transmission network in the mainland, but PPC remains the network owner. By November 2001, HTSO had recruited only half of its total staff of 335; however, it has established information systems and co-operated with the RAE in the development of the regulatory framework. The HTSO is 51% owned by the State and 49% by the generators connected to the system, which initially was only PPC. PPC still entirely owns and operates the medium- and low-voltage distribution networks.

The HTSO will operate, manage and secure the maintenance of the high-voltage transmission network and manage the interconnections; it is also responsible for planning the development of the system based on load forecasts. Every year the HTSO has to prepare a load forecast and a transmission system development plan covering the next five years. Following the approval of the transmission plan by the

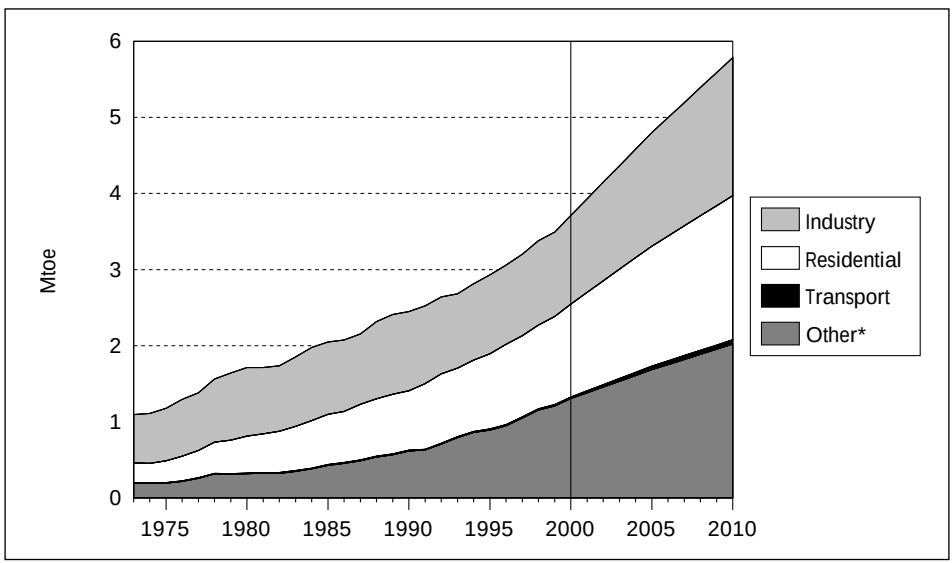
RAE and the Ministry of Development, PPC has to make the necessary investments to reinforce the network. The cost of reinforcement is then transferred to the transmission access tariffs (see section below on Introduction of Competition).

DEMAND AND SUPPLY

Demand

Electricity sales totalled 45 TWh in 2000. Approximately 33% of electricity is consumed by the residential sector, 31% by industry, 28% by the services sector, and 7% by the agricultural sector (see Figure 21). Electricity consumption grew steadily at an average annual rate of 4.2% in the 1990s and the government forecasts a 4.5% annual growth rate for the next decade. During 1990-2000, consumption grew in the residential sector by 57%, in the services sectors by 120%, and in industry by 12%. Most of the growth in electricity consumption in the household and services sectors is due to increased use of air-conditioning.

Figure 21
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, 2001, and country submission.

Approximately 92% of all electricity is consumed in the peninsula and 8% in the islands (see Table 10). The mainland and 15 islands[19] are interconnected, but the

19. All islands in the Ionian Sea, and some Cyclades islands and islands in the Aegean Sea (Sporades and Samothraki) are interconnected.

Table 10
Peak Load and Electricity Consumption in the Mainland and Islands

	Mainland		*Crete*		*Rhodes*		*Other Islands*
	MW	GWh	MW	GWh	MW	GWh	GWh
1995	6 063	35 521	301	1 476	95.3	407	956
1996	6 503	36 811	317	1 563	99.3	415	1 007
1997	6 705	38 372	342	1 659	104.5	442	1 062
1998	7 372	40 108	387	1 801	120.0	472	1 132
1999	7 366	41 427	407	1 924	126.8	502	1 197
2000	8 531	44 955	418	2 079	136.4	550	1 291

Source: Ministry of Development.

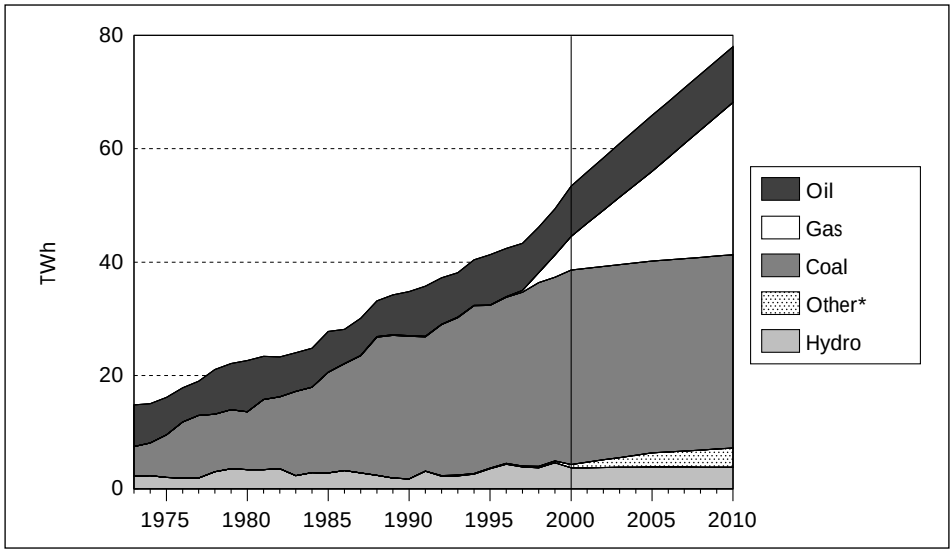
majority of islands are served by isolated systems. The largest isolated island systems are in Crete and Rhodes. However, the number of interconnected islands is slowly increasing. Because of rapid growth of the tourism industry, the annual average rate of growth in electricity consumption between 1995 and 2000 was 7.0% in Crete, 6.2% in Rhodes and 6.2% in the other islands compared to about 4.8% in the mainland.

Generation

In 2000, gross electricity generation was 53.4 TWh[20]. Lignite is the main fuel used for power generation in the mainland (64.2% of total in 2000), while island systems principally operate with heavy fuel oil and diesel and, increasingly, renewables. Between 1990 and 2000, lignite use in generation grew by 19%, although its share fell by some 8 percentage points. The share of oil in power generation has been steady at around 16.5% over the decade. There has been some annual variation in hydropower production, which had a 6.9% share in 2000. Depending on the weather, power generation by hydro can fluctuate significantly since water from dams is also used for irrigation and other water needs. The share of natural gas in electricity production increased from only 0.3% in 1990 to 11.1% in 2000. Wind amounted to 0.8% and waste 0.3% of total generation. The government estimates total generation to reach 78 TWh by 2010. It expects the share of lignite to decrease to 43.7% of generation and the share of gas to increase dramatically to 34.4% by 2010. The share of oil is expected to decrease to 12.6%, and the share of non-hydro renewables and waste to increase to 4.5%.

20. Net production after own use by power plants was 45.8 TWh. When imports and exports are taken into account, total supplied electricity was 45.6 TWh. Transmission and distribution losses were 3.3 TWh and consumption by the energy sector was 1.7 TWh.

Figure 22
Electricity Generation by Source, 1973 to 2010



* includes geothermal, solar, wind, combustible renewables and waste.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001, and country submission.

