INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

GREECE

2006 Review

OECD

INTERNATIONAL ENERGY AGENCY

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

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

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

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

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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

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

TABLE OF CONTENTS

Tables and Figures

TABLES

FIGURES

ORGANISATION OF THE REVIEW

REVIEW TEAM

The 2006 IEA in-depth review of the energy policies of Greece was undertaken by a team of energy specialists from IEA member countries. The team visited Athens from 20 to 27 January 2006 to meet with government officials, energy suppliers, trade associations, and others. This report was drafted on the basis of those meetings and the government's official response to the IEA's policy questionnaire. The team is grateful for the co-operation and assistance of the many people it met during the visit. It is only thanks to their willingness to share information that this report could be prepared. The team wishes special mention to be made of the understanding and courteous professionalism displayed by Aphrodite Tzika, Olympia Tsgarakou, Maria Hiodini, Achilles Kyrtsis, Nikos Katsis and Dimitrios Kouris, all from the Greek Ministry of Development, in preparing and accompanying the visit.

The members of the team were:

Lars Guldbrand
Ministry of Sustainable Development, Sweden

Anne-Marie Fiquet
Directorate-General for Energy and Transport, European Commission

Öztürk Selvitop
Ministry of Energy and Natural Resources, Turkey

Jun Arima
Country Studies Division, International Energy Agency

Kazunari Kainou
Research Institute of Economy, Trade and Industry, Japan

Andreas Biermann
Country Studies Division, International Energy Agency

Andreas Biermann managed the review and drafted the report. Monica Petit and Bertrand Sadin prepared the figures. Marilyn Ferris provided editorial assistance.

ORGANISATIONS VISITED

- Centre for Renewable Energy Resources (CRES)
- EPA Attiki
- Electricity Consumers Association
- Federation of Greek Industries
- Greek Association for Electric Energy

- Greek Association of Renewable Energy Sources
- Hellenic Competition Commission
- Hellenic Petroleum S.A.
- Hellenic Regulatory Authority
- Hellenic Transmission System Operator (HTSO) S.A.
- Ministry of Environment, Physical Planning and Public Works
- Ministry of Development
- Ministry of Finance.
- Ministry of Transport.
- Motor Oil Hellas
- National Observatory of Athens (NOA)
- Public Power Corporation (PPC) S.A.
- Public Gas Corporation (DEPA) S.A.
- Prometheus Gas

REVIEW CRITERIA

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

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

There have been many positive developments in Greek energy policy. Energy diversification has been progressing and Greece is actively increasing interconnections with neighbouring countries and has also played a crucial role in the Energy Community of South East Europe Treaty. Such efforts will not only contribute to security of supply but also make Greece an important energy hub. The impressive developments in public transport and renewable energy capacity are also encouraging examples. In the area of market reform, bills regarding the liberalisation of the Greek electricity market and the natural gas market were enacted. Important challenges remain, however.

One challenge for the Greek government is to maximise the benefit of the proposed market reforms. Important issues to be addressed are the strong market power of incumbents, and the level of independence of the transmission system operator and the independence of the Regulatory Authority for Energy (RAE). The market power of the partially state-owned incumbents, the Public Gas Corporation (DEPA) and the Public Power Corporation (PPC), constitutes a big impediment to effective competition. Unless it is addressed, effective competition is not conceivable and the benefits for consumers will be significantly diminished, even though the electricity and gas markets are now open on a legal basis. Increasing interconnection with neighbouring countries is an option to reduce the dominance of the incumbents, but domestic measures will need to be pursued with vigour to ensure the development of competition. A number of measures could be taken, such as prohibiting the participation of PPC in all future tenders for generating capacity, and/or setting a decree mandating the incumbent to reduce its market share to a certain level by a certain time.

PPC remains one of the two principal owners (49%) of the Hellenic Transmission System Operator (HTSO), and continues to own the network. DEPA will be the sole owner of the gas transmission system operator, DESFA, with DESFA owning the network. Over a 10-year period, DESFA's Board of Directors will be appointed by the Greek State. Full operative asset ownership and independence of the electricity and gas system operators is a prerequisite for effective competition. It may be preferable for the government to consider transferring HTSO and DESFA to 100% government ownership, not ruling out their later privatisation. Cross-shareholdings of electricity and gas incumbents also require close monitoring to avoid anti-competitive consequences for the markets. The government should be careful that such cross-shareholdings do not become a barrier to competition. With the enactment of the new market laws, RAE's responsibilities have been enhanced, but the regulator still continues mainly in its advisory role.

Consideration should be given to extend the RAE's powers to include those recommended for regulatory authorities in the EU market directives.

Greece suffers from a high level of local resistance and administrative barriers to new energy infrastructure. The government has introduced new laws for the simplification of the licensing procedure for Renewable Energy Sources (RES) systems, as well as for the industrial sector, including energy-related infrastructure (Law 3325/2005). In addition, the government is preparing a Special Spatial Plan focusing on areas of high RES potential, which will be completed at the end of 2006. In order for the Greek government to become sufficiently active in communicating its energy policy and the policy goals and constraints to the general public, Law 3438/2006 was recently passed in Parliament establishing the "National Energy Strategy Council".

The government is using energy pricing and taxation to achieve social objectives, such as equal cost of energy across the whole country. This practice distorts the energy market and it may also discourage energy efficiency efforts. Social policy objectives are crucial, but they can be addressed more efficiently through direct support.

Greece has made important and commendable progress in the sector of energy and environment policy but with +23.5% in 2003, greenhouse gas (GHG) emissions are already very close to the 2010 Kyoto target of 25% above 1990 levels. The National Allocation Plan was approved in 2005 and following the establishment of the registry in April 2006, Greece now participates in the EU-ETS. The government should assess the impact of the European Union Emissions Trading Scheme (EU-ETS), which is not considered in its national programme, and, if necessary, update the programme with supplementary measures. The Greek government should also consider addressing non-CO_2 GHG emissions.

There are no institutional arrangements or exchanges between the new energy statistics system and the national GHG inventory system under the United Nations Framework Convention on Climate Change (UNFCCC), even though the quality of UNFCCC GHG inventory system fundamentally depends on the energy statistics system. This can cause policy inconsistencies between energy policy and climate change policy.

Currently, Greece does not have a comprehensive energy efficiency strategy. Greek energy policy seems to be overly supply-side oriented, and stronger emphasis should be placed on the demand side. Greek energy demand is increasing, in particular in the transport and non-industrial sectors. While the energy intensity of Greece has stabilised after increasing to the level of the IEA Europe average, given the country's high economic growth, further efforts will be necessary to improve energy efficiency. Developing a comprehensive energy efficiency strategy with measurable objectives/targets, ensuring co-operation among relevant ministries, could help to balance Greek energy policy.

A reactive approach merely transposing EU directives may miss particular policy opportunities in Greece. Reducing the rate of increase and managing peak demand are the main challenges for future Greek energy efficiency policy, and it could be useful to consider more market-based instruments, including a more cost-reflective energy tariff to *e.g.* discourage demand at peak times. The introduction of a stronger building code in line with the EU Directive on Energy Performance in Buildings and its enforcement are also essential.

In Greece, the share of oil in total primary energy supply (TPES) and electricity generation is among the highest in the IEA, and needs to be reduced. The Greek government should, therefore, consider specific policies to reduce it. For example, Greece has recently made very significant and visible progress in the public transport sector, and tax incentives have encouraged renewal of the private car fleet. Efforts to introduce alternative fuels in public transport in Athens are commendable, and investment in such measures should be continued and increased. However, lower excise tax on road fuels, compared to other EU countries, and an absence of tax benefits for the use of fuel-efficient vehicles does not encourage modal shifts and reduces the incentive to further increase the fuel efficiency of the vehicle fleet. The government should introduce the EU vehicle label, linked to taxation.

The high level of market power in the refining sector could potentially cause problems in the future, and the government should continue to closely monitor the market. Widely diverging tax rates for light fuel oil use in stationary and mobile applications encourage tax evasion, and the government has taken various measures against this.

Greece has come into compliance with IEA stockholding requirements since the last review. This is commendable, and every effort should be made to ensure that stockholding requirements are complied with in the future.

Greek demand for natural gas has reached approximately 7% of TPES and is increasing. The successful penetration of natural gas into the energy supply in Greece is to be praised. However, gas supply in 2005 was considerably less than was forecast at the time of the last review in 2002, and the reason for this discrepancy is the failure to construct most of the planned natural gas-fired power stations. Particular consideration could be given to the prioritisation of natural gas infrastructure in spatial planning.

The effort to diversify supply and increase international gas interconnections is highly commendable. The new natural gas transmission pipeline with Turkey will be operational at the beginning of 2007, while construction of the gas interconnector between Greece and Italy is estimated to start in 2008. At the moment it appears that Greece will have overcapacity in import connections, and the government should ensure that the potential cost of excess investment in infrastructure will be passed on to the users of the interconnector according to a cost-reflective transit tariff scheme.

Greece has also made commendable progress in laying the foundations for the restructuring of the natural gas market. The full implementation of the liberalisation laws has the potential to increase competition in the Greek gas market. It is now important for the Greek government and RAE to focus on the rapid passage of the decisions which are required to implement the ministerial decree on the transportation tariffs of the Greek electricity transmission system in March 2006. With the increasing liberalisation of the Greek gas market, it is now a matter of urgency to increase the staffing at RAE's gas section.

To increase the coverage of the low-pressure gas network, long-term monopoly licences were given to three regional distribution companies in 2000, which cover a significant number of households, and approximately 10% of gas demand volume. Care should be taken that the planned establishment of three new regional gas monopolies (EPA) does not impede the development of retail competition. The EPAs are partially owned by a subsidiary of DEPA and the government should exercise vigilance in ensuring that full operational separation is preserved to enable them to develop into competitors to DEPA.

With 35% part ownership of DEPA by Hellenic Petroleum, the most important new entrant in the power generation market, PPC's option to purchase 30% of the shares of DEPA from government and PPC's "most-favoured" customer clause for its gas supplies from DEPA give rise to concern that the incumbents in the power sector would hold control over the fuel supply of their potential competitors.

With Greece's growing share of gas in the fuel mix, measures to ensure security of gas supply, including an emergency fuel switching plan and more storage facilities, will certainly become necessary in the future. From the viewpoint of short-term energy security, an emergency plan is needed in case international gas interconnections are affected by failure incidents.

Greek renewables development is positively affected by the country's very good resource potential. Greece's primary development in new renewables is in the wind sector, but care should be taken to ensure that other renewable sources are developed where they provide an economical alternative. A serious barrier encountered by renewables development in the past was a long licensing process of at least two to three years, tackled by the new law on renewables. The new law for the promotion of electricity production from RES was passed in Parliament in June 2006. The new regulatory framework provides for a simplified licensing procedure for the installation and operation of RES systems, a new set of prices for electricity produced from RES, with increased prices for power generated by photovoltaic and solar systems.

An area of serious concern is the low completion rate of renewable projects developments that have licences. A significant barrier is an absence of sufficient grid capacity. HTSO and the PPC have developed plans to reinforce the grid, in the next 4-year period, according to the "Electricity System Development Plan

2006-2010". A national campaign with the aim to raise public awareness and support of RES is soon to be launched throughout Greece.

Given Greece's very good wind resources, the government should analyse its optimal level of support. In areas with very good wind resources, the current level of the feed-in tariff may be too generous; it should be gradually reduced, capturing the benefits of the learning curve, and according to the new RES law, the duration period of the payment is set at 12 years. The risk of oversubsidisation could be further reduced by incorporating more market-oriented elements in the support scheme.

The main challenge for achieving competition in the Greek electricity policy is the dominance of the incumbent supplier, the PPC. Commendable progress has been made in setting the framework for the reduction of the dominance of the PPC in the future, including the exclusion of PPC in possible tenders for new generating capacity. However, these measures are not likely to develop sufficient competition in the Greek market. Because effective competition in generation has not emerged, the government may have to consider extending the restriction placed on the PPC when new power capacity is tendered. The RAE should be praised for its efforts to achieve progress in unbundling the accounts of the PPC. However, the independence of the HTSO from the PPC may not be sufficient under the current arrangement. Consideration should be given to transferring ownership of the transmission system to the HTSO.

Although the annual increase in electricity demand is only around 3%, the generation reserve margin is getting smaller, and the current plan for adding capacity through HTSO's tender falls short of this goal. Appropriate investment in transmission and distribution is also essential for security of supply. The capacity mechanism of the new electricity code is another measure and it is a positive development. The new code is also commendable in terms of market liberalisation and it will provide for more transparency of generation prices. The regulator and the government should carefully review the impact of the capacity availability certificates (CACs) on the electricity market, and be prepared to remove the mechanism once the generation shortage has been overcome.

At the moment, there is no incentive in the tariff structure to reduce consumption to help the system operator during peak demand times. Full demand-side participation by load customers in the daily market should be enabled. The RAE and the government should urgently consider the development of interruptible tariffs, and tariffs enabling the use of modern metering infrastructure in a market framework. Curbing demand growth is also essential to facilitate effective competition.

The island communities of Greece present another specific challenge to the country's energy policy. The inhabitants of the non-interconnected islands are paying the same electricity tariffs as the rest of Greece, despite the much higher cost of supply. The cost of this social service obligation is estimated at

four euros per MWh of electricity delivered. The requirement of geographically uniform tariffs, reinforced by the existence of sector-specific rebates, constitutes a cross-subsidy between different categories of consumers, resulting in non-optimal behaviour. Other measures, such as the taxation system, are often less distorting, both in economic and environmental terms.

Lignite, the main domestic fossil fuel resource of Greece, will continue to play a major role in the country's fuel mix in the future. Further potential exists to increase lignite generating capacity, and the government and the regulator should carefully consider introducing more advanced generation technology through retrofits or into new lignite power stations, where it is economically feasible. In terms of further developing competition, it may be an option for the government to consider allowing another operator to construct a power station using lignite from unopened deposits, for the exploitation of which a new bidding procedure is currently open.

It is a cause for concern that reliable and consistent energy R&D data seem to be missing. This situation does not allow the proper assessment of the impact of energy R&D. With relatively limited government resources, it may be necessary to further sharpen priorities in order to maximise the cost-effectiveness of government energy R&D programmes. A stronger focus on increasing the efficiency of fossil fuel conversion could contribute significantly to reducing the environmental impact from power generation in Greece. The development of R&D clusters is commendable, but the absence of private-sector involvement is a cause for concern.

RECOMMENDATIONS

The government of Greece should:

General Energy Policy

- *Reduce the dominance of PPC and DEPA to create true and effective competition in electricity and gas markets by setting a clear target and timetable for reducing the market share of the incumbents.*
- *Consider all possible options to reduce the dominance of the incumbent electricity and gas companies.*
- *To enhance regional security of supply and increase competition, further promote the establishment of new energy interconnections and increase the existing ones where this is economically advantageous.*
- *Ensure full independence of the electricity and gas TSOs from PPC and DEPA.*

- *Consider transferring DESFA and HTSO to 100% government ownership, not ruling out their later privatisation.*
- *Carefully monitor cross-shareholdings in the energy industry to prevent these from becoming an obstacle to competition.*
- *Further strengthen the power of the RAE by allowing it to make regulatory decisions, including the ones on regulated tariffs, and consider giving the RAE full powers envisaged for regulators in the EU Electricity and Gas Market Directives.*
- *Simplify licensing procedures not only for renewable energy projects but also other crucial energy infrastructure projects and specify them in spatial planning.*
- *Involve all the stakeholders in the formulation of the long-term national energy strategy, enhance its visibility and disseminate information on the national energy situation and future challenges to the general public.*
- *Ensure consistency between energy and environmental policies, and enhance the co-operation between relevant organisations.*
- *Establish organisational arrangements between the National Observatory of Athens (NOA), the Centre for Renewable Energy Sources (CRES) or other organisations to achieve effective co-ordination in data analysis, quantitative forecasting and policy evaluation activities for energy demand and supply and energy-related GHG emissions.*
- *Place greater overall emphasis and attention on energy efficiency and the demand side in energy policy-making.*
- *Pursue social policy objectives by means other than energy taxation and pricing.*
- *Continue efforts to improve the coverage, accuracy and speed of issue of Greek energy statistics.*

Energy and the Environment

- *Reflect the evaluation results and implications of the National Climate Change Programme in the design of future programmes.*
- *Consider the introduction of stronger and more concrete GHG reduction policies in the residential, commercial and transport sectors, taking into account recent developments in Greek energy markets.*
- *Assess the impact of the National Allocation Plan (NAP) on the energy and industrial sectors and, if necessary, amend the ongoing Second National Climate Change Programme as soon as possible.*
- *Address non-CO_2 GHG emissions, in particular hydrofluorocarbons (HFCs) from cooling appliances.*

- *Ensure that the general energy statistics and UNFCCC National Greenhouse Gas Inventories are consistent.*

Energy Efficiency

- *Formulate a comprehensive and clearly structured policy framework for improving energy efficiency with measurable targets as an integral part of a long-term energy policy strategy.*
- *Establish an effective monitoring system to achieve energy efficiency targets, and ensure that all programmes are evaluated objectively, preferably by a third party.*
- *Ensure the continued co-operation between all the ministries involved in energy efficiency in the development and implementation of such a plan.*
- *Ensure the speedy implementation of the EU Directive on the Energy Performance in Buildings by publishing the new building code and training sufficient numbers of building energy auditors.*
- *Consider the introduction of more market-oriented instruments. These could include cost-reflective energy pricing and information and awareness initiatives.*
- *Consider the removal of preferential tariffs for particular sectors and groups if these distort consumption behaviour.*
- *Utilise the experience from other countries in mandating energy suppliers to achieve energy efficiency targets.*
- *Introduce effective policies to reduce electricity demand at peak times.*
- *Develop a framework for the operation of energy service companies and energy efficiency auditors.*
- *Consider policies specifically addressed to reduce the Greek economy's heavy dependence on oil.*
- *Continue the efforts to achieve modal shifts, by* e.g. *improving public transport and transport infrastructure, and by introducing cost-reflective pricing.*
- *Introduce the EU vehicle label at the earliest opportunity.*
- *Consider the introduction of efficiency-related vehicle taxation, linking to EU vehicle labelling.*
- *Evaluate the possibility to further increase the use of alternative fuels in the public and private trucking and bus sectors.*

Oil

- *Enhance and improve the national strategy for oil exploration and production, given the potential for discovery of domestic oil resources,* e.g. *by conducting a further licensing round for oil and gas exploration to establish the potential of new reserves in Greece.*
- *Monitor the refinery market to prevent potential abuses of market power.*
- *Consider a rapid introduction of already planned tax measures aiming to reduce fraud, and monitor the situation closely, preparing to introduce further tax alignments where these are required.*
- *Remove restrictions on the ownership of tanker trucks where these result in barriers to entry of new retailers and allow import terminals to move towards the most efficient operating regime.*

Natural Gas

- *Continue to promote the development of critical gas infrastructure, such as pipelines, by* e.g. *prioritising them in spatial planning.*
- *Study the possibility to introduce zonal access charges to the transmission system.*
- *Strengthen the gas sector regulation division of the Regulation Authority for Energy.*
- *Evaluate the impact of the creation of new distribution monopolies on the introduction of retail competition in the gas sector.*
- *Ensure the independence of the existing gas distribution companies from DEPA, the Public Gas Corporation, to allow them to compete freely once the market is further opened.*
- *Remove the "most-favoured customer" clause between DEPA and the Public Power Corporation (PPC).*
- *Establish an emergency plan taking into account the projected demand increases for gas and the role gas will play in power supply in Greece in the future.*

Renewable Energy

- *Reduce administrative barriers to renewables development by in particular:*
  - *Putting in place a one-stop shop for licensing renewables projects.*
  - *Establishing clear guidelines for authorisation procedures with a clear attribution of responsibilities to all institutions involved.*
  - *Establishing pre-planning mechanisms that require regions and municipalities to assign locations for renewables (spatial planning).*
  - *Introducing more simplified procedures for small projects.*

- *Ensure grid access and infrastructure availability.*
- *Optimise the current feed-in tariff scheme to improve cost-effectiveness, with a view to reflecting the technology learning curve and limiting the duration of the subsidy, while ensuring investor confidence.*
- *Consider incorporating more market-oriented elements in the national renewables support scheme, taking into account the experience of other countries.*
- *Develop renewables other than wind that could be appropriate for Greece, in particular geothermal, biomass, photovoltaics and biofuels, paying attention to their cost-effectiveness.*
- *Formulate a comprehensive strategy and policy framework for the introduction of biofuels in order to take advantage of their possible benefits.*

Electricity and Lignite

- *Consider transferring ownership of the transmission and, later, the distribution network from PPC to HTSO, the Hellenic Transmission System Operator.*
- *Consider an option to further restrict PPC bids in future tenders for capacity in order to reduce its dominance.*
- *Ask PPC to offer plants scheduled for retirement to investors willing to prolong their life, where this is practicable.*
- *Ensure the availability of sufficient capacity at peak demand times by the preparation of a policy framework, including* e.g. *long- and short-term measures to reduce demand in peak load situations and increase grid capacity between northern and southern Greece.*
- *Ensure continued full cost transparency of the operation of the transmission grid.*
- *Consider leaving open the choice of fuel for power generation in future tenders for capacity.*
- *Carefully analyse the capacity development and adjust the capacity availability certificate mechanism to reflect the value of lost load and the probability of loss in the future.*
- *Develop tariffs for interruptible customers and full demand-side participation in the daily market.*
- *Ensure cost-reflective electricity pricing eliminating cross-subsidies among consumers, and evaluate the negative effects of geographically uniform tariffs.*
- *Ensure that future liabilities from environmental restoration continue to be taken into account in the price of lignite.*

- *Consider whether modern environmental control technologies for mining and using lignite in power stations allow the opening of new mines and power stations, and follow the development of such control technologies.*
- *Ensure full information disclosure of the costs of the lignite produced by PPC to increase transparency in electricity price formation, and allow potential non-PPC power station operators full access on commercial terms to PPC's lignite deposits.*

Energy Technology and R&D

- *Develop and provide a detailed overview of priorities, funding, and actors in line with Greece's energy policy objectives.*
- *Develop clear criteria with which government R&D programmes are evaluated.*
- *Improve the collection of data on government R&D funding.*
- *Encourage the increase of the R&D capabilities of the private sector.*
- *Strengthen the research focus on reducing the environmental impact of fossil fuel use and increasing energy efficiency.*
- *Consider opportunities in joining IEA Implementing Agreements.*

Figure 1

Map of Greece

BACKGROUND

Greece is located on the south-eastern periphery of the European Union (EU). The land area of Greece covers approximately 132 000 square kilometres, consisting of the large peninsulas of the Peloponnese and Attika, the northern mainland, and over 2 000 islands covering more than one-fifth of Greek territory. Greece has extensive coastlines on the Aegean Sea, the eastern Mediterranean, and the Ionian Sea. A large part of the mainland is difficult to access and sparsely populated owing to its mountainous nature.