The net available capacity of the interconnected system was 9 334 MW at the end of 2000, with the peak load reaching 8 531 MW. The forecast for the development of capacity and a reserve margin is shown in Table 11. Three large generation units were commissioned after 1997 and one unit has gone through fuel conversion. The three new units, all installed by the PPC, are Big Lavrion (combined cycle gas turbine, 560 MW), Thissavros (hydro pumping, 3 x 128 MW) and Platanovryssi (hydro, 2 x 58 MW). The Aghios Georgios power plant (360 MW) was converted from oil to natural gas. PPC will commission an additional three new units for the mainland system by 2003, namely Komotini (natural gas, 495 MW), Meliti-Achlada in Florina (lignite, 330 MW) and Messochora (hydro, 162 MW). PPC is also studying the feasibility of installing two 250 MW lignite-fired units at Elassona. In the non-interconnected islands, several small generation units, with a total electric capacity of 241 MW, started operation since 1997.

The average efficiency of electricity plants in Greece (37.2% in 1999) is almost 3 percentage points lower than the average for IEA or EU countries. To address this problem, the PPC has initiated several measures. The lignite milling system of the Aghios Dimitrios power plant will be improved. Upgrading the cooling towers in the Kardia (units III and IV) and Ptolemais (unit IV) lignite power plants will increase their efficiency by 0.5%. The rehabilitation of the steam turbines of units III and IV of the Kardia power plant will increase efficiency by 3.5%, which is equivalent to a capacity increase of 25 MW per unit. Improvements in the boiler systems of some lignite plants are expected to increase their efficiency by 2%. Some efficiency improvements are also being implemented in the smaller oil-fired units.

Table 11
Development of a Reserve Margin in the Interconnected System

	2000	*2001*	*2002*	*2003*	*2004*
Peak load (MW)	8 531	8 600	9 200	9 700	10 200
Net available capacity (MW)	9 334	9 354	9 824	10 116	10 892
Reserve margin (MW)	803	754	624	416	692
Reserve margin (%)	8.6	8.06	6.35	4.11	6.35
Reserve margin (%) with interconnections (total 1 000 MW)	14.12	13.60	15.00	12.74	14.23

Source: The Ministry of Development.

Trade and Interconnections

The total volume of international electricity trade to and from Greece amounted to 3.5 TWh in 2000, but exports and imports offset each other (see Table 12). Greece both exported electricity to and imported electricity from Albania, the Federal Republic of Yugoslavia and Bulgaria. The total interconnection capacity is 600 MW, in almost equal proportion with the three countries.

Table 12
Import and Export of Electricity, TWh

	1990	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Import	1.33	1.39	2.66	3.00	2.50	1.81	1.73
Export	0.62	0.59	1.31	0.71	0.89	1.65	1.74
Net import	**0.71**	**0.80**	**1.35**	**2.29**	**1.61**	**0.16**	**–0.01**

Sources: *Electricity Information 2001* and *Oil, Gas, Coal & Electricity Quarterly Statistics*, IEA/OECD Paris, 2001.

Greece has not been connected to western Europe since the link to Austria was lost because of the Yugoslav civil war. However, a new inter-connector of 500 MW between Italy (Otranto) and Greece (Aetos) was commissioned in early 2002. Given the electricity bulk sale prices in the two countries, it is likely that Greece will export rather than import electricity. Greece is also exploring possibilities to rebuild the link with Austria through former Yugoslavia. A feasibility study on a new link with Turkey has been completed, and the interconnection will take place as soon as Turkey will have joined the Union for the Co-ordination of Transmission of Electricity (UCTE). One of the long-term priority objectives of the Greek government is to establish a competitive energy market in south-east Europe.

PRICING AND TARIFFS

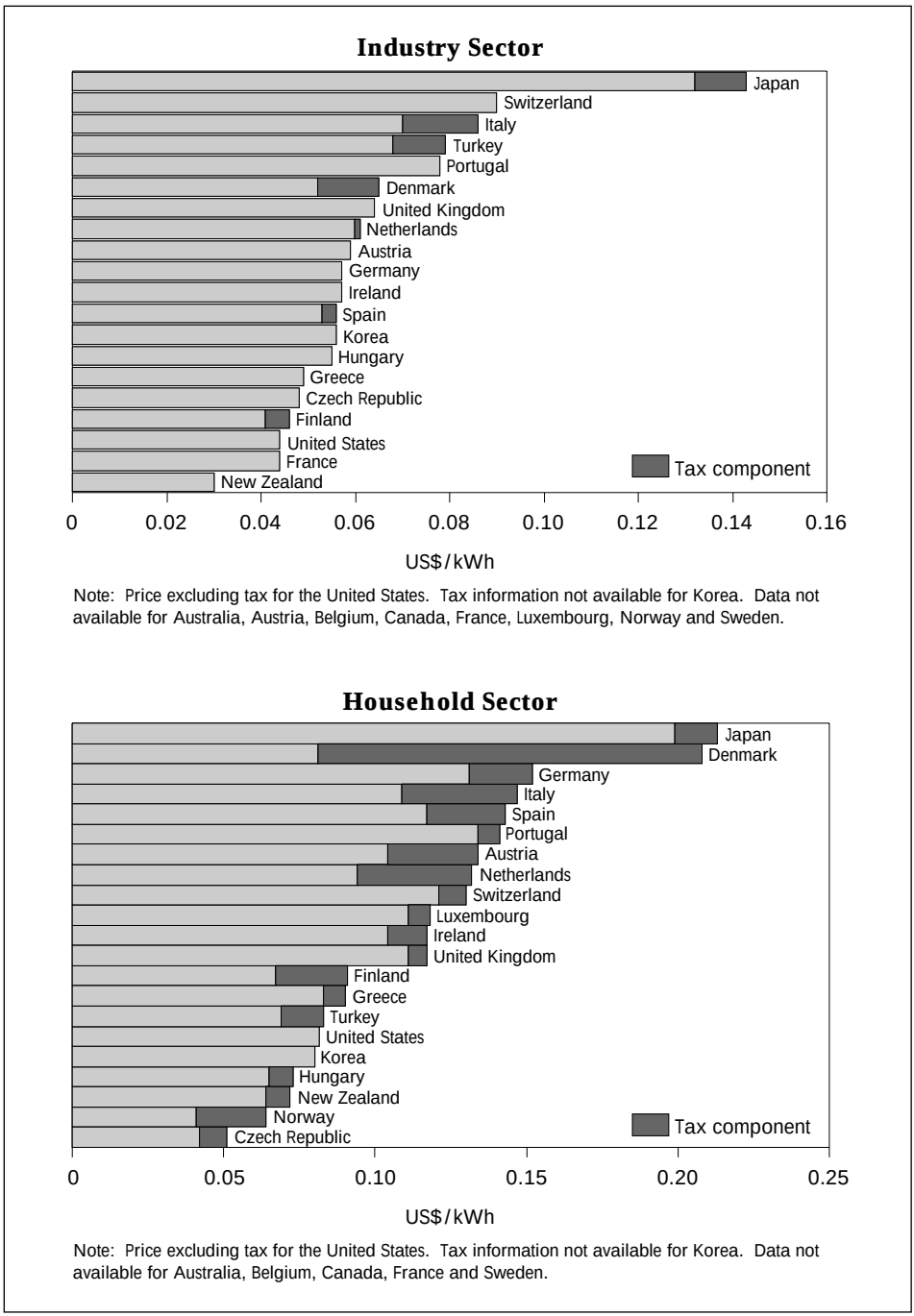
Greece has lower industrial electricity prices than most other IEA countries, and household electricity prices are slightly below the IEA average (see Figure 23). Electricity prices in Greece have been falling despite increasing investments in generating capacity over recent years (see Figure 24). One reason for this is that investments do not need to be fully financed through tariff revenues because Greece has received financial support from the EU for some power plant and infrastructure investments. Until 1995, PPC was investing less than €279 million/year, but by 1996-2000 this had increased to between €405 million and 440 million/year, with the exception of 1999 when it invested clearly less, €258 million. PPC's investments have grown by about 5% per year in real terms. Both PPC and private generation projects have received EU financing. Some recent projects, which were all implemented by PPC and received financing from the Operational Programme for Energy, are the Aghios Dimitrios, Lavrion and Komotini power plants (total subsidy of €180 million in 1994-2001) and the Italy-Greece inter-connector (subsidy of €117 million).