The population of Greece reached close to 11 million in the 2001 census, an increase of 7% from 1991, when it stood at 10.25 million inhabitants. Almost 66% of the population lives in urban areas. The population is concentrated in the Attika peninsula, where approximately four million people or 35.5% of the total Greek population live. Of these, 2.8 million live in the prefecture of Athens, which is part of the Attika peninsula. The setting, with many remote islands, an uneven distribution of the population, and mountainous regions, poses a challenge to energy policy makers. Greece is geographically remote from its partners in the EU, except for Italy, and either has or is developing energy links with its neighbouring countries: Italy, Albania, the former Yugoslav Republic of Macedonia, Bulgaria, and Turkey. Greece is a member of the Euro-zone.

Greece is a parliamentary democracy with a president at its head and a government conducted by a cabinet under a prime minister. The current government is formed by the conservative New Democracy party which gained an absolute majority of seats in Parliament in the March 2004 general elections. The country is divided into 13 regions with elected governments, and these are subdivided again into 51 prefectures. Prefectures are headed by an administrator appointed by the central government, and are subdivided into 147 counties. Below the prefectural level, elected local authorities govern in the 900 urban and 133 rural communities.

In 2004, Greek GDP reached USD 133 billion[1], an increase of 48% from 1990, when it stood at USD 90 billion. Per capita GDP had reached EUR 15 000 in 2004, 82% of the EU-25 average, and 77% of the average of the Euro-zone member countries. The average annual growth reached 2.8% for the period 1990–2003, and 4% between 2003 and 2004, when the Olympic Games

1. In 2000 USD. On average in 2005, EUR 1 = USD 1.2422.

were held in Athens. Unemployment stood at 10.2% in 2004, an increase from 9.3% in 2003. While Greek GDP has grown in recent years, energy use has not grown as quickly, leading to a reduction of energy intensity.

The main industries in Greece are tourism and shipping. Greece has the highest number of merchant ships in the world, concentrating on the operation of tankers and bulk shipping. A large part of the Greek workforce is employed in the public sector, with 20% in industry, and 12% in agriculture. Greece is classified as an Objective 1 funding area by the EU and is currently benefiting from support to a level of 3-4% of GDP per year through the EU's structural funds. The Greek energy sector has benefited substantially from this support. Because of uncertainties about the future level of support available for Greece within the next EU budget, Greece has secured a total of EUR 20.1 billion in EU funding for the period 2007-2013.

EU energy policy has already had an influence on the energy sector in Greece, despite derogations in the timetable for implementing reforms. Recent legislative developments may further accelerate energy sector reform in Greece.

SUPPLY AND DEMAND OVERVIEW

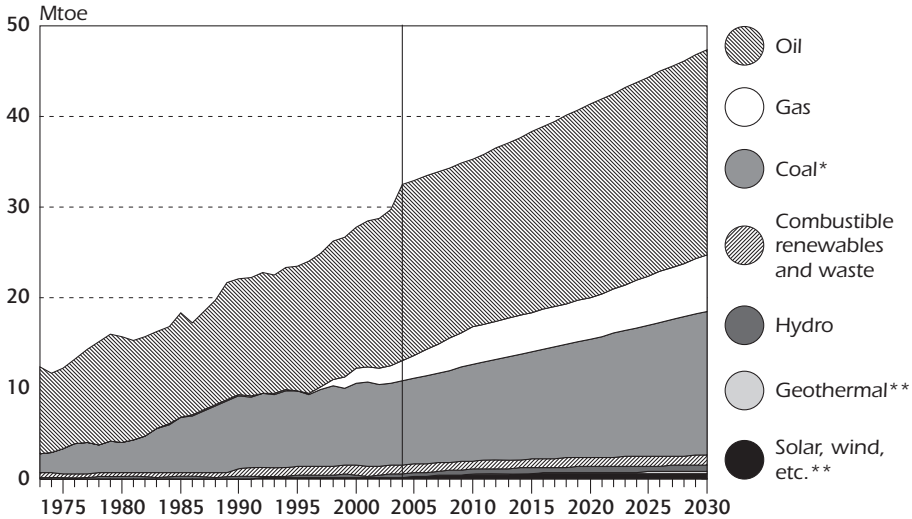
ENERGY SUPPLY

In 2004, Greek TPES reached 33 Mtoe. This was an increase of 48% over the 1990 level of 22 Mtoe. TPES has grown by an average of 2.3% per year between 1990 and 2003, but grew by 9.5% between 2003 and 2004. TPES growth is forecast by the Greek government to average 1.4% between 2004 and 2010, reflecting efforts to increase energy efficiency and to achieve fuel substitution through the further penetration of gas in the Greek economy (see Figure 2).

The most significant change in the fuel mix of TPES has been a shift from coal to gas use. Coal accounted for 8 Mtoe (36% of TPES) in 1990, and 9 Mtoe (28%) in 2004, a decrease in its share of 23%. Gas was introduced into the Greek energy supply in 1995, and has since then experienced strong growth, increasing from 0.14 Mtoe (0.6%) in 1990 to 2.23 Mtoe (6.8%) in 2004. The share of oil in TPES has also increased, from 12.8 Mtoe (58%) to 19.5 Mtoe (59.5%). The share of all renewables in TPES has been stable at 5% of TPES between 1990 when they contributed 1.1 Mtoe, and 2004, when they contributed 1.6 Mtoe. Because of the share of large hydropower plants, the production of renewable energy can vary significantly from year to year. The most important indigenous fossil fuel is lignite, which is exclusively used for electricity generation (see Chapter 8). Although there are almost no active reserves of natural gas and oil left in Greece, it is assumed that new exploitable hydrocarbon reserves exist in certain regions of the country (see Figure 3.)

Figure 2

Total Primary Energy Supply, 1973 to 2030



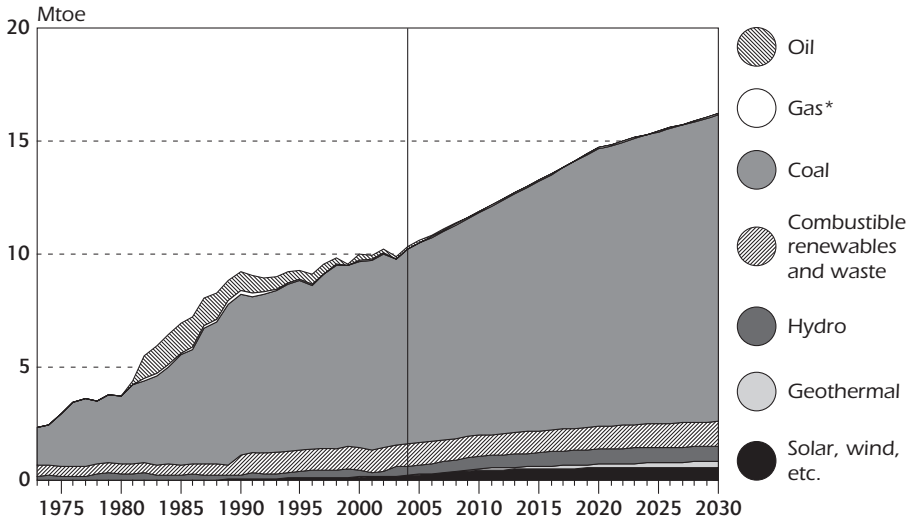
* Coal = lignite. Energy supply does not take into consideration conversion losses, which are particularly high for power generation from lignite. See Table 21 for a breakdown of Greek power generating capacity by fuel.

** negligible.

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

Figure 3

Energy Production by Source, 1973 to 2030



* negligible.

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

ENERGY DEMAND

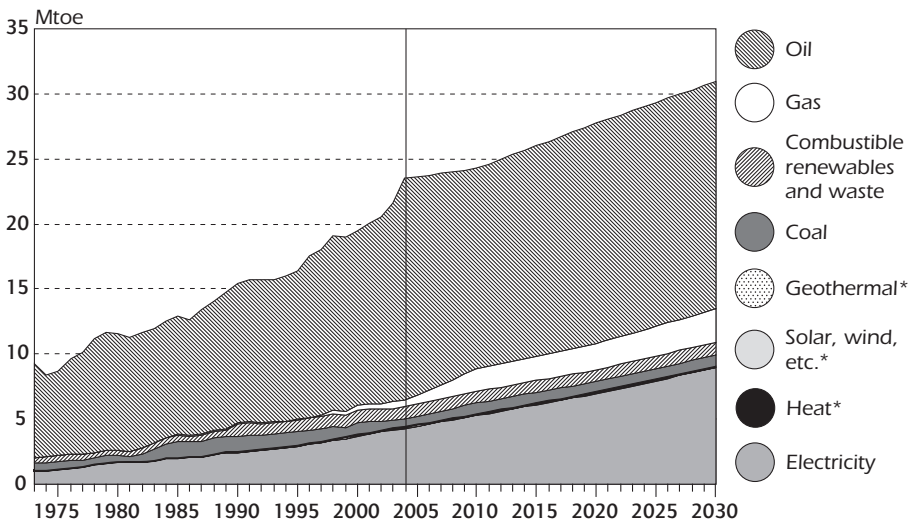
In 2004, Greek total final consumption (TFC) reached 23.5 Mtoe, an increase of 52% compared to the 15.5 Mtoe consumed in 1990. TFC rose by 2.6% per year during the period 1990 to 2003, and by 8.8% between 2003 and 2004. The Greek government expects it to rise by only 0.5% per year during the period 2004 to 2010 because of increased investment in energy efficiency and fuel switching.

The share of oil in TFC has risen from 11 Mtoe (69.5%) to 17 Mtoe (72%) between 1990 and 2004 (see Figure 4). Consumption of oil has risen by 58% during the same period. The next important fuel in TFC is electricity, which contributed 4.3 Mtoe in 2004, a rise of 75% from the 1990 level of 2.45 Mtoe. The share of electricity in TFC increased slightly from 16% to 18%. Renewables contributed 0.95 Mtoe in 1990, and this had risen to 1.06 Mtoe by 2004, resulting in a fall of their share of TFC from 6.2% to 4.5%.

The transport sector is the main consumer of energy, with 9.1 Mtoe in 2004, a rise of 3 Mtoe or 58% compared to 6 Mtoe in 1990[2]. In 2004, the transport sector consumed 39% of energy in Greece, largely unchanged from the 38%

Figure 4

Total Final Consumption by Source, 1973 to 2030



* negligible.

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

2. There is however concern about the correctness of the statistics, and actual transport energy demand may even be understated owing to tax fraud (see Chapter 6 on Oil)

consumed in 1990. Other sectors[3] represent an important share of TFC, with 9 Mtoe consumed in 2004, a rise of 4 Mtoe, or 87%, compared to 1990, when they consumed 5 Mtoe. Industry consumed 5.4 Mtoe in 2004, an increase of 0.7 Mtoe or 15% as compared to 4.7 Mtoe in 1990. The changes of TFC shares in the other sectors and industry are an indication of the changing nature of the Greek economy, reflecting the increased importance of the tertiary sector.

All sectors experienced strong increases between 2003 and 2004, probably reflecting the surge in construction activity and travel related to the Olympic Games. Transport energy demand increased by 1.1 Mtoe or 14% year-on-year, and the other sectors' demand increased by 0.5 Mtoe or 6%, while industry increased by 0.3 Mtoe or 5% year-on-year.

ENERGY POLICY

Energy Policy Objectives

Greek energy policy is formulated at central government level, with the Ministry of Development in charge of overall policy formulation. Since the last review, the government has made considerable efforts in shaping the new regulatory and legislative framework in the energy sector, as well as in promoting the use of renewable energy sources and the construction of large-scale interconnection projects with its neighbouring countries. These changes are in line with the overall objectives of the energy policy, which are outlined below. They are:

- Securing the country's supply in energy and diversifying energy sources.
- Enhancing the productivity and competitiveness of the national economy.
- Balancing regional development within the country.
- Protecting the environment and promoting renewable energy sources.

Energy Policy Developments Since the Last Review

Since the last review, significant progress has been made in Greek energy policy. International interconnections were strengthened and are being developed further. The national climate change strategy was updated, and the National Allocation Plan (NAP) for CO_2 trading has been published and accepted by the European Commission (EC).

Important changes have also been made in Greek legislation, with new laws on the Liberalisation of the Electricity and Natural Gas Markets leading to the incorporation of the EU Directives 2003/54 and 2003/55 into Greek legislation.

3. The other sectors comprise commercial, residential, agriculture, and government.

In December 2005, a new law (3423/2005) for the introduction of biofuels in the Greek market was approved in Parliament in the area of renewables, which transposed the EU target of 5.75% biofuels contribution in 2010 into Greek law. The new law for the Promotion of Electricity Generated from Renewable Energy Sources was voted in Parliament in May 2006.

In terms of energy infrastructure, since the last review, the regional gas distribution companies, EPAs, have started to significantly extend the local gas distribution network. Four new large power stations have been commissioned, a lignite plant at Florina and three combined-cycle gas turbine (CCGT) power stations, as well as several renewable power developments and a 150-MW gas-fired peaking power station.

Market and Regulatory Reform

The main drivers behind liberalisation in Greece are the EU energy market directives, from which Greece has enjoyed derogations for full implementation. These derogations expire at the end of 2007. The intention of the government is to leave the current incumbent companies in a central position in the energy markets once the liberalisation process envisaged in the recently passed legislation is completed. A weakening of the incumbents' position is expected to be achieved over time through the development of independent new companies alongside the incumbents, but not through other restructuring measures.

Since the last review, progress in providing the basic framework for energy market reform has been made. Law 3175/2003 set the initial basis for the liberalisation of the gas market by introducing regulated third-party access (TPA) for the gas transmission system, while the electricity market Law 3426/2005 and the natural gas market Law 3428/2005 followed this in December 2005 with the establishment of the framework for full market liberalisation in Greece. In electricity, the new Grid and Power Exchange Code was issued in May 2005, providing a transparent framework for both the efficient operation of the Greek Electricity Transmission System as well as that of the Daily Electricity Market, while the new law will enable the creation of an independent distribution system operator and full account unbundling by 2007. In gas, the network access tariffs were published in March 2006 in the form of a ministerial decree. In oil storage, the new Law 3335/2005 has enabled direct import by retailers.

The incumbents in the Greek energy sector are closely interlinked through cross-shareholdings, and the major companies in each market (electricity, gas and oil) have at least a significant part of their shares owned by the Greek government. Regulatory rules and procedures are in place with the intention of assuring the independence of network operators, *e.g.* by controlling the number and background of board members who can be appointed by an owner with a significant interest, even though full independence of the network operators has been ruled out.

Since its establishment in 2000, the independent energy regulator RAE has been entrusted with different categories of responsibilities (administrative, quasi-judicial, legislative and monitoring). Its function and powers have been further strengthened by the Laws 3426/2005 and 3428/2005. According to the new laws, members of RAE's council are increased to seven and two vice-presidents. The chairman and the other members of RAE are appointed for five years. Following the passage of Law 3428/2005, RAE now has to give a consenting opinion to the Ministry of Development where decisions on gas issues are concerned.

International Energy Connections and Long-term Policy

In the field of international energy co-operation, the Greek government has focused on upgrading the country's role in the international energy map through the development of its international interconnections. In the view of the Greek government, the newly formulated regulatory framework for the energy industries, and the recent agreements outlined below, aim to upgrade the regional position of Greece and should lead to the establishment of the country as the energy hub of the wider region. The following developments have occurred since the last review:

- On 12 April 2005, Greece, Russia, and Bulgaria signed a Memorandum of Co-operation for the construction of the Burgas-Alexandroupolis oil pipeline from the Black Sea to the Aegean Sea.
- On 3 July 2005, ground was broken for the Greek-Turkish natural gas pipeline.
- On 4 November 2005, the intergovernmental agreement for the construction of the Greek-Italian natural gas pipeline was signed by Greece and Italy, in the presence of the Turkish Minister of Energy.
- On 25 October 2005, the treaty for the establishment of the South-East European Energy Community was signed in Athens by the EC and Croatia, Bosnia and Herzegovina, Serbia, Montenegro, the former Yugoslav Republic of Macedonia (FYROM), Albania, Romania, Bulgaria and the United Nations Mission in Kosovo (UNMIK) on behalf of Kosovo. The treaty aims to create an integrated energy market in the south-east European region and following that, its integration into the EU energy market.
- On 7 May 2006, a Memorandum of Co-operation was signed by Greece and Egypt for the promotion of the two countries' co-operation in the fields of natural gas and oil.

ENERGY POLICY INSTITUTIONS

Ministry of Development

The Ministry of Development is the central institution in energy policy-making in Greece. Within the ministry, the General Directorate of Energy is responsible

for energy policy and the publication of energy statistics. It is also responsible for the development of renewables policy, and the implementation of energy-related EU directives into Greek legislation. The ministry oversees the RAE, and is responsible for the exercise of majority shareholder functions of the PPC, and the gas company DEPA. The ministry is also managing the Operational Programme for Competitiveness (OPC), a grant programme utilising EU structural funds that supports investment in infrastructure (public and private) and energy efficiency (see box below). The General Secretariat for Research and Technology (GSRT) within the ministry is responsible for all R&D in Greece, including energy R&D.