The 1999 Electricity Market Law (Law No. 2773 Liberalisation of the Electricity Market – Energy Policy Matters Regulation and Other Provisions, 22 December 1999) stipulates that the tariffs must cover all costs, including public service obligations, and provide a reasonable profit; it further stipulates that PPC cannot cross-subsidise between liberalised and captive consumers. Following tariff increases over the past few years, prices are approaching the level of supply cost for some consumer groups, but for other consumers the tariffs still do not fully reflect supply cost. An aluminium company and a nickel company, for instance, obtain electricity at heavily subsidised prices. These subsidies are to be phased out in 2006 and 2003 respectively, but PPC is trying to renegotiate the tariffs before the expiration of the contracts. Revenues collected from households do not quite cover the supply cost, and agricultural customers have clearly paid less than the supply cost. Furthermore, lower tariffs are applied to some households for social reasons. Only commercial and small industrial consumers have paid prices well above the supply cost.

In order to ensure that prices fully reflect cost, the government has initiated tariff restructuring. The RAE has proposed guidelines for tariffs and put them to public consultation, after which the RAE will forward its proposal to the Minister of Development. The proposed guidelines indicate that tariffs must reflect long-run marginal costs of generation; the cost of using the transmission system, medium- and low-voltage networks, and payment for public service obligations must be calculated separately; and the profit will be defined on the basis of regulated assets and regulated rate of return on capital. One price distortion will remain, however, as the government does not intend to differentiate tariffs geographically to take into account significant regional differences in supply cost.

At present, PPC proposes end-user tariffs for captive consumers, and the RAE gives an opinion on them before they are approved by the Minister of Development. When the market is liberalised, the prices will be set by the market players. The

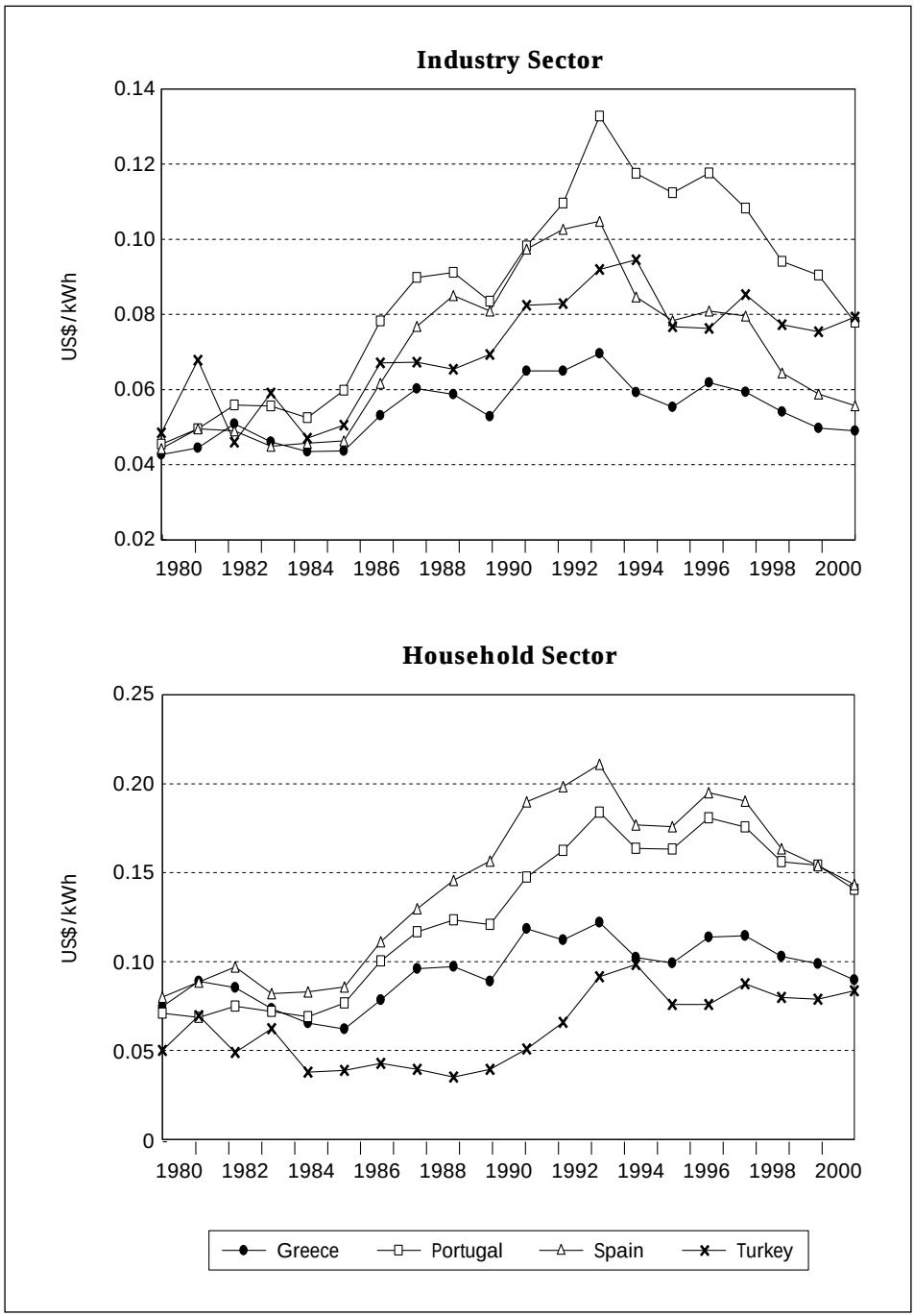
Figure 23
Electricity Prices in IEA Countries, 1999



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2001.

Figure 24

Electricity Prices in Greece and in Other Selected IEA Countries, 1980 to 2000



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2001.

government nonetheless intends to continue exercising control over PPC's tariffs as long as PPC supplies 70% or more of eligible consumers. If PPC's share of the eligible market drops under 70%, then PPC can set its prices freely in this market segment the same as other suppliers.

The government has applied to the European Commission for approval of a compensation scheme for stranded costs. The stranded cost compensation proposal assumes that PPC will increase its productivity by reducing all operational costs, including fuel, staff and other costs. The scheme would principally be financed through a levy on electricity tariffs.

INTRODUCTION OF COMPETITION

Greece's 1999 Electricity Market Law was adopted to comply with the EU Electricity Directive, and stipulates that the market be opened in line with the directive, which has given Greece a two-year derogation. Following the law, consumers with 100 GWh of annual consumption or more – *i.e.* 7 500 consumers or 34% of the market – became eligible to choose their supplier on 19 February 2001. This slightly exceeded the minimum opening of 30% of the market set by the directive. The next step defined by the directive is opening the market to 35% in total by February 2003; this step will be final unless the proposed new EU Electricity Directive is adopted and enters into force. The Greek government supports the proposed new directive, which would fully open the market in 2005.

The Electricity Market Law established the Regulatory Authority for Energy (RAE). One of the first tasks of the regulator was to prepare operation codes for the market. The codes have been completed:

- The Code for Authorisation Regulation for Generation and Supply defines the authorisation procedure, including the application formula and the factors that the RAE needs to take into account when giving an opinion on the application.

- The Grid Code defines the technical rules for licensed users to access the transmission system, and establishes the responsibilities and operational procedures for the Hellenic Transmission System Operator (HTSO) to perform its role. The transmission prices and other access terms must be non-discriminatory. Dispatch priority may be given to co-generators and to generating units that use indigenous sources (lignite, up to 15% of the total) or renewables.

- The Power Exchange Code governs the economic relationship among sector participants. *Inter alia*, it provides the basis for calculating the System Marginal Price at which settlement takes place.

- The Distribution Operation Code sets the terms for generators, suppliers, and eligible customers to access the distribution network.

- The Eligible Consumers' Supply Code sets minimum contractual terms that apply to all contracts between the suppliers and eligible consumers so that the latter will be protected in the newly opened market.