Ministry of Environment, Physical Planning, and Public Works

The ministry is responsible for all environmental policies relating to energy, including climate change policy. It is co-operating closely with the National Observatory of Athens (NOA) and the Ministry of Development in the formulation of climate change policies and measures. The ministry is also in charge of the development of the transport infrastructure in Greece. This includes in particular the development of public transport.

Ministry of Transport and Communications

The ministry is in charge of transport policy planning, and it co-ordinates closely with the Ministry of Development and the Ministry of Environment.

Ministry of Economy and Finance

The ministry is responsible for taxation, and the exercise of the majority shareholder function in Hellenic Petroleum. It develops energy taxation policy in close co-operation with the Ministry of Development. The ministry is also responsible for grant administration under the economic development law.

Local and Regional Authorities

Local and regional authorities as well as the prefects appointed by central government have responsibility for permitting within their areas of responsibility, including energy installations.

Regulatory Authority for Energy (RAE)

The RAE was set up in 2000 as the independent regulator for all energy markets, electricity, gas and oil. It has primarily advisory powers, although its powers have been significantly enhanced through changes in legislation since the last review, giving it some direct powers over prices in natural gas retail as well. The RAE is also responsible for giving an opinion to the Minister of Development regarding the issuance, renewal or extension of electricity generation licences, both for renewables and other energy

developments. The RAE is overseen by the Ministry of Development, and its chairman and two vice-presidents are appointed by the Ministerial Council, following the consent of the Greek Parliament.

Hellenic Competition Commission (HCC)

The HCC is an independent body that is responsible for the proper functioning of competition in all markets in Greece. It can commence inquiries into market power or market abuse *ex ufficio*, and it acts as an advisory body to the government. The HCC is overseen by the Ministry of Development.

Centre for Renewable Energy Sources (CRES)

CRES started as an R&D body in the field of renewables (see box in Chapter 10 on Energy R&D). It is now also producing energy statistics. It performs energy systems analysis for the Ministry of Development, and is active in EU-funded projects. CRES is overseen by the Ministry of Development, acting as the national co-ordinating body in all matters relating to renewables and energy efficiency following a change in the law in 1999.

National Observatory of Athens (NOA)

The NOA is the main body responsible for UNFCCC relations. It has developed scenarios on future GHG emissions development and abatement in Greece. It is supervised by the Ministry of Development, through the General Secretariat for Research and Technology.

Public Power Corporation (PPC)

The PPC is the majority state-owned electricity producer, distributor, and supplier in Greece, generating and supplying approximately 97% of electricity. It owns 49% of the Hellenic Transmission System Operator (HTSO), a separate company that also operates the day-ahead market in electricity (see Chapter 9).

The Public Gas Corporation (DEPA)

DEPA is the main gas supplier in Greece. The shares of DEPA are 65%-owned by the Greek government, while the remaining 35% of shares are held by Hellenic Petroleum. The PPC holds an option on a further 30% of DEPA's shares. DEPA's gas is supplied under long-term partially flexible take-or-pay contracts from Russia through a pipeline and from Algeria as liquefied natural gas (LNG). It owns 100% of the transmission network, and through its subsidiary EDA, 51% of the regional gas distribution companies (the EPAs).

The Operational Programme for Competitiveness (OPC)

The Ministry of Development Operational Programme "Competitiveness" was established under the EU's 3rd Community Support Framework (3rd CSF) 2000-2006. It incorporates a package of actions and subsidies designed to improve the competitiveness of the Greek economy and to promote the country's social and economic convergence with the other member States of the EU.

Energy-related Strategic Directions of the OPC

Axis 6: Security of Energy Supply and Promotion of a Deregulated Energy Market (EUR 725 million available):

- Access to alternative sources of natural gas supply.
- Support for flexibility, stability and reliability of the natural gas system.
- Special energy infrastructures for the islands and for the promotion of renewable energy.
- Operation of the deregulated energy market.
- Promotion of renewables, combined heat and power (CHP) plants and energy efficiency.

Axis 7: Energy and Sustainable Development (EUR 397 million available).

- Broader use of natural gas.
- Safety infrastructures for the movement of oil products.
- Exploitation of natural resources and support in meeting environmental commitments.

Available Resources

The OPC has a total budget of EUR 6.7 billion under the EU's 3rd Community Support Framework (2000-2006). Greek public spending amounts to EUR 1.29 billion, and private funding (contributions by grant recipients) to EUR 3.32 billion. The EU contribution to the OPC comes from two sources: the European Regional Development Fund (EUR 1.9 billion), supporting the correction of the main regional imbalances and helping the less advantaged regions of the European Union catch up with their more developed neighbours; and the European Social Fund (EUR 159 million), contributing to the development of employment by fostering an entrepreneurial spirit, employability, adaptability of the workforce, and equal opportunities, as well as investment in human resources. Results from the OPC are described in more detail in Chapters 5 and 8.

ENERGY STATISTICS

The Greek government is producing energy forecasts up to 2030. These forecasts have seen considerable deviations, compared to real data.

Greek submissions on energy statistics to international organisations such as the OECD are often substantially delayed, reducing the value of the statistical information by restricting its coverage and timeliness.

ENERGY PRICES AND TAXES

Energy Pricing

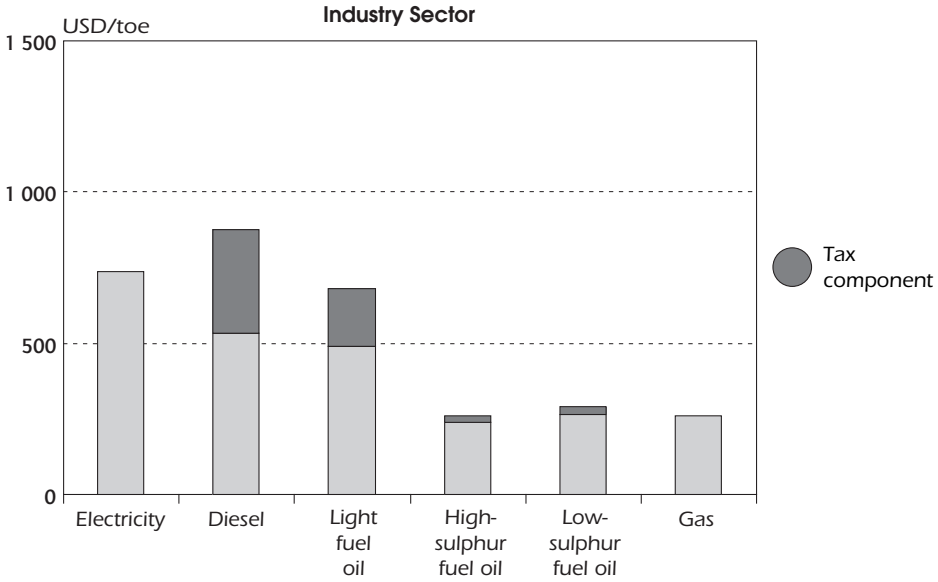
Energy prices in Greece are set by the market, the government, or the RAE, depending on the type of energy and at which level of the market the prices are set. Prices for road fuels and heating oil are freely set by the market, and a wholesale day-ahead electricity market exists in which prices are set by competitive bidding. All electricity consumers, apart from residential consumers, who become eligible customers in July of 2007, are free to choose their suppliers, but only 2.8% of electricity was delivered by suppliers other than the PPC in 2004. Tariffs for electricity consumers are also set by the government as long as the PPC's market share is above 70% by volume of electricity sold. A uniform tariff applies to the whole of Greece, varying by connection voltage level and type of consumer, and not taking into account geographical variations, even on grid-isolated islands. The price for gas in the areas of the EPAs is proposed by the EPAs, and RAE undertakes a check of the appropriateness of the proposals. Network access prices are set by the government, with consenting advice from the RAE necessary. Special discounts for electricity retail prices apply in the agricultural sector, to PPC employees and to families with at least four children.

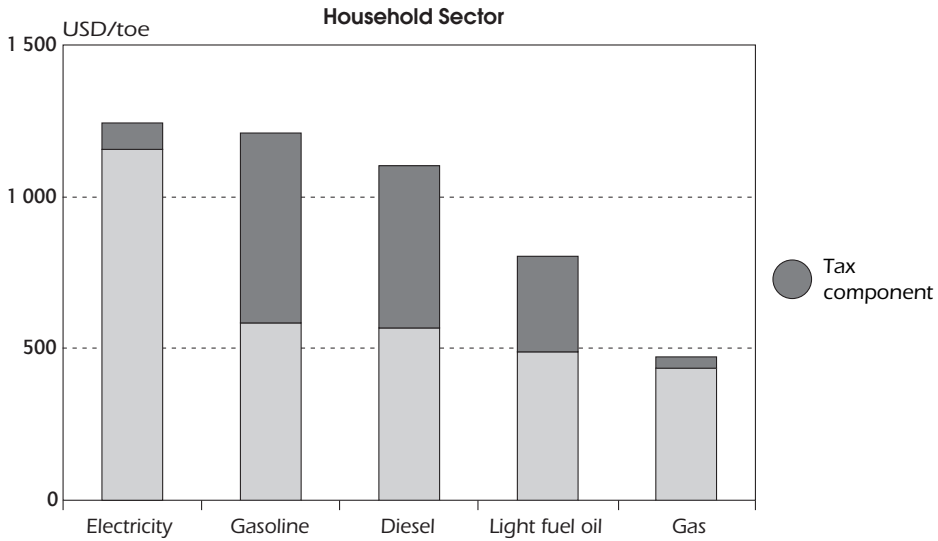
Energy Taxation

Energy taxes in Greece are used by the government to influence the use of energy and to mitigate prices to avoid social hardship. Significantly different tax rates for fuels that are substitutable lead to tax fraud, *e.g.* the lower tax rate for heating fuel oil compared to diesel encourages heating oil use in vehicles. The government is using more stringent controls, and is in the process of changing the tax rates to address this problem. Special tax rates apply to natural gas which is exempt from excise tax until 2014. Gas also benefits from a lower rate of VAT at 8% instead of 18%; electricity also benefits from 8% VAT, and diesel used for space heating benefits from a tax reduction during the heating season between October and April, based on Law 2960/2001. According to the new renewables law, local authorities impose a 2.5 to 3% tax on renewable energy production.

Figure 5

Fuel Prices, 2004





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

Table 1

Energy Taxes in Greece, 2004

Sector/fuel	*Excise tax €/unit*	*VAT %*
Household electricity	0	8
Household natural gas	0	8
Household heating oil (25 April – 15 October)	0.247/litre	13 – 18
Household heating oil (16 October – 24 April)	0.018/litre	13 - 18
Household coal	0	18
Non-commercial lead replacement gasoline	0.337/litre	13 – 18
Non-commercial unleaded gasoline	0.296/litre	13 – 18
Non-commercial diesel	0.244/litre	13 – 18
Industry electricity	0	
Industry natural gas	0	
Industry fuel oil	19/tonne	
Industry coal	0	
Industry and commercial diesel	0.244/litre	
Municipal renewables tax	2.5%	

Source: *Energy Prices and Taxes,* Paris, IEA/OECD, 2006.

CRITIQUE

Since the last in-depth review in 2002, there have been many positive developments in Greek energy policy. In the area of security of supply, energy diversification has been progressing through the further penetration of natural gas, notably in the power sector, and capacity increases of renewable energy, in particular wind power. In May 2006, the government passed a new law for the promotion of electricity from renewable energy sources. Greece is actively increasing its gas, electricity and oil interconnections with neighbouring countries, *e.g.* through the ITG gas pipeline with Turkey, the IGI gas pipeline with Italy and the Burgas-Alexandroupolis oil pipeline connection with a Black Sea port in Bulgaria. Greece also played a crucial role in the signing of the treaty establishing the Energy Community of South-East Europe (ECSEE), which took place in October 2005 in Athens, to create an integrated energy market in the Balkan region which may be incorporated in the EU internal market at a later stage. Such efforts will contribute not only to security of supply in Greece but also in Europe, making Greece an important

energy hub between East and West. In the area of climate change mitigation, the government adopted the 2nd National Climate Change Programme in May 2002. The National Allocation Plan based on the EU Emissions Trading Scheme (EU-ETS) was approved by the EU Commission in 2005. The impressive developments in public transport and renewable energy capacity are also encouraging examples in this context. In the area of market reform, the government submitted bills to the Parliament, which were enacted in December 2005, regarding the liberalisation of the Greek electricity market (Law 3426/2005) and the natural gas market (Law 3428/2005), aiming at full adoption of the 2nd EU Electricity and Gas Market Directives. These developments are all commendable. The Greek energy policy goals also reflect the IEA's 3Es (Energy security, Economic growth and Environmental protection) and the overall concerns relating to the energy supply of the country. However, because they are not easy to align, it is possible that pursuing them contributes to some of the distortions discussed in other chapters and Greece still faces many energy policy challenges.

Despite commendable progress in transposing EU directives into domestic legislation, it is a challenge for the Greek government to maximise the benefit of the proposed market reforms. While details will be discussed in the electricity and natural gas chapters, common problems in both sectors are the strong market power of incumbents, the level of independence of the transmission system operators in electricity and gas, and the independence of the energy regulator.

While a series of steps have been taken to reduce the dominance of the incumbent utility companies, PPC in the electricity sector and DEPA in the gas sector, their market power constitutes a big impediment to effective competition. Unless this dominance is addressed, effective competition is not conceivable, even though the electricity and gas markets are now open on a legal basis. PPC is still supplying 97% of electricity demand, and DEPA is still the only gas importer. . However, the expected significant increase of natural gas consumption leaves room for new suppliers to obtain an important stake in the Greek natural gas market. The government does not intend to split PPC's generation assets into competing companies. Instead, it is trying to reduce the market share of PPC by excluding it from the Hellenic Transmission System Operator's (HTSO) tender for 900 MW of capacity. This will, however, have a very limited impact on the dominance of the PPC, that will still hold 80 to 85% of the electricity generating capacity. On the gas side, DEPA is currently the only importer and supplier of gas to large customers, and owns 51% of the regional distribution monopolies. At the end of 2005, the law on "The Liberalisation of Natural Gas in Greece" was approved by the Greek Parliament (Law 3428/2005) to transpose the requirements of the Directive 55/2003/EC. According to this law, a new company should be established by the end of 2006 as the sole subsidiary of DEPA, with its main responsibility being the operation of the Greek transmission system in a transparent and fully competitive way. Nevertheless, in order to avoid a potential dominance of

incumbent companies in the electricity and gas markets, a number of measures could be taken, such as prohibiting the participation of PPC in all future HTSO tenders for generating capacity, and/or setting a decree mandating the incumbent to reduce its market share to a certain level by a certain time (*e.g.* as is done in gas markets in Italy and Turkey).

Increasing interconnection with neighbouring countries is another option, and the efforts made by Greece in this respect are praiseworthy. However, under current plans the effect on competition may be limited, and domestic measures will need to be pursued with vigour over the long term to ensure the development of competition.

The level of independence of the network operators is another issue. PPC remains one of the two principal owners (owning 49%) of the HTSO, and continues to own the transmission network. PPC will also continue to own the distribution system after the HTSO[4] has been established as distribution system operator in 2007. DEPA will be the sole owner of the gas transmission system operator, DESFA, to be established by the end of 2006, with DESFA owning and operating the transmission network. DESFA's Board of Directors will be appointed by the Greek State for a period of 10 years from the beginning of its operation. Full operative and ownership independence of the electricity and gas system operators is a prerequisite for effective competition and adds transparency to the market. The government is already taking or considering various measures to achieve this, but these fall short of legal independence. The experience shows that countries where effective competition has emerged have chosen effective unbundling during the initial stage of their market reform, establishing a 100% government-owned or private TSO in which incumbents do not have a stake. Although the liberalisation Laws 3426/2005 (electricity) and 3428/2005 (gas) set the framework for HTSO and DESFA to operate in a non-discriminative way, it may be preferable, to ensure transparency and confidence from new entrants, for the government to consider full ownership unbundling of the HTSO and DESFA, including the network assets, not ruling out their later privatisation as independent entities.

Cross-shareholdings of electricity and gas incumbents also require close monitoring to avoid anti-competitive consequences of such relationships for the markets. Hellenic Petroleum owns a significant portion (35%) of DEPA and is itself 35%-owned by the government; the PPC has a standing option to purchase 30% of DEPA. The government should be careful that such cross-shareholdings do not become a barrier to competition. In particular the exercise of PPC's option on DEPA could become a serious obstacle to effective competition in electricity and gas, especially if the "most-favoured customer" clause is not removed (see Chapter 7 on Natural Gas).

4. The remaining shares are held by the government.

With the enactment of the new market laws, RAE's responsibilities have been enhanced, but the regulator still continues mainly in its advisory role. While the authority given in setting prices for the regional gas distribution and supply companies is commendable, there are still further possibilities to enhance RAE's authority in the field of tariff setting (*e.g.* for the network and end-use tariffs), where its role is currently limited to an advisory one. The current system, whereby the RAE proposes tariffs to be approved by the government, limits the strength of the RAE. This issue is particularly crucial in Greece given that the government still owns large shares of the major energy companies. Consideration should be given to extend the RAE's powers to include those recommended for regulatory authorities in the EU market directives, such as the ability to set prices and tariffs.

In order to obtain security of supply and more active competition, timely investments in energy production, transportation and interconnection are essential. Like many other countries, Greece suffers from a high level of local resistance and administrative barriers affecting new energy infrastructure. The government, through a new law passed in Parliament in May 2006, intends to take the commendable first step to set a time limit of six to twelve months for the authorisation process of all required licences for renewable energy systems, as well as to provide strong incentives to local authorities for the installation of RES systems in their jurisdiction. The same issues are also delaying the construction of other energy-related infrastructure such as power plants and transmission lines. Simplifying the licensing procedure is a critical requirement for ensuring energy policy goals in Greece. The government should consider introducing similarly simplified licensing procedures for all energy-related infrastructure.

However, local concerns about infrastructure development cannot be overcome by only simplifying the licensing procedures. The Greek government may not be sufficiently active in communicating its energy policy, policy goals and constraints to the broader public. The general public in Greece is often hostile to energy developments, with the notable exception of local gas supply infrastructure, indicating that a poor understanding of energy policies and challenges prevails in the country. In particular, local authorities and communities should have a good understanding of the national energy situation and its challenges so that their decisions reflect national as well as local interests. It is timely that the government has just set up the National Energy Strategy Council for long-term energy policy planning. In this process, all the stakeholders such as relevant ministries and institutions, energy industries, large and small consumers, as well as local authorities, should be involved. The general public should be fully informed about national energy policy challenges, *e.g.* by clarifying the energy supply and demand scenario, investment needs and the implications of delay in such investments. In addition, to avoid lengthy judicial challenges, it may be useful to identify high priority investments such as specific wind power plants or transmission

network projects in land-use planning documents. The role and responsibilities of stakeholders should be defined in a way that reinforces the ability of market players in a competitive market to respond to the needs of the energy system rather than creating additional uncertainty about their role.

In discussing long-term energy policy planning, stronger emphasis should be placed on the demand side. Greek energy policy seems to be overly supply-side oriented. For example, in the 2nd National Programme for Climate Change, the bulk of CO_2 emissions reductions are expected from further penetration of natural gas and renewable energy sources into the supply mix. Also, the major share of funding from the OPC is devoted to renewable energy projects rather than energy efficiency projects. While the government is transposing the relevant EU directives on buildings and energy labelling, there is no comprehensive energy efficiency strategy or legislation with national or sectoral targets. Developing such a strategy could help to balance Greek energy policy.

Finally, a potential national energy strategy should ensure the consistency between energy and environmental policy. To this end, such a strategy should be backed by thorough data analysis, quantitative forecasting of energy supply/demand and energy-related GHG emissions and policy evaluation.

The government has used energy pricing and taxation to achieve social objectives such as rural development, and to combat social exclusion. For example, lower taxes on heating fuels apply during the heating season and the total amount of the cost for the public service obligation in electricity is estimated at EUR 200 million per year, or approximately EUR 4 per MWh of electricity delivered in Greece. This practice distorts the energy market. It may also discourage energy efficiency efforts, and lower taxation based on fuel end-use may encourage tax fraud. Social policy objectives are crucial, but they can be addressed more efficiently and without distortion through direct support rather than energy pricing.