Generation in the interconnected system is based on an authorisation system. The Minister of Development, following an opinion from the RAE, gives authorisation. After February 2001, in the first wave of applications for generation licences, numbering about a thousand, nine applications for large power plants were approved (see Table 9) and the RAE gave a favourable opinion on 1 565 MW generation capacity using renewable energy sources and 140 MW using co-generation. Applications that were not approved mostly had problems associated with the project site, engineering plan, environment and the financial stability of the applicant.

Generation authorisation for the non-interconnected islands is granted under a tendering procedure, except for generation from renewables or by co-generation, in which case the project developers apply for generation licences. Every two years the RAE prepares an inventory for all the non-interconnected islands that indicates their needs for new or replacement capacity over the next five years. Then, the Minister of Development puts out a call for tender to generators. The RAE evaluates the proposals that are received and issues an opinion to the Minister of Development, who grants the generation licences. The electricity generated by the new units will be sold to PPC, who is obliged to purchase it by contract and under conditions that were specified to generators before they submitted their proposals.

The HTSO provides access to the transmission system using regulated third-party access (TPA) tariffs. It is the HTSO's responsibility to propose the TPA tariffs, which are approved by the Minister of Development following recommendations of the RAE. The first TPA tariffs (for 2002) were approved by the RAE in February 2002, a year after market liberalisation began. The reason for the delay was that the HTSO needed information from PPC to propose the tariffs but, as of November 2001, PPC had not submitted all the necessary cost information to the HTSO. However, the code stipulating the structure of TPA tariffs is in place.

Access to interconnection capacity is granted by annual auctions. The total of this capacity is 600 MW, of which PPC has a fixed 220 MW quota, 200 MW will be auctioned, and 180 MW reserved to cover fluctuations in demand. The first auction took place in December 2001.

CO-GENERATION

In 2000, the installed electric capacity of the combined heat and power plants (CHP) was 708 MW_e, with electricity production amounting to 3 122 GWh and heat production to 1 103 TJ[21]. The government estimates that the total potential for CHP is 400-700 MW_e in

21. Most CHP installations in Greece are operated by autoproducers. The IEA statistics for heat production by CHP plants comprise only heat sold to third parties and not the autoproducers' own consumption.

the industrial sector and 100 MW_e in the services sector if current policies to support CHP are taken into account. With milder winters than most other European countries, the economic potential of CHP in Greece is considered limited without some financial support from the government. In 2001, generation licences were granted for the construction of 400 MW_e of CHP capacity including small and large plants.

Most of the CHP units operating in Greece today are industrial power plants burning oil. A few units, operated by PPC, burn lignite and provide district heating in the northern part of the country. One is in Kozani, where the thermal capacity in use is 70 MW_{th}. Another system, with thermal capacity of 50 MW_{th}, operates in Ptolemais and provides approximately 45% of the town's demand for heat. Three new systems are in the planning phase, namely Florina (70 MW_{th}), Amyntaio (40 MW_{th}) and Megalopolis in the Peloponnesus (20 MW_{th}).

CHP has been promoted mainly through investment support. The mechanisms used to allocate this support are the Greek Development Laws (1982/90 and 2601/98), and the Operational Programmes for Energy (OPE) and Competitiveness (OPC), which receive financing under the EU Community Support Framework. Investors may choose the subsidy mechanism they prefer. The fuel efficiency requirements for receiving a subsidy are 60% and 65% for the industrial and services sectors, respectively. For CHP, subsidies of a maximum of 35% of the investment cost have been provided by OPE, leading to a 185 MW_e increase in CHP capacity. The investment subsidy maximum under OPC will also be 35%, and the increase in CHP capacity is estimated to be 375 MW_e and 690 MW_{th}. Under the Development Law of 1998, investors can benefit from a 40% investment subsidy. However, most investors prefer the lower subsidies provided under the Operational Programmes because they are available at the beginning of the investment project and not after it has been completed, as is the case with subsidies under the Development Law.

Law 2773/99 replaces the provisions of Law 2244/94 on the buy-back tariffs for electricity produced by CHP. In the interconnected system, the generator receives a compensation rate for energy that represents 90% of the energy part in the medium-voltage end-use tariff, and for capacity the rate is 50% of the capacity part in the same tariff. Prices in the non-interconnected system are based on percentages of the current PPC low-voltage residential tariffs, ranging from 60% for CHP using fossil fuels to 90% for CHP using renewable energy sources.

Weak economic competitiveness has not been the only barrier hampering the wider use of CHP. For instance, the prevailing legislation does not permit the installation of CHP or any other industrial plants in Attica (the region surrounding Athens) for environmental reasons. There are plans, however, to revise the legislation to allow CHP installations using natural gas.

LIGNITE

Lignite is used for 82% of Greece's indigenous energy production and for 64% of its electricity supply. The government anticipates that, between 2000 and 2010, lignite

use in power generation will grow in absolute numbers by 19%, yet its proportion in generation will decrease to 43.7% because of an increased use of natural gas. Although it is widely used, the quality of Greek lignite is low, and lignite mining and use can have environmental impacts (see Chapter 4). For the moment, information on the cost of lignite mining is not available owing to the recent unbundling of PPC's accounts.

Production is centred on the Ptolemais-Amyndeon complex in north-western Greece and at Megalopolis in the south. The PPC runs both of these mining areas. It is also developing the Florina deposits close to the border of the Former Yugoslav Republic of Macedonia, and is evaluating resources in Elassona (central Greece) and in Drama (eastern Macedonia). While the Greek State owns the lignite deposits, PPC exploits them under a state licence. Access to lignite deposits for operators other than PPC became legally possible when market liberalisation was launched in February 2001, but these operators still play a very limited role. Private mines in Florina sell 2 Mt to PPC per year, *i.e.* less than 5% of total lignite mined.

Table 13 summarises lignite production for 2000 and estimated reserves of the main lignite mines. Lignite production grew at an average rate of 2.0%/year between 1990 and 2000. PPC estimates that the known reserves are adequate to cover demand for 50 years.

Table 13
Production and Reserves of Major Lignite Fields

Mining Area	*Location*	*2000 Production (Mt)*	*Exploitable Reserves (Mt)*
Ptolemais (PPC)	Western Macedonia	42.01	1 542
Amyndaion (PPC)	Western Macedonia	8.82	322
Megalopolis (PPC)	Peloponnesus	12.5	286
Florina (PPC)	Western Macedonia	..	139.5[1]
Drama (PPC)	Eastern Macedonia	..	900
Elassona (PPC)	Central Greece	..	145
Komnina (PPC)	Western Macedonia	..	100
Privately-owned mines	Western Macedonia	0.15	..
Total		**63.48**	**3 434.5**

[1] 58% belong to private concessions.

Note: Fields at Drama, Elassona and Komnina have not been commercially developed.

Source: Ministry of Development.

CRITIQUE

A key challenge for Greece is to increase generation capacity without delay to meet fast growing demand for electricity. Even under the assumption that new power plants will be commissioned as planned, supply will be very tight over the coming 3 to 4 years. Several factors contribute to making this a difficult challenge. The uncertainties of hydropower are likely to increase the potential of supply risk. Because of limited transmission capacity, electricity imports can play only a marginal role. To attract new investors, the market must be improved, and fixing electricity and fuel price distortions is essential.

The generation capacity utilisation factor is falling because the summer demand peak is becoming more acute. Adjusting tariffs to discourage electricity use in peak time could be an effective measure to address the problem of a decreasing reserve margin at peak demand and increase the capacity utilisation factor. If prices were set to correctly reflect the supply cost, load management could be supported by different technological means. For instance, electricity consumers could be encouraged to have power companies or energy service companies install equipment that reduces loads during peak consumption time by, for example, periodically turning off water-heating systems.

Electricity market reform in Greece started two years after the rest of the EU. For a number of reasons, Greece was given a derogation in schedule to meet the EU Electricity Directive on market liberalisation. Essentially these include Greece's isolation from the other European networks, its geographical setting with many islands that makes introducing competition difficult, and the concentration of its electricity market. The electricity market is more concentrated in Greece than in any other EU country. A state-owned vertically integrated utility, the Public Power Corporation (PPC), controls more than 97% of electricity generation, owns the transmission networks, and owns and operates the distribution lines. The last IEA Greek Energy Policy In-depth Review of 1998 recommended unbundling the accounts of PPC. In order to meet the requirements of the EU Electricity Directive, the 1999 Electricity Market Law did in effect bring about the unbundling of PPC's accounts for generation, transmission, distribution and other activities, and the Transmission System Operator (HTSO) was created by legal separation of PPC's network operation functions. These are commendable improvements.