Energy statistics are the basis for all sound energy policies. Countries need to build a strong statistics capacity in order to provide policy makers with the most detailed, complete and timely information on the energy situation of the country, the region and the world. Since the last review in 2002, the CRES has established a powerful new energy data processing and analysis system, including a geographical potential survey of renewable energy under the support of the Ministry of Development. This system became operational in 2005, and is a positive first step in line with the 2002 recommendations and should improve quality and delivery speed of Greek energy statistics.

The main problem encountered regarding international co-operation on energy statistics by Greece is timeliness. Monthly, quarterly and annual submissions to international organisations, such as the International Energy Agency and the European Commission, are often late and sometimes very late. The monthly oil questionnaire (MOS) sent to the IEA, for instance, is a good illustration of the

delay chronically encountered by Greece in collecting the basic information from the oil companies, in processing it and then transmitting it to international organisations. Over the last two years, Greece has sent the MOS questionnaire on time only twice. Delays of two months, and more recently of three months, are not rare. In fact, Greece is the only OECD member country which has been so consistently late in data submissions.

Such delays have an impact on international energy statistics, but also on Greece which has difficulties knowing in a timely manner the oil situation in particular, and the energy situation, more broadly. At a time when energy transparency is high on the international as well as the Greek agenda, Greece needs to strengthen its energy statistics capacity by allocating additional resources to this end, by reviewing its collecting, reporting and processing mechanisms as well as by enhancing its links with the energy industry.

Currently, the NOA and the Centre for Renewable Energy Sources (CRES) are carrying out analysis of energy data. However, there is a risk that their activities are not fully co-ordinated and that they may duplicate work. To maximise the benefit of their high-quality expertise, their responsibilities and division of labour should be clearly defined and their close co-operation should be ensured. The Greek government should consider further improving the accuracy and speed of statistical information in energy.

RECOMMENDATIONS

The government of Greece should:

- *Reduce the dominance of PPC and DEPA to create true and effective competition in electricity and gas markets by setting a clear target and timetable for reducing the market share of the incumbents.*
- *Consider all possible options to reduce the dominance of the incumbent electricity and gas companies.*
- *To enhance regional security of supply and increase competition, further promote the establishment of new energy interconnections and increase the existing ones where this is economically advantageous.*
- *Ensure full independence of the electricity and gas TSOs from PPC and DEPA.*
- *Consider transferring DESFA and HTSO to 100% government ownership, not ruling out their later privatisation.*
- *Carefully monitor cross-shareholdings in the energy industry to prevent these from becoming an obstacle to competition.*

- *Further strengthen the power of the RAE by allowing it to make regulatory decisions, including the ones on regulated tariffs, and consider giving the RAE full powers envisaged for regulators in the EU Electricity and Gas Market Directives.*
- *Simplify licensing procedures not only for renewable energy projects but also other crucial energy infrastructure projects and specify them in spatial planning.*
- *Involve all the stakeholders in the formulation of the long-term national energy strategy, enhance its visibility and disseminate information on the national energy situation and future challenges to the general public.*
- *Ensure consistency between energy and environmental policies, and enhance the co-operation between relevant organisations.*
- *Establish organisational arrangements between NOA, CRES or other organisations to achieve effective co-ordination in data analysis, quantitative forecasting and policy evaluation activities for energy demand and supply and energy-related GHG emissions.*
- *Place greater overall emphasis and attention on energy efficiency and the demand side in energy policy-making.*
- *Pursue social policy objectives by means other than energy taxation and pricing.*
- *Continue efforts to improve the coverage, accuracy and speed of issue of Greek energy statistics.*

CLIMATE CHANGE

GREENHOUSE GAS EMISSIONS

In 2003, Greek GHG emissions stood at 138 Mt of CO_2 equivalent. This was an increase of 23% above base-year levels despite the Kyoto target of 25% above base-year levels by 2008 to 2012. The main share of GHG emissions in Greece is from energy use, which contributed 80% of all Greek GHG emissions in 2002. This share has remained relatively stable since 1990, when energy use contributed 78% to total emissions. Assuming business as usual, the Greek government predicts that GHG emissions will rise to 36% above the base-year levels by 2010. With the implementation of the measures currently foreseen to restrict growth, the increase should be restricted to 24.5% above base-year levels by 2010.

CO_2 EMISSIONS

In 2002, 92% of all CO_2 emissions originated from the production, transport and use of energy. Within energy-related CO_2 emissions, recent steep increases of oil combustion have led to oil becoming the main source of emissions. In 2003, oil contributed 55% of all energy-related CO_2 emissions, while lignite contributed 40%. With future plans for efficiency improvements and the closure of some old lignite power stations, the share of lignite is likely to decline further. Natural gas has so far been a small contributor to emissions, with 5% of CO_2 emissions in 2003 originating from gas use. With the projected growth of gas use, particularly in power stations, it is likely that its share will increase rapidly over the coming years.

Greek CO_2 emissions per unit of GDP are higher than those in other IEA countries in southern Europe (see Figure 7). This reflects the heavy reliance on lignite for electricity generation compared, for example, to Spain or Italy, where gas is making a significant contribution to electricity supply.

NON-CO_2 GHG EMISSIONS

A strong increase was experienced in emissions from hydrofluorocarbons (HFCs), in particular emissions from their production. Manufacturing, operation and maintenance of refrigeration (residential sector only) and air-conditioning

equipment are significant contributors to HFC emissions, and emissions from the use of F-gases increased by 19% between 1995 (base-year) and 2002, mainly because of the increase of air-conditioning equipment in the residential sector and passenger cars with air-conditioning systems. The share of perfluorocarbon (PFC) gases was further reduced because of changes in the aluminium production process that contributed to reduced CF_4 and C_2F_6 emissions.

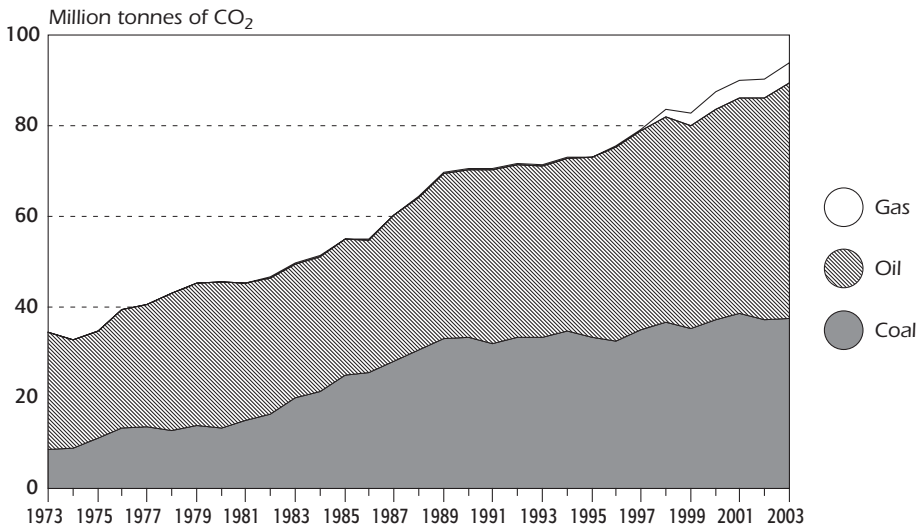
Methane (CH_4) emissions from the energy sector are mainly fugitive emissions from coal mining and from the production, processing and distribution of liquid fuels and natural gas. They account for 19% of the total methane emissions and increased by 48% between 1990 and 2002.

GREEK COMMITMENTS

The Greek government agreed to the UN Framework Convention in 1994, and became a signatory to the Kyoto Protocol, ratifying the protocol in 2002 with Law 3017/2002. Under the EU burden-sharing agreement from 1998, Greece has to restrict the increase of GHG emissions to no more than 25% from base-year levels.

Figure 6

CO_2 Emissions by Fuel*, 1973 to 2003



* estimated using the IPCC Sectoral Approach.

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

Table 2

Greenhouse Gas Emissions by Sector, 1990 to 2002 (in Mt CO_2 equivalent)

Year	*Energy*	*Change from 1990*	*Industrial processes*	*Change from 1990*	*Solvent and other product use*	*Change from 1990*	*Agriculture*	*Change from 1990*	*Waste*	*Change from 1990*	*Total without LUCF*	*Change from 1990*
1990	80 996	Base year	9 140	Base year	170	Base year	13 603	Base year	4 044	Base year	107 953	Base year
1995	84 622	4.4%	11 520	27.5%	153	-13.1%	12 573	-6.1%	4 651	14.2%	113 520	5.4%
2000	101 636	25.4%	12 879	42.6%	145	-17.6%	12 425	-7.2%	4 617	13.4%	131 701	22.3%
2002	103 998	28.3%	12 526	38.7%	155	-11.9%	12 175	-9.1%	4 609	13.2%	133 464	23.9%

LUCF = Land Use Change & Forestry.

Source: Ministry of Environment.

Table 3

Greenhouse Gas Emissions by Gas[1] (without LUCF), 1990 to 2002 (in Mt CO_2 equivalent)

Year	*CO_2*	*Change from 1990*	*CH_4*	*Change from 1990*	*N_2O[2]*	*Change from 1990*	*HFCs[3]*	*Change from 1990*	*PFCs*	*Change from 1990*	*Total*	*Change from 1990*
1990	83 905	Base year	8 715	Base year	14 140	Base year	935	Base year	258	Base year	107 953	Base year
1995	87 497	4.3%	9 418	8.1%	13 152	-7.0%	3 369	Base year	83	-67.8%	113 519	5.2%
2000	104 072	24.0%	9 644	10.7%	13 564	-4.1%	4 272	26.8%	148	-42.6%	131 700	22.0%
2002	106 172	26.5%	9 787	12.3%	13 418	-5.1%	3 999	18.7%	88	-65.9%	133 464	23.6%

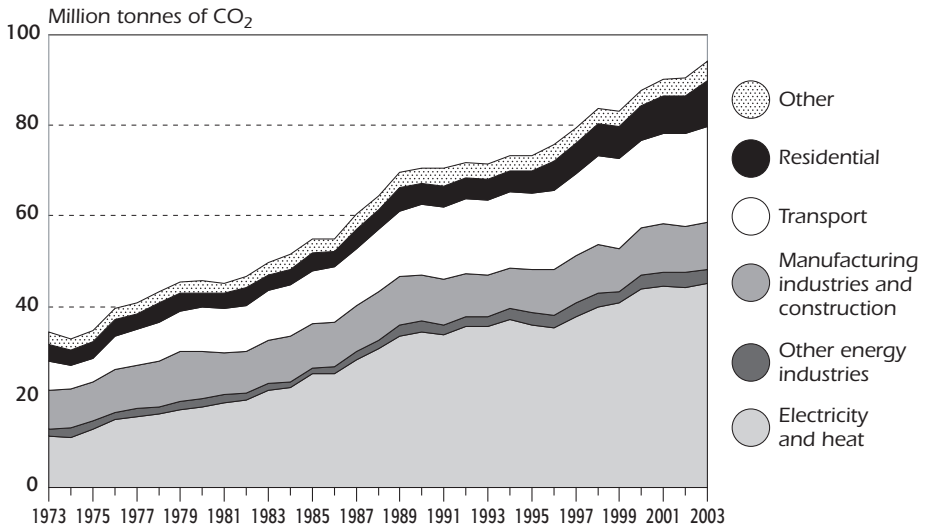
LUCF = Land Use Change & Forestry

1. SF_6 not available. **2.** Primarily from agriculture. **3.** Primarily from air-conditioning.

Source: Ministry of Environment.

Figure 7

CO_2 Emissions by Sector*, 1973 to 2003



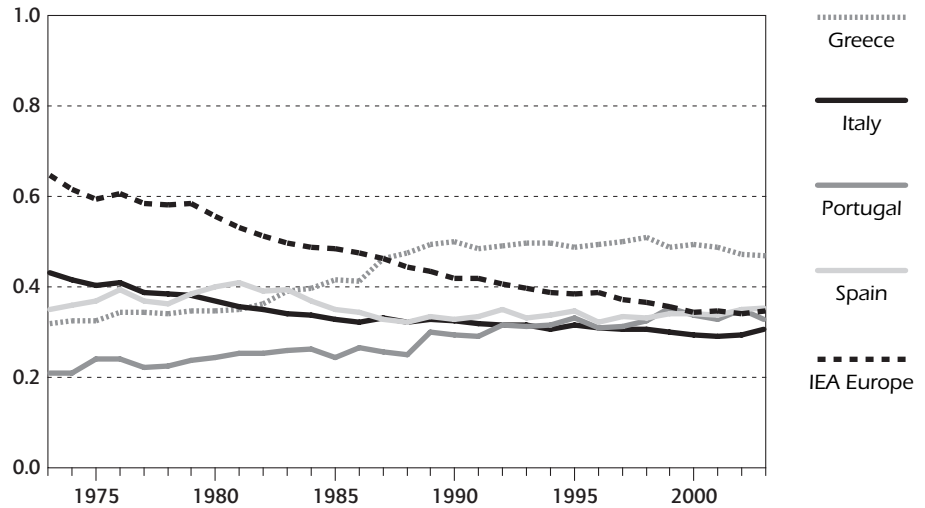
* estimated using the IPCC Sectoral Approach.

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

Figure 8

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

(tonnes of CO_2 emissions per thousand USD GDP using 2000 prices and purchasing power parities)



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

ABATEMENT PROGRAMMES AND INSTITUTIONS

The Ministry of Environment is responsible for monitoring Greek emissions, and for reporting to the UNFCCC. Together with the Ministry of Development it is in charge of developing policies to achieve the targets set for Greece under the Kyoto Protocol and the EU burden-sharing agreement. The NOA has been designated as the body responsible for data collection and reporting for the UNFCCC, and has been instrumental in developing government plans to mitigate GHG emissions.

The transposition of the Directive 2003/87 regarding the establishment of a scheme for greenhouse gas emission allowance trading within the EU into national legislation was completed in December 2004 with the issuance of the Ministerial Decree 54409/2632. The Greek NAP, under which CO_2 emission rights for the EU-ETS are assigned, was published in 2004, and accepted by the EC in 2005. In April 2006, the Greek National Greenhouse Gas Emission Registry was set up. Additional economic instruments to support CO_2 emissions reductions, such as grant programmes, are being examined by the Greek government. There is no budget provision to support the use of flexible mechanisms at this time, and no intention by the government to use them.

National Observatory of Athens and the IERSD

The NOA is the oldest scientific institution in modern Greece, founded in 1842. It consists of five institutes, conducting research in the areas of physics, space, geodynamics, astronomy, and environment and sustainable development. The latter is performed in the Institute of Environmental Research and Sustainable Development (IERSD), which was renamed in 1998 from the Institute of Meteorology and Physics of the Atmospheric Environment. Under its prior name it had been the original institute of the NOA, operating since 1846. The NOA is supervised by the General Secretariat for Research and Technology in the Ministry of Development. It was designated by the Ministry of Environment as the official organisation in charge of the UNFCCC national GHG inventory systems in Greece.

The IERSD was the first organisation that started a systematic study of urban pollution in Athens. The first automatic measurements of pollutant concentrations were taken in 1980. Today the institute works with universities and research centres both in Greece and abroad. Among the institute's main research interests are air pollution, solar and wind energy, atmospheric chemistry, energy conservation, atmospheric electricity and water quality and management. The Institute participates in a number of state and EU-funded research programmes.

The official long-term outlook of energy-sector GHG emissions in Greece is based on the output of econometrical models developed by the NOA and the National Technical University of Athens.

In 1995, Greece set up the "Hellenic Action Plan for the Abatement of CO_2 and other GHG emissions" – also known as the "First National Climate Change Programme". This programme was designed to restrict the increase of GHG emissions to no more than 15% (plus or minus 3%) from base-year levels by the year 2000. The plan was based on the quantitative analysis of the NOA models which considered policy measures and actions taken by ministries at that time. It considered the introduction of natural gas in power generation and as an alternative fuel in the industry sector, the increasing penetration of renewable energies, and energy conservation in residential, household and transport sectors. Despite the plan, Greek GHG emissions reached 23.3% above base-year levels in 2000.

The "Second National Programme for Reducing Greenhouse Gas Emissions 2000-2010" was agreed in May 2002 and adopted by the Greek cabinet on 5 March 2003. It defines the additional policies and measures to be undertaken in order to ensure compliance with the target set in the Kyoto Protocol and by the EU burden-sharing agreement, restricting the increase of GHG emissions to 24.5% over the period 2008–2012, compared to base-year emissions. The programme is based on the First National Programme and related evaluation report which was produced by the NOA. The main actions foreseen in the programme are outlined in Table 4.

The Second National Programme is accompanied by a monitoring and evaluation system by the Ministry of Environment, funded under the 3rd EU Community Support Framework. The monitoring of the implementation of the National Programme is under the responsibility of the Ministry of Environment which has launched a special programme for this task, and the final monitoring results for the first phase to 2005 are expected in 2006. The ministry also co-ordinates the Inter-Ministerial Committee for Climate Change established in 1996, which comprises representatives from the following ministries and organisations:

- Ministry of Environment, Physical Planning and Public Works (co-coordinator).
- Ministry of Foreign Affairs.
- Ministry of the Interior, Public Administration and Decentralisation.
- Ministry of Economy and Finance.
- Ministry of Development.
- Ministry of Merchant Marine.
- Ministry of Transport and Communications.
- Ministry of Agriculture.
- Public Power Corporation.
- University of Athens.
- National Observatory of Athens.

Table 4

Estimated Technological and Economic GHG Emissions Reduction Potential of the Measures Included in the Second National Programme for Climate Change (kt CO_2 eq)

Measures of greenhouse gas emissions reduction	*Technologic Potential 2005*	*2010*	*Economic Potential 2005*	*2010*
Promotion of natural gas	3 191	3 925	1 787	2 198
Operation of NG power plants as baseload units	*3 065*	*3 350*	*1 716*	*1 876*
Further penetration of NG in industry	*126*	*337*	*71*	*189*
Further penetration of NG in residential/tertiary sectors	*0*	*237*	*0*	*133*
Further penetration of NG in transport	*0*	*2*	*0*	*1*
Promotion of renewable energy sources	1 489	6 359	834	3 561
Further penetration of RES in electricity generation	*770*	*4 027*	*431*	*2 255*
Further penetration of RES in industry	*343*	*385*	*192*	*216*
Further penetration of RES in residential/tertiary sectors	*376*	*1 628*	*210*	*912*
Further penetration of RES in transport	*0*	*319*	*0*	*178*
Other measures in industry	234	238	131	133
Other measures in residential/tertiary sectors	874	2 250	489	1 260
Other measures in transport	188	595	105	333
Agriculture	49	92	34	64
Waste	37	98	26	69
Industrial processes	0	4 651	0	4 651
Total	**6 061**	**18 208**	**3 406**	**12 270**

Source: 3rd Submission to the UNFCCC, NOA.

The National Programme is relying on further changes in the electricity generation fuel mix for many of its savings. The primary savings on the supply side are expected from further penetration of renewables and the introduction of natural gas as baseload power units. Together these are expected to contribute 47% of the reductions that are economically feasible by 2010. The contribution that was expected from these two sources by 2005 was almost certainly not achieved, because the new CCGT power stations were either not constructed (see Chapter 9), or are not operating as baseload plant, while the deployment of renewables has fallen behind the expectations of the government.

Changes to industrial processes and in the residential/tertiary sectors are expected to contribute the remaining 50% of the savings. Most of these measures will be energy efficiency measures.

There is no explicit strategy to address the substantial non-CO_2 GHG emissions. These contributed 20.5% of all GHG emissions in 2002.

The National Programme was introduced before the EU-ETS was finalised. As a consequence, it is not considering the possibility of CO_2-allowance trading, and the potential for interactions between measures foreseen in the programme and the EU-ETS.