However, much work remains to be done for ensuring effective competition. The incumbent PPC holds the predominant share of HTSO, which may compromise the Transmission System Operator's independence. For instance, HTSO could not propose third-party access tariffs because PPC did not provide the necessary information. Also, electricity prices are still largely distorted at present. Market liberalisation has thus not sufficiently promoted competition, and the number of active new entrants expected in the near future is limited. It is true that about 400 MW of old interconnector capacity and the new 500 MW link between Italy and Greece were auctioned to new market players representing about 10.5% of peak capacity in the Greek system. However, as wholesale prices in Italy are considerably higher than in Greece, the interconnector between Italy and Greece is more likely

to be used for exports, with imports having some, but very limited, near-term impact on competition in Greece. Still, the government's objective of establishing a south-east European electricity pool could contribute towards increased competition in the long term. The Regulatory Authority for Energy (RAE) has recommended that trading companies be allowed to enter the market. On the one hand, this does not help to create competition if there are few suppliers but, on the other, it may help new generators to enter the market by reducing their commercial risks.

The first transmission network tariffs have been approved by the RAE but still need final approval from the Ministry of Development. Setting the tariffs was very slow given that market liberalisation started a year ago. Also, the government should ensure that the tariffs can be adjusted without delay when the reinforcement of networks and associated investments make such adjustments necessary.

The government should consider further liberalisation as many other IEA Europe countries have already liberalised, or plan to liberalise, the market well beyond the current EU directive requirements. This is likely to bring additional benefit to the country by increasing economic efficiency. Furthermore, because of the common reciprocity requirements, further liberalisation may become a precondition for trading electricity between Greece and countries that have liberalised their markets more than Greece.

Distorted electricity prices have negatively affected investment. The gas-fired power plants that new entrants are planning to build in Greece will not be commissioned before 2005-2006, and there is a risk that the projects may be delayed. Under the current high gas prices and low electricity prices, financing the projects can be difficult. Two large industrial companies, which accounted for 26.4% of all industrial electricity consumption in 2000, enjoy artificially low prices owing to long-term contracts; this practice does not provide an incentive to look for new suppliers. Opening the gas market to competition sooner than 2006 could reduce gas prices. It is therefore encouraging that the government is already taking steps in this direction.

Regional and social development is an important policy goal; the issue is how to pursue this goal without compromising energy policy objectives. Increasing economic efficiency by introducing competition in the energy market is also regarded as a means to enhance social welfare. This is an important energy policy objective of the Greek government. If the electricity tariff should indeed be equal throughout the country, there is no prospect for competition since no entrant can try to out-compete the other. As currently constructed, the uniform tariff acts as a barrier to increasing economic efficiency. If the government wishes to reap the economic benefits of liberalisation and continue to subsidise some consumers, it will need to find new policy mechanisms to accomplish this.

The Greek government recognises some of the benefits of geographical differentiation of prices. However, it considers geographically uniform tariffs to be a part of its public service obligation and a necessity to preserve economic and

social cohesion. Therefore, the government uses this tool to reduce the regional and social imbalances in different parts of the country. It is concerned that a sharp increase in electricity tariffs in certain geographic areas would contribute to an increase in internal emigration.

As a part of the market has been liberalised, the requirement for uniform tariffs appears to be interpreted by the government to mean that the price for the captive market is equal throughout the country but that it can vary for eligible customers. Thus, competition can theoretically occur in the liberalised market segment. However, whether competition can effectively occur and the market become more efficient depends on whether the electricity prices are set to reflect the costs. The review team considers that the captive consumers may be subsidising the industrial consumers or the prices for industry may be set below marginal costs, because industrial prices are clearly lower than the OECD average for industrial consumers, but only modestly lower for households. The Greek government considers that such price differences are mainly due to the geographical distribution of consumers, fuel mix used and consumption profiles.

Even when there is no cross-subsidisation between the eligible and captive consumers, price uniformity means that there is significant cross-subsidisation among consumers in the captive market, or substantial welfare transfer from metropolitan citizens to rural inhabitants. The government needs, at least, to disclose the real size of transfer so that the population can better understand the implications of uniform tariff policy and can show preference for changing policy if it so wishes.

It should also be noted that such tariff uniformity is very likely to make it difficult for renewables to find niche markets. Greece is considered to be a country, because of its geographical setting and climate, where some types of renewables can be competitive if the electricity prices reflect costs. If renewables have an absolute competitive advantage, or provide the cheapest option to generate power, they will be deployed regardless of the uniform tariff. A more likely situation is that there are rural areas in the country where renewables have only modestly higher costs than traditional types of generation. In this case, the incentives that government would need to provide to deploy renewables could be small, if electricity prices are set to reflect costs. Wider deployment may further reduce the costs of renewables, making them more economic. However, if electricity prices are set below cost as a consequence of the uniform tariff, the government will need to provide a larger amount of subsidies and the prospects of renewables taking off become poor.

Account separation may not be sufficient to provide a level playing field to all new entrants as long as PPC keeps such a predominant share in the market, from generation to retail. Deeper separation of PPC activities should be sought if sufficient competition does not appear to happen. The government has decided not to divest PPC’s generation assets into two or more generation companies allegedly to maintain PPC's competitiveness in the long run, and to avoid capacity deficits that could result from capping PPC's generating capacity. If no proof of

competition emerges in two or three years, the government should not preclude creating competing generation companies from PPC's generation assets. Keeping an overwhelming incumbent in the market does not create a favourable environment for competition. This effect is strengthened by present electricity prices and few prospects for international competition owing to cross-border transmission constraints. If PPC intends in the future to increase its business outside Greece, separation is also needed between the domestic and international operations to ensure that international operations are not subsidised by domestic revenues or *vice versa*.

As long as PPC remains one of the two principal owners of the HTSO and the owner of the transmission network, there is concern about the independence of the HTSO. Also, PPC might use its access to confidential commercial information about market entrants for its own advantage. Safeguarding the independence of the HTSO – particularly in terms of operation, maintenance and development of the transmission system – is essential for effective competition. Greece can learn from the experience of other countries where an independent transmission system operator owns the network, as in some of the Scandinavian countries, and has a direct financial incentive to develop the network in the most efficient way. In Spain, transmission network ownership has been mostly transferred to the transmission system operator, and legislation enables the HTSO to purchase those parts still owned by the utilities when this becomes financially possible. Allowing private investors to build direct lines from the power plant to the point of consumption could give an incentive to minimise transmission costs.

There are a number of reasons why CHP use is moderate in Greece. Climatic conditions as well as moderate heat demand in industrial processes limit the possibilities for finding matching heat and electricity loads. Also, high gas prices and low industrial electricity prices have made industries hesitant to invest in co-generation. CHP does however benefit from a high level of investment subsidies because of the government policy of increasing the use of CHP to achieve energy efficiency and reduce emissions. The fuel efficiency requirement to qualify for such subsidies is low, only 60-65% depending on the type of installation. With these modest criteria, there is the possibility that other means of providing electricity and heat might lead to better energy efficiency and environmental benefits than CHP. Efficient CHP should be competitive in nature and not need support. Consequently, the government should ensure that these subsidies do not become permanent. Overall, more attention should be paid to preparing an appropriate market environment for the promotion of CHP and providing more certainty for the future. Gas market liberalisation could help CHP generators to find cheaper gas.