ENERGY AND ENVIRONMENT STATISTICS

NOA is the designated body to interact with the UNFCCC, and to prepare Greek climate change statistics. At the same time, CRES is developing a modern and in-depth energy statistics system for the Ministry of Development. The two statistics systems are not currently being linked, and there is no co-operation between CRES and NOA to ensure their consistency.

Table 5

Projections of GHG Emissions in the Business-as-Usual (BaU) Scenario and with "Additional Measures" included in the Second National Programme[1]

(in kt CO_2 eq)

Sector	*1990*	*1995*	*2000*	*2005*		*2010*	
	Historic data	*Historic data*	*BaU*	*BaU*	*Measures*	*BaU*	*Measures*
Energy	80 789	84 386	101 062	107 787	104 441	116 890	109 404
Industrial processes	9 591	11 725	12 874	13 667	13 667	15 899	11 248
Solvent and other product use	177	156	169	173	173	177	177
Agriculture	10 448	9 737	10 227	9 736	9 702	9 668	9 604
Land-use change and forestry	1 391	–307	4 138	2 030	2 030	2 030	2 030
Waste	3 749	4 422	5 319	4 042	4 016	2 542	2 473
Total	**106 145**	**110 119**	**133 789**	**137 435**	**134 029**	**147 206**	**134 936**
Change from base year (=100)	98	102	123	127	124	136	125

1. The BaU scenario was originally developed in the context of the Second National Programme of Climate Change (2002). This scenario has now been revised in order to consider updated information regarding input data as well as recent developments in the various economic sectors. Data for the years 1990, 1995 and 2000 are based on the results of GHG emissions Inventory included in the Second National Programme of Climate Change. These results have been partially revised in the subsequent inventories.

Source: 3rd Submission to the UNFCCC, NOA.

Environmental Impact of Lignite Combustion

The share of lignite-fired power plants in total electricity generation in Greece has decreased in recent years as a result of the significant penetration of natural gas and the increased deployment of renewables. Greek government policy is to further diversify the electricity generation fuel mix through the increased use of natural gas and renewables, in order to decrease lignite consumption.

Sulphur dioxide (SO_2) emissions increased by 3.6% from 1990 to 2002. Emissions from electricity generation, which is the main source of SO_2 emissions in Greece, increased by only 2.8% by 2002, compared to 1990, as a result of the operation of a new desulphurisation plant at Megalopolis, and the increase of natural gas and renewables contributions to electricity generation. The implementation of new EU regulations reducing the allowed sulphur content in liquid fossil fuels also contributed to restrict the increase of SO_2 emissions from the rest of the energy sector. Emissions from industrial processes decreased owing to reductions in industrial production.

Modernisation of the existing lignite power units has already started following the transposition of the EU Directives 96/61/EC/ and 2001/80/EC, and is scheduled to be completed by October 2007. According to the provisions of the directives, nitrogen oxides (NO_x) emissions will not have to be reduced before 2016. The current investment programme for emissions reductions is therefore focusing on particle emissions, and the upgrading of electrostatic filters is planned at several units. Sulphur emissions are of particular concern in the four lignite generation units of Megalopolis in the Peloponnese, because unlike the Macedonian lignite, the lignite used in these units does not contain a natural catalytic element removing sulphur during combustion. A desulphurisation plant is now in operation in one of the units, and a second plant is under construction with operation planned for early 2008. The other two generation units are scheduled to operate for only 20 000 hours between 2008 and 2012, at an average load factor of 46%, and they will then be decommissioned in line with the national plan for emissions reductions and the requirements of EU Directive 2001/80/EC.

It is currently planned that any new large power station will use natural gas. Should new lignite units be constructed, they would have to be in compliance with the air emission limits that are foreseen in Directive 2001/80/EC, most likely requiring the installation of flue-gas desulphurisation units such as were installed at the 330-MW Florina lignite plant which was commissioned in 2003.

Local Air Pollution from Mobile Sources

Local air pollution is of serious concern in Athens. Since the last review, progress has been made in reducing the age of the vehicle park and in extending public transport throughout the Athens area. The metro system was significantly extended for the Olympic Games of 2004, and new bus and tram lines were added. These contribute to reduced emissions. A further improvement to air quality is gained from the ongoing modernisation and conversion of buses to run on compressed natural gas (CNG). A CNG filling station has been installed.

Through Law 1350/1983, regular technical inspection of vehicles became mandatory in Greece, and a control has to take place once every three years at one of the 58 specified centres in the country. The frequency of inspections was not satisfactory in the past, because of problems in the prefectural administrations that lacked technical infrastructure and personnel. As a consequence, Law 2963/2001 was passed to provide for the establishment of private technical inspection centres, of which six are now in operation, as well as the improvement of the public centres and the creation of a special service that will supervise the operation of all inspection centres.

Since 1994, an annually renewed exhaust gases control card is required for all vehicles, and the card is issued exclusively by certified automobile service establishments. By 2004, approximately 5 000 such establishments had been certified, providing coverage for the whole country. To enforce the implementation of the measure, mobile inspection units have been put into service. By 2004, there were 15 such units in the Attica prefecture and 20 more in other prefectures, which have carried out a total of 25 000 vehicle inspections in 2004.

Law 2682/1999 introduced differentiated taxation of vehicles based on engine size and environmental performance. However, it is not linked with fuel efficiency. Since January 2004, the acquisition and possession of a car with an ex-factory price up to EUR 50 000 does no longer constitute proof of a high standard of living. The change is leading to lowered taxation, and supports the modernisation of the car fleet by removing a disincentive for the purchase of a new car, even though it was not intended as an efficiency policy.

Access to the commercial centre of Athens by most types of vehicles (including taxis and motorcycles, but excluding public buses) has been prohibited since 1995. This measure resulted in a significant improvement in traffic conditions and, in combination with the circulation of minibuses providing greater frequency and flexibility, promoted the use of public transportation. Since the mid-1980s, an alternating traffic system has restricted the use of passenger cars in central Athens. During peak traffic periods, cars with odd-numbered plates may be used only on odd days and cars with even-numbered plates only on even days.

CRITIQUE

Since the last review, Greece has made important and commendable progress in the sector of energy and environment policy: the EU-ETS NAP was submitted in 2004 and accepted by the EC in 2005, and a new lignite-fired plant with modern environmental controls was commissioned in 2003. Additional CCGTs were commissioned in 2004 and 2005, and a new national policy to address climate change and achieve the Kyoto target of more than 25% emissions above the base-year levels has been adopted.

Nevertheless, great challenges remain for Greek energy and environment policy. At 23% above base-year levels, GHG emissions in 2003 are already very close to the 2010 target. Further challenges are the successful implementation and updating of the government plans to meet the Kyoto target, the integration of CO_2 trading into the government's plans for GHG abatement, further improvements to the development of Greek energy statistics, and a removal of administrative barriers hampering the development of clean solutions in the energy sector (see Chapter 3 on General Energy Policy, and Chapter 8 on Renewables).

Greek climate change policy is driven by international commitments, both directly through Greece being a signatory to the Kyoto Protocol, and through membership of the EU. The NOA has produced a comprehensive evaluation of the policy measures and actions suggested in the First National Programme, and reported this to the government in 2002. The government took this report into consideration when developing the Second National Programme and adopted an approach to develop a new policy on the basis of a comprehensive review and recommendations based on previous policy measures and actions. This is commendable.

The result of the First National Programme review and the monitoring and evaluation of the Second National Programme indicate that the implementation of policy measures and actions tends to be delayed in Greece. In particular, a lack of concrete measures such as regulatory standards and taxation, especially in the residential/commercial and transport sectors, is a cause for concern. The government should ensure that measures foreseen under the Second National Programme are promptly implemented to support the full achievement of the plan.

The Second National Programme was established before the EU directive for the EU-ETS was adopted in 2004. Therefore, the impact of the EU-ETS was not reflected in the programme. The Greek government has transposed the EU Directive on emissions trading into legislation, and the Greek NAP has been accepted by the EU Commission. Moreover, following a lengthy delay, the Greek National Greenhouse Gas Emission Registry was set up in April 2006, allowing for Greek companies to trade credits they have generated.

While the Second National Programme assumes that its targets are to be achieved only through domestic measures, the introduction of the EU-ETS and the NAP could

have a serious impact on the implementation of the programme. Major energy and industry sector companies such as the PPC have begun to purchase credits. For example, the PPC has a clear strategy to purchase the necessary CO_2 allowances to continue operating lignite power plants as baseload, instead of replacing them with CCGTs. The low fuel cost of lignite and the price increases for natural gas are making it uneconomical for operators to run CCGT power stations as baseload plants in Greece. This development is not in line with the Second National Programme, which expects the bulk of emissions reductions (50% and 15% respectively of economic potential in emissions reduction in 2005 and 2010) to come from the shift in the fuel mix of baseload generation from lignite to natural gas. While some CO_2 emissions reduction can still be expected from PPC's refurbishment programme aimed at higher efficiency in old lignite plants, there are concerns that one of the main contributions to the programme may not be realised. Of course, this situation will be very much affected by future CO_2 prices from the EU-ETS and the price trend of natural gas. In any case, the government should assess the impact of the EU-ETS and other factors which were not taken into account in the Second National Programme, and update the programme with supplementary measures, if necessary.

The Second National Programme is lacking a strategy to address the strong increase in emissions from non-CO_2 GHGs. In particular, the rise in the use of air-conditioning is creating a problem of controlled removal and destruction of HFCs. Other IEA members, such as Germany and Norway, have experienced great success in reducing non-CO_2 GHG emissions, and similar potential should exist in Greece, where over 20% of GHG emissions are from gases other than CO_2. The Greek government should consider addressing all non-CO_2 GHG emissions within the national programme, and should in particular consider measures addressing the rise of air-conditioning in Greece, and ensure the adequate disposal of HFCs at the time of retirement of old air-conditioning units.

The official Greek energy statistics still contain a significant potential for problems in policy-making for GHG emissions reductions. For example, at present there are no institutional arrangements or exchanges between the new energy statistics system developed by CRES and the UNFCCC national GHG inventory system maintained by the NOA, even though the quality of the national GHG inventory system fundamentally depends on accurate energy statistics. CRES and NOA individually develop their own energy statistics analysis systems and forecasting models for policy analysis, evaluation and planning. There is concern that this situation could cause policy inconsistencies between energy policy and climate change policy.

It is commendable that there has been an improvement in the local air pollution situation due to the reduction of the age of the vehicle park and the expansion of public transport. The government should consider further pushing for modal shifts in transport to address local air quality concerns, in particular in the Athens area.

RECOMMENDATIONS

The government of Greece should:

- *Reflect the evaluation results and implications of the National Climate Change Programme in the design of future programmes.*
- *Consider the introduction of stronger and more concrete GHG reduction policies in the residential, commercial and transport sectors, taking into account recent developments in Greek energy markets.*
- *Assess the impact of the NAP on the energy and industrial sectors and, if necessary, amend the ongoing Second National Climate Change Programme as soon as possible.*
- *Address non-CO_2 GHG emissions, in particular HFCs from cooling appliances.*
- *Ensure that the general energy statistics and UNFCCC National Greenhouse Gas Inventories are consistent.*

OVERVIEW

Greek energy consumption has risen significantly in recent years, particularly in the transport and residential sectors, leading to temporary shortages of electricity at peak demand times during the summer. Contrary to forecasts at the time of the last review, energy intensity has stabilised, staying just below the IEA Europe average, indicating that the Greek economy has not become less efficient in using energy. It is possible that this stabilisation was the consequence of the increasing penetration of gas and added renewables capacity to the energy supply in Greece, which may have contributed as much as a third to the reduction between 1990 and 2003, together with significant investment into industrial energy efficiency, which was supported by EU funds.

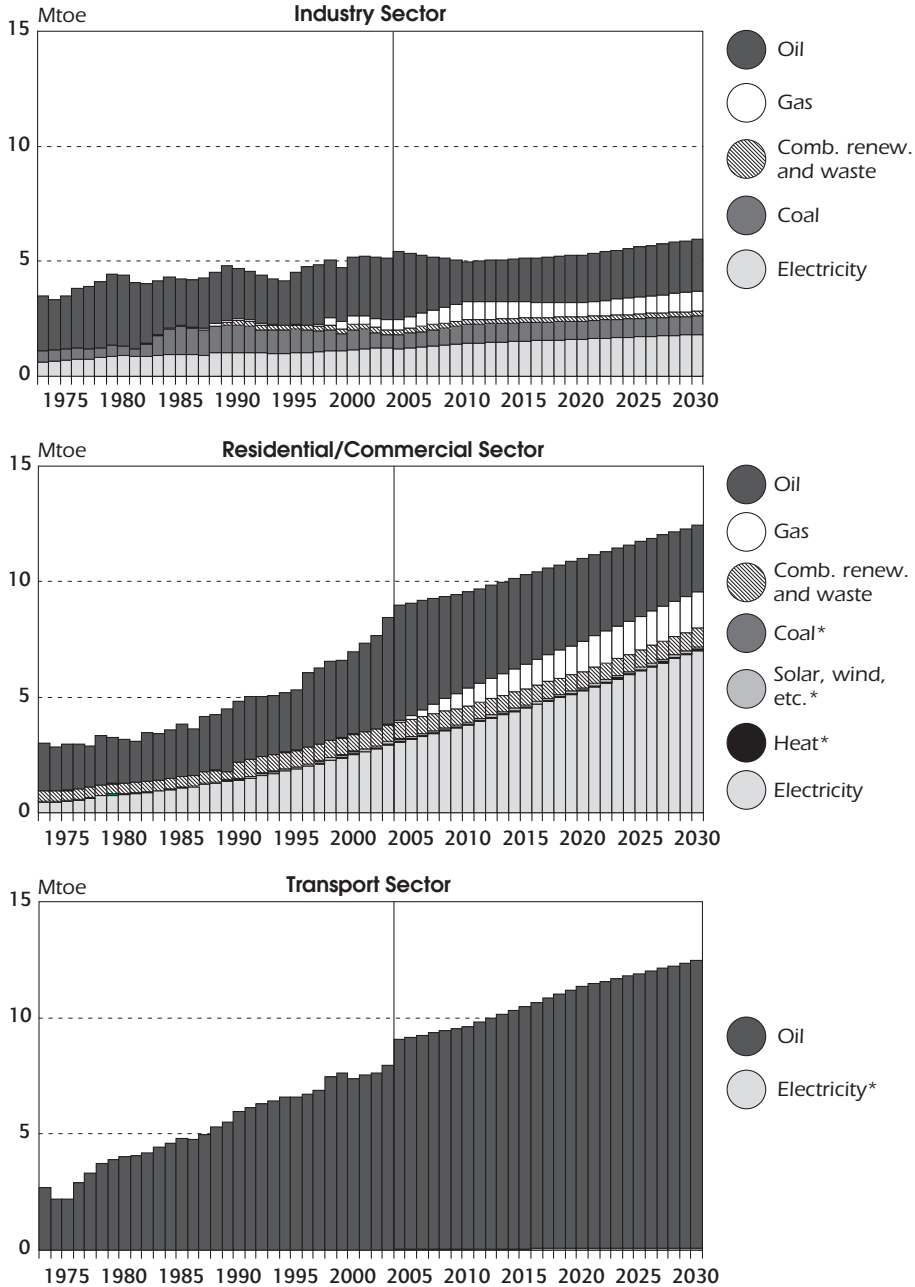
Greek total final consumption (TFC) has risen by 52% from 15.5 Mtoe in 1990 to 23.5 Mtoe in 2004. The share of oil in TFC has risen from 69.5% to 72% over the same period, and contributed 17 Mtoe to TFC in 2004. Oil is primarily used in transport, where 9.1 Mtoe, or 53%, is consumed, and as a heating fuel in the Other sectors[5], where 29.5% is consumed. The remainder is used in industry. It is expected that with planned taxation changes and increasing penetration of natural gas into the stationary sector, the consumption of oil outside the transport sector will be reduced over the coming years. The next most important fuel in TFC is electricity, which contributed 4.3 Mtoe or 18% in 2004, an increase of 75% over 1990, when it contributed 2.5 Mtoe.

In 2004, the transport sector had become the largest consuming sector in the Greek economy, consuming 9.1 Mtoe, or 39%, of TFC. Since 1990, transport TFC has grown by 52% from 6 Mtoe, and industry TFC by 15% from 4.7 to 5.4 Mtoe, which amounts to 23% of TFC. The next most important sector is the Other sectors (including the residential sector), which consumes 9 Mtoe, or 38% of TFC. It has experienced the fastest growth in consumption since 1990, by 87% from 4.8 Mtoe, with electricity consumption growing by 118% from 1.4 Mtoe to 3.1 Mtoe. During the same period, electricity consumption in industry has grown by 16% from 1.04 Mtoe to 1.21 Mtoe. A particular problem for Greek energy efficiency policy is the low capacity margin in electricity (see also Chapter 9).

5. Residential/commercial/agriculture.

Figure 9

Total Final Consumption by Sector and by Source, 1973 to 2030

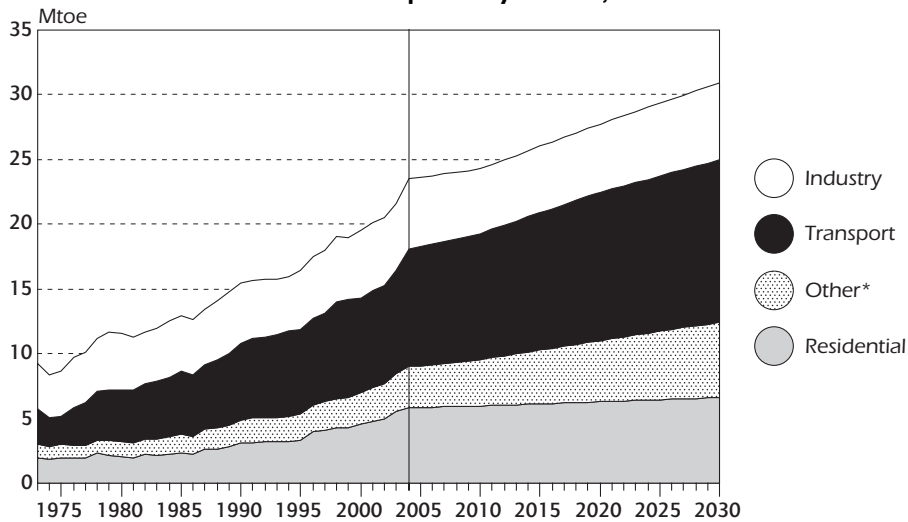


* negligible.

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

Figure 10

Total Final Consumption by Sector, 1973 to 2030



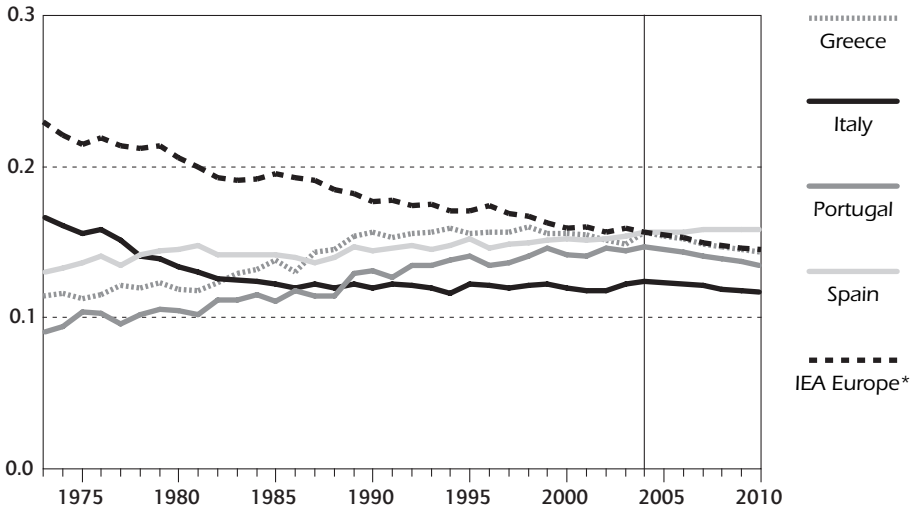
* includes commercial, public service and agricultural sectors.