Access to fuel is essential for competition in electricity generation, and new entrants face many difficulties in this respect. Under the current natural gas pricing scheme, the new entrants have no possibility, compared to PPC, to obtain gas under competitive conditions. This is because there is only one gas supplier, and this supplier sells gas at cheaper prices to PPC than to potential competitors (see Chapter 7). With regard to hard coal, present legislation does not restrict its use for electricity generation. However, when generation was opened to competition, only

proposals for electricity production from natural gas and renewables were accepted. If new coal technologies were to replace ageing power plants using low-quality lignite, hard coal could contribute to increased security of supply and environmental benefits. It should thus not be precluded from the fuel mix. It is likely, though, that the higher price of hard coal, compared to domestic lignite, will keep coal use modest. Until February 2001, PPC had exclusive rights for developing the lignite deposits, and it has invested considerably in this activity. Although other generators now legally have access to domestic lignite, in practice this access may be difficult for them, except through partnerships with PPC. Before any new generator can have fair access to lignite, there has to be transparency in lignite production costs but no such information is currently available. PPC, which was a vertically integrated company, separated its accounts for mining from other functions only recently, and it has not yet published reliable information on the cost of lignite supply.

RECOMMENDATIONS

The Government of Greece should:

☐ Address the problem of capacity margin.

☐ Ensure that, when necessary, third-party access tariffs will be adjusted without delay.

☐ Ensure that electricity prices reflect costs; social pricing and cross-subsidisation should be phased out.

☐ Consider carefully the negative effects of geographically uniform tariffs.

☐ Ensure that the incumbent does not have access to confidential commercial information about new entrants.

☐ Allow the construction of private transmission lines for self-consumption.

☐ Continue efforts to develop the south-east European electricity market.

☐ Prepare to separate distribution and retailing from the other businesses of PPC; as a first step, examine the feasibility of transferring ownership of the transmission network from PPC to HTSO; if competition does not emerge, the government should not preclude splitting PPC's generation assets into several companies with different ownership.

☐ Ensure that captive consumers benefit from the efficiency gains achieved from market liberalisation. Study the benefits of extending market liberalisation to smaller consumers.

☐ With regard to security of supply, the environment and competition, clarify the government position on the future role of coal and lignite in electricity generation.

☐ Improve access to lignite for electricity generators by, for example, ensuring transparency in lignite production costs.

10

ENERGY RESEARCH AND DEVELOPMENT

The General Secretariat for Research & Technology in the Ministry of Development is responsible for research and development (R&D) policies in Greece. The main objectives of energy-related R&D programmes are to encourage partnerships between research organisations and industry, and to promote innovation in renewables and energy efficiency. More specifically, the following areas are emphasised:

- Improvement of the efficiency of the components used in renewable energy systems and reduction of costs. This includes activities on biomass use, photovoltaic cell and wind turbine efficiency, reducing the manufacturing costs of equipment (*e.g.* turbine blades and photovoltaic panels).

- Improvement of power quality, optimisation of local load factors, increase of capacity utilisation, and integration of renewables with the electricity grids.

- Development of new technologies and applications for saving energy in buildings, transport and industry.

Table 14
Greek Government R&D Budget for Energy, million euros

Year	*1996*	*1997*	*1998*	*1999*	*2000 estimate*	*2001 estimate*	*2002 estimate*
Budget	8.9	15.9	..	..	5.7	7.0	8.8

.. = not available.

Sources: *Energy Policies of IEA Countries 2000 Review* ("the Compendium"),Annex B, IEA/OECD Paris, 2000, and the Ministry of Development.

For implementing these policies, financial support is provided mainly by the general state budget, competitive programmes (see Chapter 3), and EU research programmes. Some 57.8% of all energy R&D financing is national, and 42.2% comes from the EU. The Greek State's energy R&D budget is very small and varies significantly from year to year (see Table 14). The budget is essentially used for making national contributions to projects financed under the EU programmes, including the Operational Programmes, and as direct financial support to the Centre for Renewable Energy Sources (CRES) and the Centre for Solid Fuels Technologies and Applications (CSFTA). In the 2000 estimate, 37% of the budget is allocated to power and storage technologies, 31% to renewables, 16% to nuclear technologies[22], 9% to energy conservation and 8% to fossil fuel technologies.

22. Nuclear research is mainly undertaken at various institutes of the National Centre for Scientific Research (Demokritos). It focuses on environmental and medical applications and to radiation protection issues.

The total budget of the Targeted Programme for R&D on Renewable Energy and Energy Saving of the Operational Programme for Competitiveness (see Chapter 3) is €16 million during 2000-2006, including a government contribution of €9 million. The R&D objectives of the Targeted Programme are:

- Improving industrial competitiveness and encouraging links between research organisations and the private sector.

- Upgrading existing laboratories and establishing new ones for testing and certification services.

- Providing support to research units for the standardisation and commercial use of research results.

- Creating new employment and new companies using research results, for example through spin-offs originating from research organisations and researchers.

- Development of research centres by supporting laboratories operated by companies and R&D users.

- Providing support for international scientific and technological co-operation and technology transfer.

The government considers international co-operation to be an important component of Greek R&D energy policy. Greece has been participating actively in EU programmes. In the 1997-2000 period, Greece took part in THERMIE (1997-1998), ENERGIE (1999-2000), SAVE (1997-2000) and ALTENER (1997-2000). The total budget for these projects was €72.5 million, with a €30.6 million EU contribution. In addition, Greece participated in the JOULE Programme. Greece also takes part in the following IEA Implementing Agreements: Building and Commercial Systems, Demand-Side Management, Energy Technology Systems Analysis Project (ETSAP), Geothermal Energy, Solar Heating and Cooling, and Wind Turbine Systems.

The CRES is the principal recipient of government R&D financing, yet several other research and academic institutions also carry out publicly financed R&D activities on energy; they include the Centre for Solid Fuels Technologies and Applications (CSFTA), the National Centre for Scientific Research (Demokritos), the Institute for Chemical Processes Engineering (CPERI), the Institute of Electronic Structure & Lasers (IESL–FORTH), and several departments of the National Technical University of Athens (NTUA). At present, the participation of public and private enterprises in energy R&D is limited, but the government is trying to increase industry's role in this area.

The CRES's main activities are:

- Planning programmes for applied research in renewables and energy efficiency so that new technologies for products and services can be developed.

- Development and execution of pilot projects in renewables and energy efficiency.

- Development of experimental and theoretical methods and procedures for the evaluation of renewables and energy efficiency.

- Development of certification systems for renewables and energy efficiency products.

- Design and laboratory development of prototypes of renewables and energy efficiency systems.

- Development of computer programmes for simulation of the potential of renewables and other applications (*e.g.* wind energy flow fields, and combustion and emissions flow in combustion systems).

- Development of measuring instruments and control systems for renewables and energy efficiency.

The research projects are monitored and evaluated by a panel of members of the General Secretariat for Research & Technology and other experts. The panel reviews the results and deliverables, including financial, management and technology issues associated with these projects. Projects funded under the new Operational Programme for Competitiveness are subject to more rigorous monitoring, often resulting in new employment, patents, reports, citations, prototypes, *etc.*

CRITIQUE

Energy-related R&D focuses on developing technologies for renewable energy use, which is in line with the government's energy policy objectives. Considering the potential of renewables in Greece because of its unique geographical setting and climate, this approach to energy R&D seems sensible. Efforts should continue to ensure that R&D activities will help to find effective technological solutions to fit with local conditions.

The government sees lignite use as a means to increase energy security and expects lignite to make a significant contribution to energy supply in the future. At present, lignite use in Greece is not based on modern clean coal technologies. Expenditure in the state R&D budget should therefore be reviewed to provide support for using these technologies. More generally, since government R&D resources are limited, there is a need to adjust the way they are allocated, targeting them more effectively on different areas so that there is greater consistency with policy priorities.

While Greece is actively participating in European Union research programmes, there is room for increasing its participation in the activities of the IEA

Implementing Agreements. Since Greece is active in the following two areas, it could benefit especially from intensified co-operation in the Implementing Agreement for Renewables and from joining the Implementing Agreement for Energy Storage. If Greece were to carry out research in clean coal technologies, it could also join the respective Implementing Agreement.

For the effective deployment of new technologies, industry should play an important role in energy R&D. The government has tried to encourage industry to carry out more energy R&D, but so far the sector has not been very responsive.