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

Figure 11

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

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



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

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

ENERGY EFFICIENCY POLICY

The Greek government's policy priorities are the promotion of energy efficiency in the industrial, residential and commercial sectors, with particular emphasis on increasing energy end-use efficiency and fuel substitution by natural gas. In the transport sector, the emphasis is on improving the transport infrastructure and on measures related to more efficient fuel use and less polluting vehicle technology. For electricity, the focus of energy efficiency policy is on increasing power station efficiency, avoiding blackouts caused by high peak demand, and on the promotion of combined heat and power plants (CHP) and consumer awareness.

Greek energy efficiency policy is primarily driven by EU directives. The task of implementing energy efficiency measures is distributed among the ministries and public bodies. General energy efficiency policy is formulated by the Ministry of Development, which also oversees the main funding instrument, the Operational Programme for Competitiveness (OPC), as well as the RAE, the HTSO, the PPC, and the CRES who are the main players in the field of energy efficiency related to electricity use. The Ministry of Environment has the primary role in formulating and implementing policy in the area of energy efficiency in buildings, and of conducting and planning investment in transport infrastructure, while the Ministry of Transport formulates policy for energy efficiency in the transport sector.

MAIN LEGISLATIVE AND FISCAL INSTRUMENTS

Underlying implementation of energy efficiency policy is the study "Planning of national actions for the next decade in the energy sector in compliance with the Kyoto Protocol national commitments", which was prepared by the NOA in 2000. The study includes specific recommendations on energy conservation measures in all sectors, with estimates of their costs, and classifies them according to their cost-effectiveness. Measures and costs outlined in the study provide support in specifying energy efficiency policy and strategy.

There have been several programmes of investment subsidies for energy efficiency-related projects under the framework of Greek development laws and the partially EU-funded operational programmes. These are described below.

National Development Law

The Law 3299/2004 aims to strengthen economic development in Greece by providing for fiscal incentives. Its implementation is managed by the Ministry of Economy. It provides for subsidies to industrial and tertiary sector investment in energy saving, for example in the exploitation of agricultural, industrial and municipal wastes and effluents. The law also supports the creation of grant

programmes for energy efficiency, and subsidies for the production of electricity through the exploitation of renewable energy sources, as well as CHP. Investment subsidies in the form of cash grants, leasing subsidies or tax exemptions can reach 55 % of the total investment, depending on the geographical location and the type of project.

Operational Programme for Competitiveness (OPC)

The OPC includes a programme of support for energy efficiency as well as the introduction of renewable energy, CHP, and the replacement of oil by natural gas. If the objectives of the programme are achieved, it will result in improved energy efficiency. It is at this stage not possible to identify how much of the budget has been invested in energy efficiency. The total available budget for the energy-related investment under the OPC is EUR 1 070 million, of which EUR 367 million is from Greek public funds, with a forecast of primary energy savings of 695 ktoe per year, equivalent to 2% of Greek TPES, and CO_2 savings of 5 Mt of CO_2 per year. It is not expected that more than 70% of the objective will be achieved. An additional EUR 283 million, including public funds of EUR 114 million, is available to further increase the use of natural gas in all sectors of the economy.

Tax Incentives for Fuel Switching to Natural Gas and Renewables

Law 3296/2004 provides for incentives to promote the use of natural gas and renewable energy sources through a 20% reduction of taxable income on the expenses for the purchase and installation of domestic appliances or systems using natural gas or renewable energy sources. It applies to the whole residential and tertiary sector. This law has the secondary effect of modernising the heating equipment at the time of the fuel switch, leading to higher energy efficiency.

Action Plan "Energy 2001"

The Action Plan "Energy 2001" was the main measure taken to comply with the EU Directive 1993/76/EC (SAVE Directive). It was prepared under the direction of the Ministry of Environment by an inter-ministerial committee and co-ordinated by the CRES. Financial incentives for energy-saving measures in buildings are being planned, but have not yet been specified.

ESCOs/Third Party Financing (TPF)

Third-party financing has been discussed by the government as an effective market-oriented instrument. Current Greek law does not allow for the creation of energy service companies (ESCOs). A legal framework is now being developed by the Ministry of Development and is expected to be implemented in the future, following the transposition of the EU Directive on energy end-

use efficiency and energy services. Preferential treatment is given to proposals for environmental and energy projects based on TPF which are submitted to the OPC, or under the Development Law 3299/2004.

PPC Programmes

The PPC has taken measures to restrict consumption of electricity during peak time, for example by reducing reactive power flow of medium-voltage (MV) customers, replacing incandescent bulbs in municipal lighting with fluorescent bulbs, informing consumers through the media (television, newspapers, etc.), establishing customer care offices who can also advise on energy efficiency, and producing advertising leaflets encouraging rational use of energy. Additional measures are planned, such as the establishment of multi-zone tariff structures for high-voltage/medium-voltage industrial consumers, and the gradual transition to a new, more cost-reflective tariff structure following approval by the RAE. Energy-saving programmes have been carried out since 1994 and also involve energy saving within the PPC's operations, *e.g.* the implementation of a programme for the increase of power plant energy efficiency by upgrading steam turbines, cooling towers, boilers and auxiliary systems.

INDUSTRIAL SECTOR ENERGY EFFICIENCY

There is no specific policy on energy efficiency in the industrial sector. Instead, subsidies from the OPC are supposed to achieve the savings outlined as economic potential in the Second National Programme (see Chapter 4).

RESIDENTIAL/COMMERCIAL SECTOR

Energy Efficiency in Buildings

The EU Directive 2002/91 on the energy performance of buildings will be transposed into Greek legislation by the end of 2006. The government has decided to launch a programme to limit CO_2 emissions from the building sector by replacing existing regulations for the thermal insulation of buildings with more stringent ones. This will establish minimum energy standards for new and renovated buildings, energy audits, and energy labelling of buildings according to EU Directive 2002/91/EC. So far, no auditors have been trained.

Energy Efficiency Standards

EU energy efficiency standards legislation has been transposed into Greek law. Sales figures for A- and A+-rated equipment are not available. Apart from the EU standards, there are no domestic standards for energy-consuming equipment in Greece.

PUBLIC SECTOR

Energy Management Offices and Energy Certification

By mid-1999, all government and public sector buildings had established energy management offices in charge of planning energy-saving measures. A timetable of actions to improve the energy management of the buildings had to be developed. From 2000, new public buildings, and from 2004, all public buildings, were required to have an energy certificate stating the energy performance of the building based on an energy audit. The cost of this project is estimated at EUR 1 130 million by 2010, while energy savings are estimated at 140 ktoe per year and the reduction of CO_2 emissions at 530 kt per year in the greater Athens area alone. A proposal for the methodology and procedures for developing energy certificates has been prepared under the EU SAVE II Programme, but the final details have to be outlined by the Ministry of Environment. The certificate system will be launched together with the introduction of the new building energy code foreseen in EU Directive 2002/91/EC.

TRANSPORT SECTOR

Like other IEA member countries, Greece has experienced strong growth in transport demand, particularly road transport, as can be seen from the increase in road vehicle stock since 1971 (see Table 8). In terms of public transport passenger numbers, the majority of passengers are carried on urban buses (927 million users in 2001), followed by inter-urban buses (132 million in 2001), and domestic sea transport (54 million in 2001). Bus travel slightly increased from a low in 1991, but was still far short of the passenger numbers achieved in 1971, when 1.2 billion journeys were made. Railway passenger travel has remained broadly stable since 1971, while rail freight has experienced a decline. Statistics do not yet take into account the most recent improvements in public transport infrastructure, and it is expected that these improvements will lead to higher use of public transport in the future.

Infrastructure Improvements

Road traffic

The work of the Ministry of Environment to enhance the existing infrastructure has focused on a number of projects in the Athens area, and most of these works have been carried out for the Athens 2004 Olympic Games. Road system improvements in large urban centres were undertaken, with the major part of these improvements also taking place in the Athens area. A number of projects to reconstruct the major highways are progressing, with a total length of 1 560 km and a total cost of EUR 6 433 million, supported by EU structural funds. Improvements in the traffic light system were made through the programme Attika SOS, an ongoing programme developed in 1994 in order to

Table 6

Passenger Transport in Greece and Predicted Growth, 1990 to 2020

(in billion passenger-kilometres)

Passenger transport		*Annual growth from 1990*
1990	96.5	
1995	124.3	5.2%
2000	151.4	4.6%
Predicted annual growth rates		
2000-2005		3.3%
2005-2010		2.3%
2010-2015		1.7%
2015-2020		1.0%

Source: 3rd National Communication to the UNFCCC.

Table 7

Freight Transport in Greece and Predicted Growth, 1990 to 2020

(in billion tonne-kilometres)

Goods transport		*Annual growth from 1990*
1990	84.8	
1995	94.3	2.1%
2000	106	2.3%
Predicted annual growth rates		
2000-2005		2.6%
2005-2010		2.3%
2010-2015		2.1%
2015-2020		1.9%

Source: 3rd National Communication to the UNFCCC.

Table 8

Growth in Greek Road Vehicle Stock by Type, 1971 to 2003

Type of vehicle	*1971*	*1981*	*1991*	*2001*	*2002*	*2003*	*Increase 1991/2003*
Passenger	226 893	912 385	1 777 484	3 423 704	3 646 069	3 839 549	116%
Buses	10 546	17 367	22 080	27 115	27 247	27 139	23%
Trucks	107 361	441 081	792 770	1 085 811	1 109 137	1 131 027	43%
Motorcycles	69 246	106 381	295 675	853 366	910 555	969 895	228%
Total	**414 046**	**1 477 214**	**2 888 009**	**5 389 996**	**5 693 008**	**5 967 610**	**107%**

Source: Hellenic National Statistical Service.

tackle the serious environmental problems in the Attica region. Improvements in four major road arteries of Athens have been carried out, and a computerised system for the control of the traffic lights in the centre of the Piraeus area was established. Similar work is in progress in Thessaloniki through the programme Thessaloniki SOS. All of these projects are expected to contribute to a reduction in congestion, thereby achieving reduced fuel usage and improved air quality.

Improvements in public transport

Improvements in the existing 28 km long Athens underground line were undertaken. Additional carriages were added to increase the capacity by 15% during peak hours, leading to reduced road vehicle traffic. By August 2004 all stations had been reconstructed and renovated, and, in 2000, two new metro lines, totalling 25 km, came into operation, servicing over 500 000 people daily. Further major extensions are under construction, and their completion is foreseen for 2008. In June 2004, a tramway system with two lines totalling 29 km came into service connecting downtown Athens with the south coast of Attika.

The Attika suburban railway network has also been extended and will continue to be upgraded. This project includes the construction of new, and renovation of, existing railway stations, the procurement of trains, the modernisation of the train traffic control system and the development of park-and-ride facilities. The first line connecting the new Eleftherios Venizelos international airport at Spata with the central railway station in Athens came into operation in August 2004, serving the Athens 2004 Olympic Games. A total network of 200 km is under construction, and is expected to be completed by 2008.

Efficiency improvements in the Athens bus system were undertaken since the last review. Old buses have been replaced by new, more energy-efficient and less polluting ones. The procurement of 295 compressed natural gas (CNG) buses, along with the construction of a central refuelling station in Athens has been completed, and a further 600 CNG buses are to be purchased. New bus lines in Athens were developed and came into operation, while some of the existing lines were expanded. These bus lines serve areas of the centre experiencing heavy traffic during peak hours. This programme, co-coordinated by the competent body for public transportation in Athens (OASA), is still in progress.

The Greek Railway Operational Plan is financed by the EU's 2nd and 3rd Community Support Frameworks with a total budget of EUR 490 million. Additional work is financed by the Cohesion Fund of the EU with a total budget of EUR 497 million, including the construction of two supplementary railway lines and electrification of the Piraeus-Athens-Thessaloniki railway line. It is expected that this improvement will lead to a shift of goods and passenger road traffic to the railway.

MONITORING/ASSESSMENT

The Greek government views the need for accurate monitoring and assessment mechanisms of energy efficiency measures and investment as the biggest challenge to the implementation of its energy efficiency and climate change policy. To assist in monitoring, data from energy audits in buildings will be collected to follow the development of the energy performance of the building stock and to help adapt energy policy in the building sector accordingly.

Implementation of the monitoring and assessment will be undertaken primarily by the OPC. It is expected that this will take into account the whole energy efficiency policy and programme landscape to help monitor Greek compliance with the Kyoto targets. In the industrial sector, investments supported by state aid will be monitored as part of the evaluation process of the OPC.

The government is considering tying publicity campaigns, such as the one run by the PPC, into energy auditing, once energy auditors have been trained. In addition to the performance of buildings, these auditors could also inspect boilers, air-conditioning systems and industrial processes.

CRITIQUE

As in most other IEA member countries, the TFC of Greece is increasing. In particular, rapid growth is seen in the transport sector (52% from 1990 to 2004) and in the Other (commercial/public and agriculture) sectors (87% during the same period). While efforts to promote energy efficiency in transport through measures to renew the vehicle fleet and to improve public transport should have an impact in the future, the rapid increase of oil consumption in the transport sector is notable and gives rise to concern. The growth in other sectors is primarily driven by increased demand for electricity and oil, and is putting a strain on the energy supply system of Greece through increasing summer peak demand levels. Reducing the rate of increase of TFC, in particular of oil, and managing peak electricity demand, are the main challenges for Greek energy efficiency policy in the future.

Despite the increase in TFC, the trend of increasing energy intensity seems, however, to have been broken since the previous review, and energy intensity fell slightly in 1990 and 2003 after increasing to the level of the IEA Europe average. This stabilisation could be the effect of significant investment from EU structural funds and the introduction of natural gas, which is a commendable development. Nevertheless, given high economic growth in Greece and its challenges in terms of energy security and climate change mitigation, further strong efforts will be necessary to improve energy efficiency.

Currently, Greece does not have a comprehensive energy efficiency strategy. The current energy efficiency measures are based to a large extent on the

Second National Climate Change Programme, and the work of the NOA to help achieve the Kyoto target. The Greek government is of the view that energy efficiency policy is best practised through the transposition of EU directives which set mandatory minimum energy performance requirements. While a significant contribution to energy efficiency policy can be expected through implementation of relevant EU directives, such an approach relying on outside drivers is too reactive, and risks missing particular policy opportunities that exist in Greece, such as the projects undertaken to reduce reactive power. The government should consider the development of a long-term energy efficiency policy with measurable objectives/targets as an integral part of a long-term strategy (see Chapter 3) that is properly reflecting the particular features of the Greek energy supply and demand structure, and goes beyond implementing EU legislation. This approach will be more effective than relying on outside drivers that may focus on areas that are not necessarily directly relevant to Greece.

The implementation of the recently adopted EU Directive on energy services will in any case require the introduction of energy efficiency objectives and the formulation of national energy efficiency plans. Further work on data collection and indicators to follow up the different energy efficiency measures should be considered by the government.

In developing such a strategy, the work of NOA and CRES should be fully utilised. For example, NOA's study in 2000 on energy conservation measures provides useful insights on the cost-effectiveness of various policies and measures. The CRES has also formulated and proposed policies and measures to promote rational use of energy.

The responsibility for formulating energy efficiency policy is shared among several ministries and actors. This may constitute an obstacle to the formulation and implementation of a comprehensive energy efficiency strategy. Strong leadership by the Ministry of Development with close co-operation among all ministries involved is essential for the development and implementation of a successful energy efficiency policy.

The Action Plan "Energy 2001" has helped to put Greece in a good position for the implementation of the Directive on the Energy Performance in Buildings. It is now important for the government to introduce the new building code and to train sufficient numbers of energy auditors to ensure strong enforcement.

A national public awareness campaign on energy saving and efficiency has recently been initiated to further enhance the energy efficiency policy measures. This is commendable. The government should consider ensuring that this campaign is not solely driven by the need to avoid electricity shortages, but instead allow the campaign to become a long-term instrument in raising awareness of energy consumption in Greece.

Investments related to energy efficiency are supported by the OPC. However, the major share of funding from the OPC is devoted to renewable energy projects rather than energy efficiency projects. Such an overemphasis on the supply side is a concern. While the investment subsidies of the OPC seem to be effective, it could nevertheless be useful to also consider other, more market-based instruments for the further promotion of energy efficiency which could complement the subsidies by the OPC at no cost to the public budgets.

For example, there are currently no energy tariffs that reflect costs, availability and bottlenecks in energy supply. Low taxation is also encouraging the very high consumption levels of oil. To send appropriate signals to final consumers, the introduction of cost-reflective energy pricing (*e.g.* time-of-use tariffs) and continuous information and awareness initiatives (*e.g.* improved information on energy bills) should also be considered. In addition, there are preferential tariffs, *e.g.* for the agricultural sector, that may discourage the efficient use of energy. The government should consider whether there are other ways of supporting specific sectors and achieving social objectives, that will not encourage energy use and distort consumption behaviour.

In the electricity sector, peak demand is a particular concern. The Greek government should consider addressing this by measures that discourage demand at peak times, such as time-of-day tariffs, and by revising the building codes and appliance standards to reduce demand for cooling at peak times. Studying the experience and measures taken by other IEA member countries, such as Japan and parts of the United States, may be helpful in this regard.

With the introduction of competition, the government may have to reconsider the strong role the PPC is playing in promoting rational electricity use, and may either have to establish a system under which all electricity suppliers will have to contribute to such measures, or consider managing such a programme directly or through an independent agency, such as the Danish Electricity Savings Trust. For example, the United Kingdom's Energy Efficiency Commitment is compatible with a competitive energy market and has been successful in achieving its targets and is being expanded, while France and Italy are introducing so-called white certificate schemes. Greece may learn from the experiences of these countries.

Efforts have been made by the government to introduce the market-based instrument of third-party finance (TPF) to help provide the financing of cost-efficient energy efficiency investments. So far, however, TPF schemes have not been widely used in the private sector, while the legal framework to allow such financing in the public sector is still in the process of being formulated. The government should consider rapidly developing and introducing the legal framework required for TPF and energy service companies (ESCOs).

It is commendable that Greece has recently made very significant and visible progress in the public transport sector. This mainly includes the introduction of new means of public transport, such as the extension of the metro in Athens,

the installation of a CNG filling station in Athens, the construction of tramlines in the Attika region, the restriction on the use of private cars in Athens and the opening of new, higher-speed railway lines to Thessaloniki and Corinth, significantly cutting travel times. These measures should contribute to curbing the growth of private transport in the future. Much of this development has been co-financed by EU structural funds, and it will be important to establish plans for future investment once EU funds are reduced. Further potential may exist in decreasing fuel use, or investigating the potential for fuel switching in shipping, which plays a significant role in Greek domestic transport.

As a result of tax incentives for car renewal, there has been successful renewal of the private car fleet, which has halved the average age of cars, leading to higher fuel efficiency and lower emissions from these cars. On the other hand, low taxation for road fuels, and an absence of tax benefits for the use of fuel-efficient vehicles do not encourage modal shifts and reduce the incentive to increase further the fuel efficiency of the vehicle fleet. The government has not yet introduced the EU vehicle label. It should do so at the earliest opportunity and consider linking it to taxation to ensure that future fleet renewal is undertaken with the most efficient vehicles possible. When doing so, the government should consider aligning the Greek efficiency standards with those of the major car manufacturing countries in the EU, to ensure that vehicles sold in Greece are the most up to date.

Greek oil consumption as a share of TFC is among the highest in the IEA, and the Greek government should consider specific policies to reduce oil consumption. The efforts to introduce alternative fuels in the public transport of Athens are commendable, and investment in such measures should be continued.