Providing only R&D resources is neither sufficient nor effective to ensure the deployment of new technologies. It is more important for the government to create a favourable environment for new technologies. For example, for renewables this should include building infrastructure and introducing market-oriented instruments, such as portfolio standards with green certificates. This way industry can be assured that investment in renewables is economically viable (see Chapter 8).

RECOMMENDATIONS

The Government of Greece should:

- ☐ Continue R&D in order to reduce the cost and improve the efficiency of renewables; ensure adequate support for the development and demonstration of clean coal technologies.

- ☐ Seek opportunities to join international collaboration projects within the European Union and other international organisations, such as the IEA.

- ☐ Continue to encourage the participation of industry in R&D.

A

ANNEX

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	1999	2000	2005	2010	2020
TOTAL PRODUCTION		**2.33**	**8.77**	**9.54**	**9.99**	**10.76**	**11.14**	**..**
Coal[1]		1.69	7.12	8.04	8.22	8.75	8.82	..
Oil		-	0.84	0.02	0.26	0.30	0.30	..
Gas		–	0.14	0.00	0.04	0.05	0.04	..
Comb. Renewables & Wastes[2]		0.45	0.46	0.98	1.01	1.00	1.14	..
Nuclear		–	–	–	–	–	–	..
Hydro		0.19	0.15	0.40	0.32	0.33	0.33	..
Geothermal		–	0.00	0.00	0.00	–	0.11	..
Solar / Wind / Other		–	0.06	0.11	0.14	0.33	0.40	..
TOTAL NET IMPORTS[3]		**11.12**	**12.74**	**16.43**	**18.13**	**25.29**	**29.40**	**..**
Coal[1]	Exports	0.02	–	0.05	0.04	–	–	..
	Imports	0.47	0.92	0.78	0.81	0.76	0.76	..
	Net Imports	0.45	0.92	0.73	0.77	0.76	0.76	..
Oil	Exports	4.95	7.56	3.84	4.17	6.00	6.00	..
	Imports	16.51	21.87	21.42	23.44	29.62	31.22	..
	Bunkers	0.89	2.55	3.12	3.60	3.60	3.60	..
	Net Imports	10.67	11.76	14.47	15.67	20.02	21.62	..
Gas	Exports	–	–	–	–	–	–	..
	Imports	–	–	1.22	1.69	4.52	7.02	..
	Net Imports	–	–	1.22	1.69	4.52	7.02	..
Electricity	Exports	0.00	0.05	0.14	0.15	–	–	..
	Imports	0.01	0.11	0.16	0.15	–	–	..
	Net Imports	0.00	0.06	0.01	–0.00	–	–	..
TOTAL STOCK CHANGES		**–1.10**	**0.24**	**0.66**	**–0.29**	**–**	**–**	**..**
TOTAL SUPPLY (TPES)		**12.36**	**21.75**	**26.62**	**27.82**	**36.06**	**40.54**	**..**
Coal[1]		2.10	8.07	8.56	9.04	9.51	9.58	..
Oil		9.61	12.81	15.34	15.61	20.32	21.92	..
Gas		–	0.14	1.22	1.70	4.57	7.06	..
Comb. Renewables & Wastes[2]		0.45	0.46	0.98	1.01	1.00	1.14	..
Nuclear		–	–	–	–	–	–	..
Hydro		0.19	0.15	0.40	0.32	0.33	0.33	..
Geothermal		–	0.00	0.00	0.00	–	0.11	..
Solar / Wind / Other		–	0.06	0.11	0.14	0.33	0.40	..
Electricity Trade[4]		0.00	0.06	0.01	–0.00	–	–	..
Shares (%)								
Coal		*17.0*	*37.1*	*32.2*	*32.5*	*26.4*	*23.6*	..
Oil		*77.7*	*58.9*	*57.6*	*56.1*	*56.4*	*54.1*	..
Gas		*–*	*0.6*	*4.6*	*6.1*	*12.7*	*17.4*	..
Comb. Renewables & Wastes		*3.6*	*2.1*	*3.7*	*3.6*	*2.8*	*2.8*	..
Nuclear		*–*	*–*	*–*	*–*	*–*	*–*	..
Hydro		*1.5*	*0.7*	*1.5*	*1.1*	*0.9*	*0.8*	..
Geothermal		*–*	*–*	*–*	*–*	*–*	*0.3*	..
Solar / Wind / Other		*–*	*0.3*	*0.4*	*0.5*	*0.9*	*1.0*	..
Electricity Trade		*–*	*0.3*	*0.1*	*–*	*–*	*–*	..

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

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	1999	2000	2005	2010	2020
TFC	**9.21**	**15.03**	**18.97**	**19.51**	**24.15**	**29.53**	**..**
Coal[1]	0.52	1.20	0.75	0.88	0.76	0.76	..
Oil	7.15	10.75	13.33	13.46	16.37	19.87	..
Gas	0.00	0.11	0.35	0.38	1.11	1.88	..
Comb. Renewables & Wastes[2]	0.45	0.46	0.91	0.95	0.96	1.08	..
Geothermal	–	0.00	0.00	0.00	–	–	..
Solar / Wind / Other	–	0.06	0.10	0.10	0.13	0.14	..
Electricity	1.09	2.45	3.49	3.71	4.80	5.79	..
Heat	–	–	0.03	0.03	0.03	0.03	..
Shares (%)							
Coal	*5.6*	*8.0*	*4.0*	*4.5*	*3.1*	*2.6*	..
Oil	*77.6*	*71.5*	*70.3*	*69.0*	*67.8*	*67.3*	..
Gas	*–*	*0.7*	*1.9*	*1.9*	*4.6*	*6.4*	..
Comb. Renewables & Wastes	*4.9*	*3.1*	*4.8*	*4.9*	*4.0*	*3.7*	..
Geothermal	*–*	*–*	*–*	*–*	*–*	*–*	..
Solar / Wind / Other	*–*	*0.4*	*0.5*	*0.5*	*0.5*	*0.5*	..
Electricity	*11.9*	*16.3*	*18.4*	*19.0*	*19.9*	*19.6*	..
Heat	*–*	*–*	*0.1*	*0.1*	*0.1*	*0.1*	..
TOTAL INDUSTRY[5]	**3.49**	**4.62**	**4.75**	**5.19**	**6.02**	**7.32**	**..**
Coal[1]	0.46	1.18	0.73	0.85	0.72	0.72	..
Oil	2.39	2.18	2.37	2.57	2.76	3.54	..
Gas	–	0.10	0.34	0.37	0.80	0.99	..
Comb. Renewables & Wastes[2]	–	0.12	0.21	0.24	0.25	0.25	..
Geothermal	–	–	–	–	–	–	..
Solar / Wind / Other	–	–	–	–	–	–	..
Electricity	0.63	1.04	1.11	1.17	1.49	1.82	..
Heat	–	–	–	–	–	–	..
Shares (%)							
Coal	*13.1*	*25.4*	*15.4*	*16.4*	*12.0*	*9.8*	..
Oil	*68.7*	*47.2*	*49.8*	*49.4*	*45.9*	*48.4*	..
Gas	*–*	*2.2*	*7.1*	*7.0*	*13.3*	*13.5*	..
Comb. Renewables & Wastes	*–*	*2.6*	*4.4*	*4.6*	*4.1*	*3.4*	..
Geothermal	*–*	*–*	*–*	*–*	*–*	*–*	..
Solar / Wind / Other	*–*	*–*	*–*	*–*	*–*	*–*	..
Electricity	*18.2*	*22.5*	*23.3*	*22.5*	*24.8*	*24.8*	..
Heat	*–*	*–*	*–*	*–*	*–*	*–*	..
TRANSPORT[6]	**2.70**	**5.95**	**7.62**	**7.36**	**9.31**	**11.44**	**..**
TOTAL OTHER SECTORS[7]	**3.03**	**4.46**	**6.59**	**6.95**	**8.83**	**10.78**	**..**
Coal[1]	0.04	0.03	0.02	0.03	0.04	0.04	..
Oil	2.08	2.63	3.36	3.56	4.36	4.98	..
Gas	0.00	0.01	0.01	0.01	0.30	0.86	..
Comb. Renewables & Wastes[2]	0.45	0.34	0.70	0.71	0.71	0.83	..
Geothermal	–	0.00	0.00	0.00	–	–	..
Solar / Wind / Other	–	0.06	0.10	0.10	0.13	0.14	..
Electricity	0.46	1.40	2.37	2.53	3.26	3.91	..
Heat	–	–	0.03	0.03	0.03	0.03	..
Shares (%)							
Coal	*1.4*	*0.6*	*0.3*	*0.4*	*0.4*	*0.3*	..
Oil	*68.6*	*58.9*	*51.0*	*51.1*	*49.4*	*46.2*	..
Gas	*0.1*	*0.2*	*0.2*	*0.2*	*3.4*	*8.0*	..
Comb. Renewables & Wastes	*14.9*	*7.7*	*10.6*	*10.1*	*8.1*	*7.7*	..
Geothermal	*–*	*–*	*–*	*–*	*–*	*–*	..
Solar / Wind / Other	*–*	*1.3*	*1.5*	*1.4*	*1.5*	*1.3*	..
Electricity	*15.0*	*31.3*	*35.9*	*36.3*	*37.0*	*36.3*	..
Heat	*–*	*–*	*0.4*	*0.4*	*0.3*	*0.3*	..

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	1999	2000	2005	2010	2020
ELECTRICITY GENERATION[8]							
INPUT (Mtoe)	**3.34**	**8.90**	**11.08**	**11.93**	**14.71**	**16.77**	**..**
OUTPUT (Mtoe)	**1.27**	**2.99**	**4.25**	**4.59**	**5.66**	**6.72**	**..**
(TWh gross)	14.82	34.78	49.38	53.43	65.86	78.12	..
Output Shares (%)							
Coal	*35.5*	*72.4*	*65.6*	*64.2*	*51.4*	*43.7*	..
Oil	*49.5*	*22.3*	*16.5*	*16.6*	*15.0*	*12.6*	..
Gas	*-*	*0.3*	*7.9*	*11.1*	*24.1*	*34.4*	..
Comb. Renewables & Wastes	*-*	*-*	*0.4*	*0.3*	*0.3*	*0.3*	..
Nuclear	*-*	*-*	*-*	*-*	*-*	*-*	..
Hydro	*15.0*	*5.1*	*9.3*	*6.9*	*5.8*	*4.9*	..
Geothermal	*-*	*-*	*-*	*-*	*-*	*0.2*	..
Solar/Wind/Other	*-*	*0.0*	*0.3*	*0.8*	*3.5*	*4.0*	..
TOTAL LOSSES	**3.14**	**7.00**	**7.84**	**8.53**	**11.90**	**11.00**	**..**
of which:							
Electricity and Heat Generation[9]	2.07	5.91	6.81	7.31	8.98	10.00	..
Other Transformation	0.44	-0.23	-0.56	-0.70	0.90	-	..
Own Use and Losses[10]	0.64	1.31	1.58	1.92	2.02	1.00	..
Statistical Differences	**0.00**	**-0.28**	**-0.18**	**-0.21**	**-**	**-**	**-**

INDICATORS

	1973	1990	1999	2000	2005	2010	2020
GDP (billion 1995 US$)	84.54	110.50	133.32	139.07	169.20	205.86	..
Population (millions)	8.93	10.16	10.53	10.56	10.80	11.00	..
TPES/GDP[11]	0.15	0.20	0.20	0.20	0.21	0.20	..
Energy Production/TPES	0.19	0.40	0.36	0.36	0.30	0.27	..
Per Capita TPES[12]	1.38	2.14	2.53	2.64	3.34	3.69	..
Oil Supply/GDP[11]	0.11	0.12	0.12	0.11	0.12	0.11	..
TFC/GDP[11]	0.11	0.14	0.14	0.14	0.14	0.14	..
Per Capita TFC[12]	1.03	1.48	1.80	1.85	2.24	2.68	..
Energy-related CO_2 Emissions (Mt CO_2)[13]	34.4	70.6	83.1	87.8	104.8	118.2	..
CO_2 Emissions from Bunkers (Mt CO_2)	4.5	10.5	12.7	13.9	13.9	13.9	..

GROWTH RATES (% per year)

	73–79	79–90	90–99	99–00	00–05	05–10	10–20
TPES	4.4	2.8	2.3	4.5	5.3	2.4	..
Coal	8.7	8.0	0.7	5.5	1.0	0.1	..
Oil	3.5	0.7	2.0	1.8	5.4	1.5	..
Gas	-	-	27.4	39.9	21.8	9.1	..
Comb. Renewables & Wastes	-	0.3	8.6	3.4	-0.2	2.6	..
Nuclear	-	-	-	-	-	-	..
Hydro	8.2	-6.2	11.2	-19.5	0.8	-0.2	..
Geothermal	-	-	8.0	-	-	-	..
Solar/Wind/Other	-	-	7.6	25.5	18.9	4.2	..
TFC	4.0	2.4	2.6	2.8	4.4	4.1	..
Electricity Consumption	7.0	3.7	4.0	6.2	5.3	3.8	..
Energy Production	8.3	8.0	0.9	4.7	1.5	0.7	..
Net Oil Imports	2.5	-0.4	2.3	8.3	5.0	1.5	..
GDP	3.3	0.7	2.1	4.3	4.0	4.0	..
Growth in the TPES/GDP Ratio	1.1	2.1	0.2	0.2	1.3	-1.6	..
Growth in the TFC/GDP Ratio	0.7	1.7	0.5	-1.4	0.4	0.1	..

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, 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.
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, CHP and heat plants. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiency of 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 1995 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 2000 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.

B

ANNEX

INTERNATIONAL ENERGY AGENCY
"SHARED GOALS"

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

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

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

* 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.

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

5 **Improved energy efficiency** can promote both environmental protection and energy security in a 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.)

C

ANNEX

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 abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

AOPC	Association of Oil and Petroleum Companies.
bbl	barrel.
bcm	billion cubic metres.
CSFTA	Centre for Solid Fuels Technologies and Applications.
CHP	combined production of heat and power; sometimes, when referring to industrial CHP, the term "co-generation" is used.
CRES	Centre for Renewable Energy Sources.
DEPA	Greek Public Gas Corporation.
EPA	gas distribution company.
EU	European Union.
GDP	gross domestic product.
GHG	greenhouse gases (see footnote 3).
GW	gigawatt, or one watt $\times 10^9$.
GWh	gigawatt-hour = one gigawatt $\times$ one hour.
ha	hectare.
IEA	International Energy Agency.
kt	thousand tonnes.
kV	kilovolt, or one volt $\times 10^3$.
kWh	kilowatt-hour = one kilowatt $\times$ one hour.
LNG	liquefied natural gas.
LPG	liquefied petroleum gas.

m^2	square metre.
m^3	cubic metre.
m/s	metre per second.
Mt	million tonnes.
Mtce	million tonnes of coal equivalent (one Mtce = 0.7 Mtoe).
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt, or one watt $\times 10^6$.
MW_e	megawatt of electrical capacity.
MWh	megawatt-hour = one megawatt $\times$ one hour.
MW_{th}	megawatt of thermal capacity.
OECD	Organisation for Economic Co-operation and Development.
OPEC	Organization of the Petroleum Exporting Countries.
PPC	Greek Public Power Corporation.
PPP	purchasing power parity.
RAE	Regulatory Authority for Energy.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
TFC	total final consumption of energy.
TJ	terajoule, or one joule $\times 10^{12}$.
Toe	tonne of oil equivalent, defined as 10^7 kcal.
TPA	third-party access.
TPES	total primary energy supply.
TSO	Transmission System Operator.
TW	terawatt, or one watt $\times 10^{12}$.
TWh	terawatt-hour = one terawatt $\times$ one hour.
VAT	value-added tax.

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