RECOMMENDATIONS

The government of Greece should:

- *Formulate a comprehensive and clearly structured policy framework for improving energy efficiency with measurable targets as an integral part of a long-term energy policy strategy.*
- *Establish an effective monitoring system to achieve energy efficiency targets, and ensure that all programmes are evaluated objectively, preferably by a third party.*
- *Ensure the continued co-operation between all the ministries involved in energy efficiency in the development and implementation of such a plan.*
- *Ensure the speedy implementation of the EU Directive on the Energy Performance in Buildings by publishing the new building code and training sufficient numbers of building energy auditors.*

- *Consider the introduction of more market-oriented instruments. These could include cost-reflective energy pricing and information and awareness initiatives.*
- *Consider the removal of preferential tariffs for particular sectors and groups if these distort consumption behaviour.*
- *Utilise the experience from other countries in mandating energy suppliers to achieve energy efficiency targets.*
- *Introduce effective policies to reduce electricity demand at peak times.*
- *Develop a framework for the operation of energy service companies and energy efficiency auditors.*
- *Consider policies specifically addressed to reduce the Greek economy's heavy dependence on oil.*
- *Continue the efforts to achieve modal shifts, by* e.g. *improving public transport and transport infrastructure, and by introducing cost-reflective pricing.*
- *Introduce the EU vehicle label at the earliest opportunity.*
- *Consider the introduction of efficiency-related vehicle taxation, linking to EU vehicle labelling.*
- *Evaluate the possibility to further increase the use of alternative fuels in the public and private trucking and bus sectors.*

SUPPLY AND DEMAND

In 2004, oil accounted for 19.5 Mtoe, or 59.5% of Greek TPES, almost 100% of which is imported. This is a slight increase in the share of TPES, compared to the 57.8% it accounted for in 1990. This share of oil in TPES is very high compared to other IEA member countries, such as Italy (48.3%) or Spain (50.7%). A significant amount of oil (15.1% in 2003) is used for power generation in Greece, primarily on the non-interconnected islands which depend mostly on diesel generators for their electricity supply.

Greece imports 65% of its oil from non-OECD countries, primarily the Middle East, which accounted for 14 Mtoe, or 55% of imports in 2003, and the countries of the former Soviet Union. One small oilfield is in production, producing approximately 0.6% of annual oil requirements in Greece. Further exploration has so far been unsuccessful.

In 2004 oil accounted for 17 Mtoe of Greek TFC. Its share stood at 72.4%, a slight increase compared to 69.5% in 1990. The primary use of oil is in the transport sector, where 9 Mtoe out of 17 Mtoe of oil consumed in 2004 was used, accounting for 53% of oil consumption in Greece. The other sectors consume 5 Mtoe, 29.5% of the total, while industry consumes 2.9 Mtoe, 17% of total consumption.

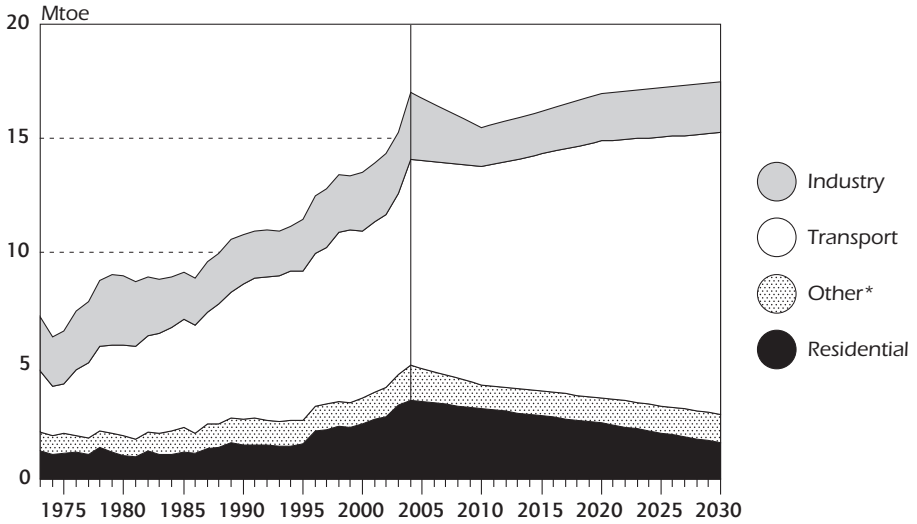
Government forecasts expect reduced oil consumption outside the transport sector as a result of increased fuel switching to natural gas. Diesel oil is the primary fuel for power generation on the non-interconnected islands, and is an important heating and industrial fuel in parts of Greece that are not connected to the natural gas grid. With increasing connections of industrial and smaller users to the gas grid and planned changes to taxation (see Chapter 3), it is expected that oil use for heating will decrease.

EXPLORATION AND PRODUCTION

Exploration and production activities in Greece can only be undertaken with a licence received from the State. Greece's oil production comes from the Prinos area in the Aegean Sea, off the coast of Kavala. The Prinos fields, which began production in 1996, are operated by the Kavala Oil S.A., 95% of which is owned by British Regal Petroleum. In 2002, estimated reserves stood at 4.5 million barrels of oil equivalent (Mboe), and daily production in 2004 stood at 2 761 barrels (bbl). The oil is sold to Hellenic Petroleum for refining.

Figure 12

Final Consumption of Oil by Sector, 1973 to 2030



* includes commercial, public service and agricultural sectors.

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

Recent exploration activity by Kavala has raised the recoverable reserve estimate (proven and probable) to 22 Mboe. Kavala Oil holds exclusive rights to exploration in the Prinos area, while Hellenic Petroleum is undertaking limited exploration in other parts of Greece.

Greece's first oil exploration licensing round was held in 1996 and awarded six concessions. In February 2001, a new oilfield was found offshore the Aegean island of Thasos (also near Kavala) by Kavala Oil, with production originally expected to be 7 000-7 500 bbl a day, but production has not commenced and the oilfield is still not confirmed as commercially viable. In May 2002, Greece announced that it would hold its second oil exploration licensing in 2004, but this round was not held. The round was to include both offshore and onshore areas in north-western and south-western Greece, plus unexplored blocks in the Ionian Sea. Exploration in the Aegean Sea is complicated by lack of agreement between Greece and Turkey on delineating continental shelf boundaries. Greece is seen as an underexplored country with remaining potential, and the most optimistic geological estimates for the northern Aegean region range up to a potential daily production of 200 000 bbl/d, covering almost 50% of Greek demand. A new law for the establishment of a state company that will undertake the task of holding tenders and awarding concessions for the exploration and exploitation of potential oilfields in various parts of Greece will be submitted to Parliament in 2006/07.

EXTERNAL TRADE

Greece is exporting significant amounts of oil products which are not in compliance with EU environmental regulations, or are not required by the Greek market, owing to the focus on heavy products in the Greek refinery yields. Exports go mainly to the U.S., Libya, Turkey, and non-OECD Europe. Exports have decreased by 23% from 7.6 Mtoe in 1990 to 5.8 Mtoe in 2004, indicating that the recent refinery upgrade investments (see below) have led to a better balance between the demands of the Greek oil market and the output of Greek refineries. This decrease in exports, coupled with increasing demands in the Greek market, has led to the country moving into balance regarding the import and export of oil products in 2004. Oil products are imported from a variety of countries, the most important being the former Soviet Union, Italy, the U.S. and Venezuela.

INDUSTRY STRUCTURE

General

The Greek oil sector was liberalised in 1992. There is still state ownership in the dominant company in the sector, Hellenic Petroleum. By law, the State's share of Hellenic Petroleum cannot fall below the current level of 35% and at present stands at 35.3%. Hellenic Petroleum is active in all segments of the oil market, owns 35% of the Greek Public Gas Corporation DEPA, and has recently also entered the power generation market. The company is also active in the South-East European region through partial ownership in pipelines and refineries, and retail subsidiaries. Multinational companies, independent filling stations and wholesalers, and the Greek company Motor Oil Hellas are the main competitors of Hellenic Petroleum in Greece.

To operate in the Greek oil market (refining, trade, retail trade, bottling of LPG, and transportation via pipeline), a licence is required by Law 3054/2002 for each activity. A legal entity is permitted to receive more than one of these licences. Since the last review, a change in the law has introduced the possibility for retailers that are not vertically integrated in Greece to access storage capacity from Hellenic Petroleum or Motor Oil Hellas to fulfil their emergency supply obligations, further liberalising the Greek market. Direct imports and direct purchases from refineries are now allowed for refineries, trading companies, supply co-operatives, retail stations for liquid fuel and/or auto LPG licensees, major end-consumers (with consumption higher than 150 000 tonnes annually) and the Greek Army.

Upstream

Pipelines

A new 53-km, 10-inch JET A-1 pipeline has been constructed since the last review, and is now operational with a capacity of 300 cubic metres per hour,

connecting the Aspropyrgos refinery with the new Athens International Airport (at Spata). In addition, oil product pipelines connect the refineries with the major trading companies. Since the last review, a new 214-km long pipeline with a carrying capacity of 2.5 Mt of oil per year was opened connecting Thessaloniki in northern Greece and the Okta refinery in the former Yugoslav Republic of Macedonia (FYROM), of which Hellenic Petroleum owns 51.35%. The pipeline is operated, and 80% of its shares are owned by Elpet Balkaniki S.A., a subsidiary of Hellenic Petroleum which owns 63% of the company, while the remaining 20% are owned by the FYROM.

The Greek, Bulgarian and Russian governments signed a protocol in 1994 to co-operate on the construction and operation of a pipeline that would provide an alternative route for the export of Black Sea oil. The planned pipeline will connect Bulgaria and Greece, providing a supplementary route to the Bosporus Straits. The feasibility study of the project has been completed and a Memorandum of Co-operation for the construction of the pipeline between Greece, the Russian Federation and Bulgaria was signed on 12 April 2005 in Sofia. The project is supported by a consortium of Russian energy companies, including Gazprom. The pipeline will reach a length of 285 km connecting the Bulgarian port of Burgas on the Black Sea with the Greek port of Alexandroupolis on the Aegean Sea. The oil will be transferred by ship from the Russian port of Novorossisk on the Black Sea to Burgas. The estimated cost is expected to be between USD 750-800 million and the pipeline will have an initial capacity of 15 Mt per year, which will be increased gradually to 35 Mt and then to 50 Mt per year. If built, the pipeline is expected to significantly ease the congestion of shipping in the Bosporus Straits.

Refineries

The Greek upstream industry is particularly dominated by the partially state-owned Hellenic Petroleum, which controls approximately 79% of the refinery market since merging with the private company Petrola in 2002. The other refiner is Motor Oil Hellas, operating a refinery at Corinth. The refineries are located at major centres in Greece (see Table 9). The refinery output in Greece concentrates on heavy products, and heavy fuel oil accounts for 34% of refined oil products. However, all Greek refineries are planning to increase light product yields over the next five years. All investments and changes are required to ensure that the recent production of all Greek refineries is in compliance with Auto Oil II specifications for 2005. In addition, the use of leaded gasoline has been forbidden since the beginning of 2002.

New units have been constructed or are under construction in the Greek refineries to meet new product specifications and environmental standards. Hellenic Petroleum's refineries started producing and supplying the market (through its distribution subsidiary EKO-ELDA) with gasoline and diesel with 2005 specifications from autumn 2003. In addition, energy-saving projects

have been taking place in all its refineries to increase efficiency. The refinery of Motor Oil Hellas has also started to produce gasoline and diesel with the 2005 specifications. The refinery is expected to increase the quantity of the above products after the completion of the installation of a new desulphurisation unit. The list of refinery improvements is included in Table 9 below:

Table 9

Refineries in Greece[1]

Ownership	*Hellenic Petroleum*	*Hellenic Petroleum*	*Hellenic Petroleum*	*Motor Oil Hellas*
Name	Aspropyrgos Refinery	Thessaloniki Refinery	Elefsis Refinery	Motor Oil Hellas
Location	Aspropyrgos	Thessaloniki	Elefsis	Agio Theodorou
Capacity in:				
Mt/year	6.7	3.45	5.0	4.5
Thousand bbl/d	135	75	100	100
Refinery type	Highly complex: catalytic, thermal, and hydrocracking; MTBE production, vacuum distillation isomerisation	Hydroskimming; vacuum distillation; isomerisation; reforming; producing gasolines	Topping: atmospheric distillation only, not producing gasolines[2]	Complex: catalytic and thermal cracking; isomerisation; MTBE production, vacuum distillation
Upgrade programme	**2000-2004:** Revamp of catalytic reforming unit Revamp of diesel HDS unit Revamp of naphtha HDS unit Construction of a TAME unit **2005-2009** Transformation of the old reformer in naphtha HDS unit Construction of a new diesel deep HDS unit	**2000-2004** Construction of a new diesel deep HDS unit **2005-2009** Construction of a new hydrogen production unit	**2005-2009** Revamp of diesel HDS unit A hydrocracking unit A vacuum distillation unit	**2005** Installation of a hydrocracking unit Installation of a HDS/HT unit **2006 and forward** Upgrading of the unit of lubricants/ production of brightstock Installation of a new atmospheric crude oil distillation unit Installation of a new circulation system «in line blending»
Constructed in	1958	1966	1972	1972

1. See also Figure 17, Map of the Gas Network for the location of refineries in Greece.
2. Undergoing an upgrade at the moment.

Sources: Ministry of Development, Hellenic Petroleum.

Downstream

The downstream sector of the Greek oil market is serviced by a number of domestic and multinational oil corporations, including Hellenic Petroleum, whose share of the market is approximately 24%. Other companies include Shell and BP. The number of retail outlets in Greece is very high, at around 7 500, compared to other countries. This is driven by the nature of the country, with its dispersed island settlements. By comparison, Spain has 8 700 filling stations, and Italy around 26 000. Greek filling stations serve on average roughly 1 500 persons and 800 vehicles. This compares to around 4 700 and 2 600 per station in Spain, and approximately 2 600 and 1 600 in Italy.

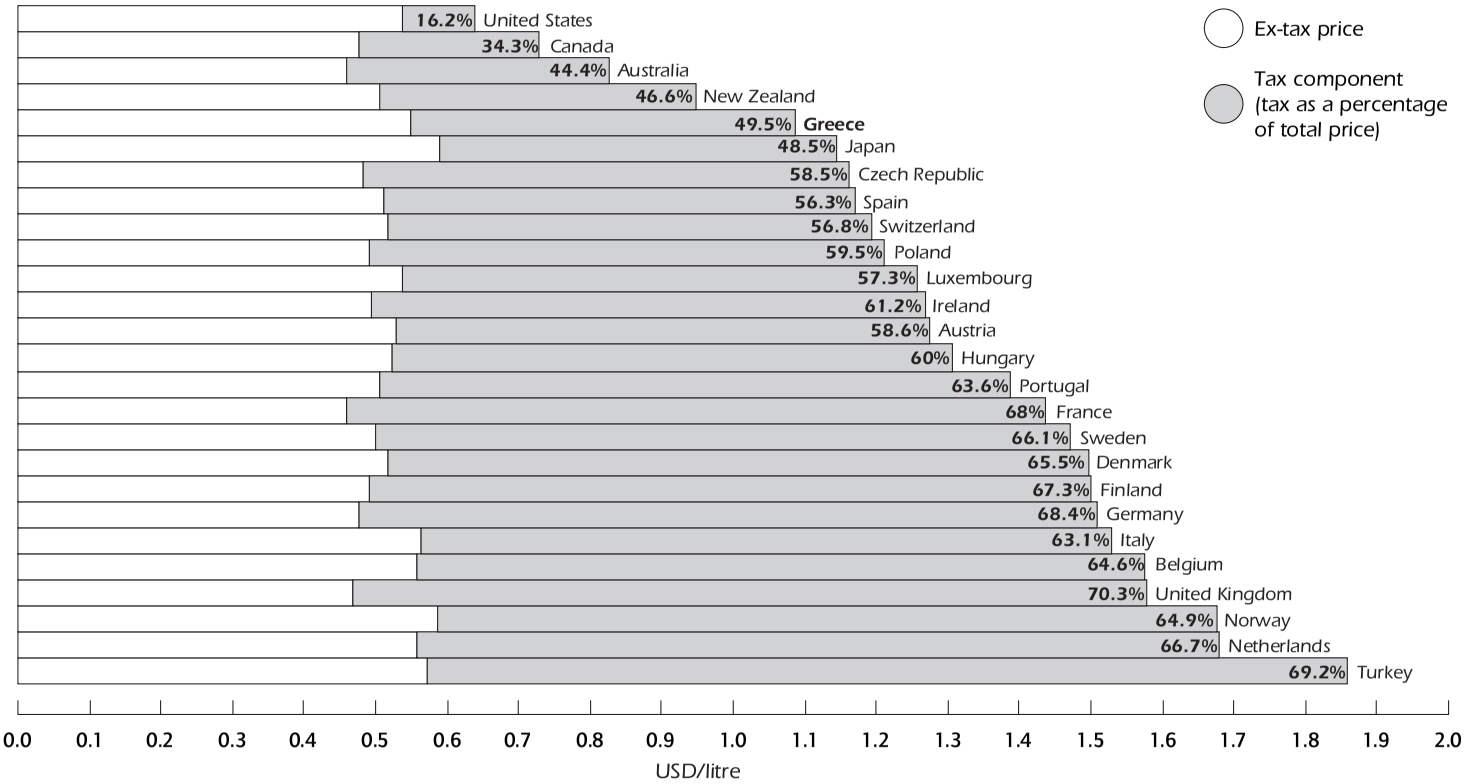
Petroleum product prices have been set by the market since liberalisation in 1992. According to Law 3054/2002, the State retains the right to introduce price ceilings on petroleum products in areas where it believes that monopoly tactics may be distorting competition. However, this is a last resort measure which will be taken only when all other measures have failed. As Figure 13 shows, Greek prices for automotive oil products are among the lowest in after-tax terms in the OECD. Pre-tax prices, however, are higher than those of many other OECD member countries. In the household and commercial/industrial sectors, the same excise tax rates for diesel apply.

The "Oil Market Law" 3054/2002 and its latest amendment (Law 3335/2005) allow all importers, which can be refineries, trading companies, supply co-operatives, major consumers, and retail stations, to import oil products directly, while requiring them to comply with the 90-day stockholding obligations for their directly imported volumes. This requirement can be met by renting space in a storage facility, or by renting stocks from the operators of the stockholding facilities under a regulated TPA regime.

The provisions of Law 2127/93, which allow the lowering of tax on heating diesel during the heating period between October and April (see Chapter 3), have led to tax fraud by encouraging the use of heating diesel in cars. Concern with such tax evasion and also with product quality in the oil products markets has led to the introduction of inspection teams (KEDAK) by the Ministry of Development, following article 18 of the Oil Law 3054/2002 and its amendment Law 3335/2005. Their purpose is to inspect installations and check the type and quality of oil products in storage facilities and in retail stations. Non-compliance with product standards will be subject to fines of EUR 5 000 to EUR 1 500 000, and can also lead to a temporary or permanent loss of the operator licence or temporary closure of the facility. The government is also planning to align the taxation of automotive and heating diesel to discourage fraud in the future. Concerns about tax evasion have also led to restrictive ownership rules for tanker trucks, the sealing of import terminals at night restricting operating hours, and the restriction of opening hours of filling stations.

Figure 13

OECD Unleaded Gasoline Prices and Taxes, Second Quarter 2005

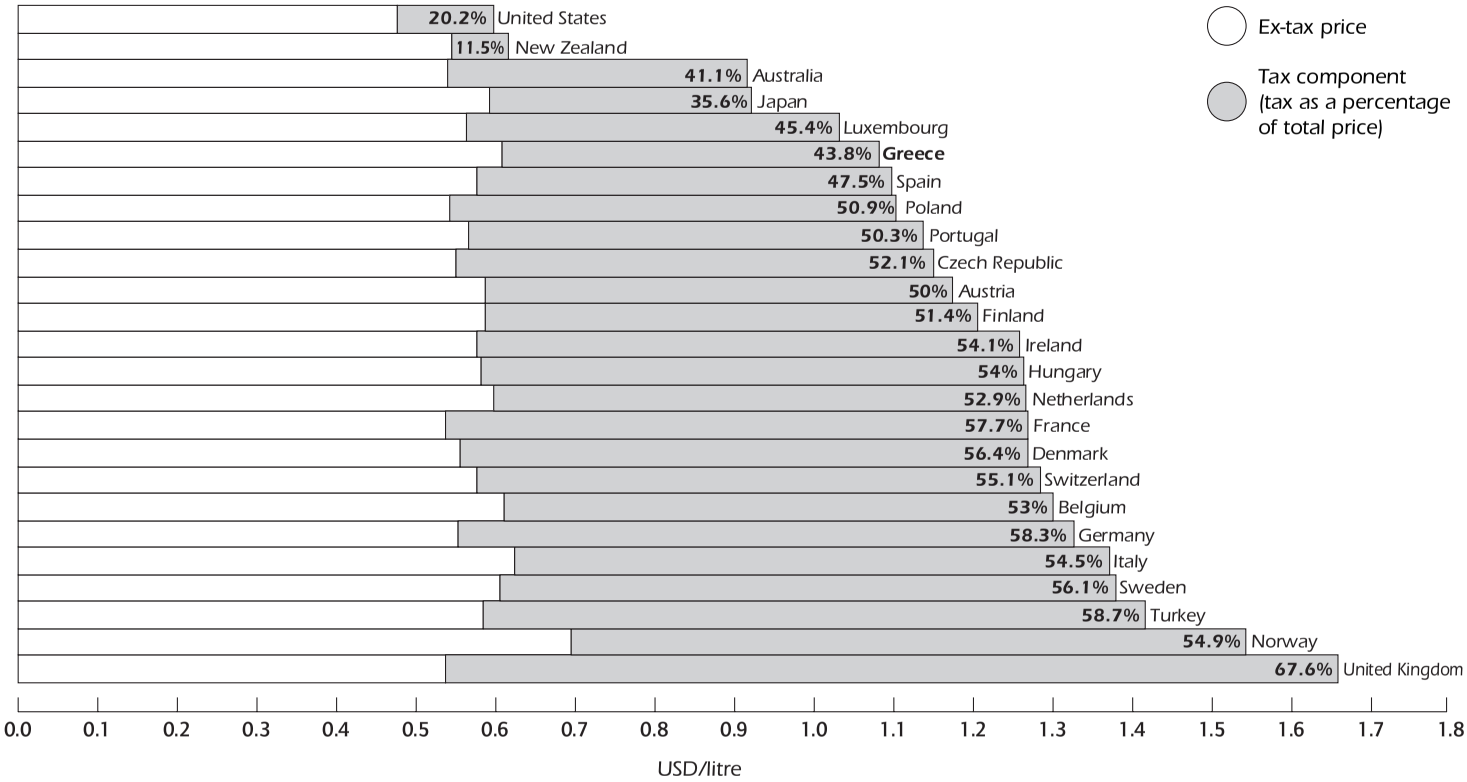


Note: data not available for Korea, Mexico and the Slovak Republic.

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

Figure 14

OECD Automotive Diesel Prices and Taxes, Second Quarter 2005



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

Emergency Response Measures

Since the partial privatisation of Hellenic Petroleum in 1998, the Greek Administration has made great strides at reviewing and revising government policies, procedures, and oil security issues, including oil stockholding data. It started with a comprehensive review of oil and emergency policies that would include a sector-by-sector study of demand restraint measures and culminated in the adoption of a new oil law by Parliament in 2002 (3054/2002)

In particular, previously there was no legal framework for participation in IEA Co-ordinated Emergency Response Measures (CERM) or sub-crisis activities as the Greek government would rely on voluntary co-operation by the oil industry and, in particular, the refining industry to release stocks to the distribution companies. The new law clearly gives full authority to the government to respond to all types of oil emergencies.

For several years Greece failed to meet its IEA International Energy Program stockholding obligations. In order to improve this situation, the Ministry of Development decided in August 2004 to take over the direct responsibility for oil and gas data collection and monitoring from Hellenic Petroleum. It also increased the supervision of stocks through intensive controls, including on-site inspections and imposition of fines. Under the new data system Greece has been compliant with its IEA 90–day stockholding requirement consistently since 1 October 2004.

At the same time, while under the new laws and regulations, oil reserves are to be held on a net import basis, the law only refers to EU product groups for the calculation of emergency reserves, without any specific reference to IEA requirements, including the deduction for unavailable stocks. As all reserves are held by industry, the ministry needs to carefully monitor the level of stocks to ensure that Greece continues to consistently meet its IEA obligation.

CRITIQUE

In Greece, the share of oil in TPES (59.5%) and electricity generation (15%) is much higher than the IEA Europe average (40.4% and 4.3%) respectively. Therefore, security of supply is critical. In this context. There have been commendable developments in the Greek oil markets since the last review. A major investment programme is forthcoming to improve the capabilities of Greek refineries. Oil import sources have been diversified. An oil pipeline, which connects the port of Thessaloniki with the OKTA refinery in Skopje in the former Yugoslav Republic of Macedonia, has been constructed and has been in operation since 2002. Another oil pipeline is planned to connect Burgas (Bulgaria) with Alexandroupolis (Greece) bypassing the Bosporus. A new law (3054/2002), introduced in 2002, has allowed importers to access storage facilities at refineries, enabling them to import directly while fulfilling stockholding obligations. Nevertheless, some challenges remain.

Despite the government's announcement of its intention to hold a licensing round for exploration in Greece in 2004, this round was not held. Greece is seen as underexplored by industry experts, and there may be some potential for an increase in reserves. Without further exploration this potential cannot be confirmed.

Partially state-owned Hellenic Petroleum merged with private company Petrola in 2003, increasing HP's market share from 58% to 79% of the Greek refinery market. An investigation by the Hellenic Competition Commission (HCC) and comments from the retailers indicate that there are no discernible problems from the result of this increase in market power. Nevertheless, this level of market power could potentially cause problems in the future, and the government, regulator and the HCC should continue to monitor the market closely.

One of the main challenges for the government in the oil market is the elimination of tax evasion. Widely diverging tax rates for light fuel oil use in stationary and mobile applications encourage tax evasion, and the government has taken various measures such as the sealing of import terminals at night, restricting their opening hours, and the opening hours of filling stations. However, these measures are having a negative impact on the operational efficiency of oil importing and retailing activities, *e.g.* the restrictions on the ownership of tanker trucks may constitute a barrier to entry for new retailing and oil transport companies. It is encouraging that the government is planning to align taxation of automotive and heating diesel to discourage the fraud, which could be more effective than draconian intervention in importing and retailing activities. The government should also consider moving quickly to allow unrestricted ownership of tanker trucks to all licensed companies.

Greece has come into compliance with IEA stockholding requirements since the last review. This is commendable, and every effort should be made to ensure that stockholding requirements are complied with in the future.

RECOMMENDATIONS

The government of Greece should:

- *Enhance and improve the national strategy for oil exploration and production, given the potential for discovery of domestic oil resources,* e.g. *by conducting a further licensing round for oil and gas exploration to establish the potential of new reserves in Greece.*
- *Monitor the refinery market to prevent potential abuses of market power.*
- *Consider a rapid introduction of already planned tax measures aiming to reduce fraud, and monitor the situation closely, preparing to introduce further tax alignments where these are required.*
- *Remove restrictions on the ownership of tanker trucks where these result in barriers to entry of new retailers and allow import terminals to move towards the most efficient operating regime.*

The Greek gas industry is still in the early stages of development, and the Greek State is heavily involved in the industry through direct and indirect ownership. Gas is a relatively new fuel in Greece and has to compete against lignite and fuel oil in its primary applications. It is expected that all new fossil power generating capacity to be added in Greece will be gas-fired.

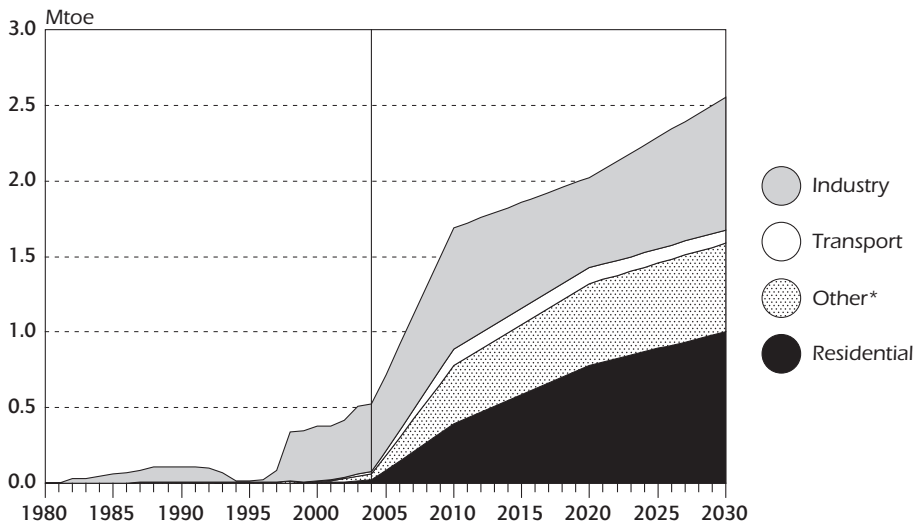
SUPPLY AND DEMAND

Greek supply of natural gas has increased by 28% from 1.7 Mtoe in 2000 to 2.2 Mtoe in 2004. Gas covered 6.8% of total Greek energy supply in 2004, and a conservative estimate is of an increase of its share to 11.7%, or 4.1 Mtoe by 2010, because of increased demand in all sectors of the economy, but primarily as a fuel for power generation. The primary use of gas is in the power generation sector, where 1.6 Mtoe, or 70% of Greek gas was consumed in 2005.

Gas contributed 0.53 Mtoe to Greek TFC in 2004, an increase of 26% over the 0.42 Mtoe it contributed in 2000. In the industrial sector, 0.45 Mtoe, or 85% of TFC, was consumed in 2004. The Other sectors consumed 0.06 Mtoe

Figure 15

Final Consumption of Natural Gas by Sector, 1980 to 2030



* includes commercial, public service and agricultural sectors.

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

in 2004, an increase of 500% compared to the 0.01 Mtoe consumed in 2000, indicating the increasing penetration of gas into the Greek economy, which can also be seen in Table 10. Greek gas demand grew by an average of 11% per year between 2001 and 2005.

Table 10

Greek Gas Consumption by Sector, 1990 to 2003

(in mcm)

Sector/year	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Electricity generation	16	15	14	13	12	11	14	79	418	1 466	1 542	1 519	1 624	1 787
Of which:														
CHP plants	*16*	*15*	*13*	*13*	*12*	*11*	*14*	*28*	*14*	*16*	*37*	*31*	*39*	*26*
Other energy	21	22	20	18	22	21	22	29	34	2	40	37	39	36
Total industry						3	6	82	392	418	396	423	459	545
Of which:														
Thermal use							*3*	*37*	*153*	*234*	*294*	*353*	*372*	*396*
Chemical use						*3*	*3*	*45*	*239*	*184*	*102*	*70*	*87*	*149*
Transport												8	14	15
Other sectors									16	14	16	21	32	56
TOTAL	**37**	**37**	**34**	**31**	**34**	**35**	**42**	**190**	**860**	**1 900**	**1 994**	**2 008**	**2 168**	**2 439**
Of which:														
Gas supply companies									*12*	*13*	*28*	*73*	*118*	*153*
Large commercial consumers												*9*	*14*	*14*

Source: Ministry of Development.

DOMESTIC PRODUCTION AND IMPORTS

Sources

Domestic production from the Kavala field in the Aegean was 0.03 Mtoe per year in 2003, covering approximately 1.5% of Greek gas supplies, and is expected to decline further.

Greek gas imports are via pipeline from Russia (through the Ukraine, Moldavia, Romania, and Bulgaria) covering 80% of import demand, and as LNG from Algeria, covering 20% of import demand. It is currently expected that, by 2007, gas supply requirements in Greece will go beyond the combined volume of the existing import contracts. To help diversify the import sources, a new pipeline will be constructed connecting northern Greece to Turkey.

Import contracts have been signed with Russian Gazexport, Algerian Sonatrach, and Turkish Botas. Contract volumes are somewhat flexible, on a take-or-pay basis for a volume range. The contract with Russian Gazexport is running to 2016, and covers up to 2.8 bcm per year at an 80% load factor, while the contract with Algerian Sonatrach runs to 2020 and covers 0.51 to 0.68 bcm per year. The Botas contract will run for 15 years from the opening of the pipeline, and covers imports from 0.25 to 0.75 bcm per year. In total this gives DEPA a contracted volume of 4.23 bcm per year.

Import Connections and Capacity

A pipeline connection to Russia through Bulgaria exists, and gas originating from Russia enters the system through a 28-inch pipeline that crosses the Greek-Bulgarian border and then connects to a north-south 512-km pipeline. The main high-pressure pipeline then transports the natural gas to the region of Attika.

A pipeline connection to Turkey is scheduled to be operational by late 2006. A pipeline connection to Italy, the Italy-Greece Interconnector (IGI), is in the advanced stages of project studies, and is expected to become operational by the end of 2010 following the signing of a Greek-Italian government agreement on this project in late 2005. Construction is expected to commence in 2008, with a consortium involving DEPA taking responsibility for the construction of the offshore section, and DEPA taking sole responsibility for the onshore section.

Total import capacity in Greece stands at 4.3 bcm per year. Following the coming on stream of projects currently under way, this is expected to increase to 9.3 bcm from 2007, and further expansion plans will take it to 20.5 bcm per year, including a potential 8 bcm per year, that are expected to transit Greece to be delivered from Turkey to Italy. The 2007 import capacity is expected to be up to three times the expected demand volume in Greece. Table 11 shows the current and planned expansion by import point.

An expansion of the Revithoussa LNG terminal is planned by the 1st quarter of 2007. The project will lead to an increase of the unloading rate from 3 500 to 7 250 m^3 liquefied natural gas (LNG) per hour; to an increase of the maximum send-out rate from 3.8 mcm to 14.2 mcm of natural gas per day; and to an effective increase in the annual send-out capacity from 1.5 to 3.5 bcm of gas per year. The project also includes a plan to improve the energy efficiency of the terminal by the installation of a combined heat and power production (CHP) plant to provide for power and thermal needs of the terminal.

Table 11

Greek Gas Import Capacity by Import Point

(in bcm per year)

Location/year	*2006*	*2007*	*Further expansion*
Greek/Bulgarian border	2.8	2.8	4.5[1]
Greek/Turkish border	n/a	3.0	11.5[2]
Revithoussa LNG	1.5	4.5	4.5
Total	**4.3**	**10.3**	**20.5**

1. According to the planned upgrade of the fiscal metering station at the Greek-Bulgarian border.
2. Includes 8 bcm per year for transit to Italy.

Source: DEPA.

INDUSTRY STRUCTURE

General

The main gas company, DEPA, which is currently the only importer of gas, is responsible for the running of the high-pressure network, and owns 51% of the regional gas distribution companies (EPAs). DEPA was established in 1988 and started commercial operations in 1996. It completed the Revithoussa LNG terminal in 1999. DEPA is the owner of all fixed gas assets in the Greek gas system, and its gas network is now covering the main centres of population in Greece.

The Greek State owns 65% of DEPA, while the remaining 35% are owned by Hellenic Petroleum, and 35% of Hellenic Petroleum is in turn owned by the Greek State. The PPC has an option to purchase 30% of the shares of DEPA from the Greek government. There is currently no indication on whether the PPC will exercise this option.

During 2006, DEPA's transmission and system operation business will split into a company called DESFA, of which DEPA will continue to be sole owner, in accordance with EU market directives. The new company will become the owner of the Greek high-pressure gas transmission system, and will be responsible for its future development and operation, including the provision of access to the gas network on the basis of published TPA tariffs under regulation by the RAE and the Ministry of Development.

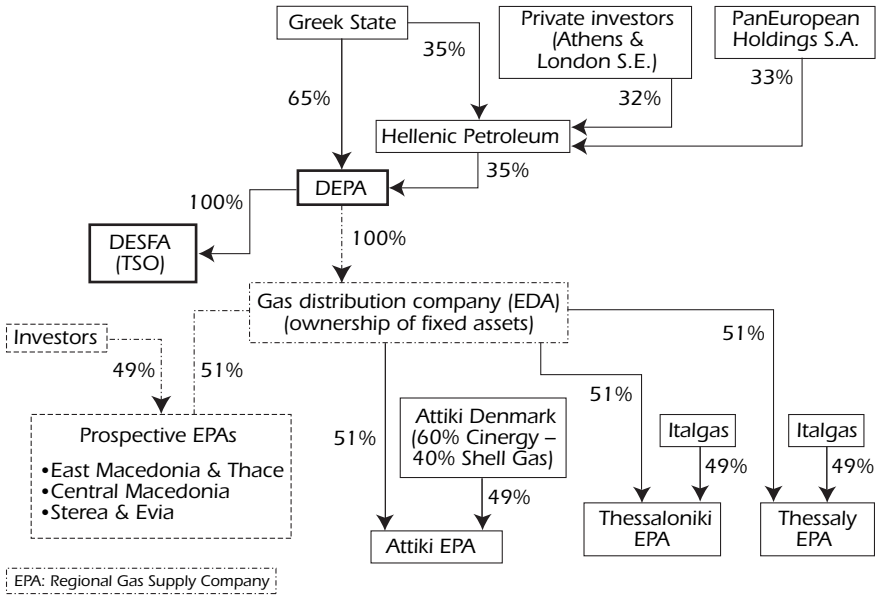
Private companies have the right to construct and operate upstream natural gas infrastructure such as LNG terminals or high-pressure pipelines, but none have as yet been constructed. Construction of low-pressure pipelines for the EPAs has been conducted by private companies on a contractor basis.

Russian gas company Gazprom has set up the joint venture Prometheus Gas S.A. with the Greek Copelouzos Group for the direct sale of gas in the Greek market.

Figure 16

Corporate Structure after DEPA's Legal Unbundling

(up to end-2006)*



*assuming the PPC is not exercising its option to acquire 30% of DEPA's shares from the government.
Source: DEPA.

Wholesale

Until the end of March 2006, the regulated TPA tariffs required under the Law 3175/2003 were not published. With Ministerial Decision 4955 of 27 March 2006, these tariffs came into force, enabling the development of a natural gas wholesale market in Greece.

Downstream

The Greek downstream market for customers below 10 mcm annual demand is serviced by regional monopolies called EPAs, whose prices are controlled by the RAE. They cover the areas of the Attika peninsula, Thessaloniki, and Thessaly. Following restructuring of DEPA under Law 3428/2005, 51% will be owned by EDA, a subsidiary of DEPA which owns the fixed assets with which the EPAs operate. The remaining 49% are owned by international companies. EPA Attiki is partially owned by a consortium of Cinergy and Shell Gas, and the other two EPAs are partially owned by Italgas. EDA has to pay 10% of its dividends to the local authorities covering the regions in which it owns gas distribution assets.

In exchange for their commitment to increase the coverage of gas in Greece, the EPAs have the exclusive right to supply customers with a gas demand below 10 mcm per year and are located within their concession areas for a

period of 30 years from the start of their licence in 2002 (see box below). The government is likely to establish three new EPAs before the 2009 date for full market opening with similar concession principles, but shorter concession periods, of 20 years. The new EPAs would be set up through a tender procedure inviting private participation in the areas of Eastern Macedonia and Thrace, Central Macedonia, and Sterea Hellas and Evia.

Table 12

Forecast for Existing EPA Meter Connections by 2010

Sector	*EPA Attika*	*EPA Thessaloniki*	*EPA Thessaly*	*TOTAL*
Domestic[1] & commercial	102 177	102 419	23 564	228 160
Industrial	146	64	52	262
Total	**102 323**	**102 483**	**23 616**	**228 422**

1. Domestic customers: The figures represent the number of meter connections. About 80-90% are central heating connections to blocks of flats with an average of 8 flats per block.

Source : EPAs.

EPA Attiki

EPA Attiki is the most important of the three EPAs that were set up by DEPA in 1995 and partially sold off in 2000. Its concession covers the Attika prefecture. The new EPA started operations in late 2001, with a concession period of 30 years. The operations of the EPA Attiki cover the marketing of natural gas as a fuel, the extension of the gas network, and the sale to clients connected to the natural gas network. In the case of new installations, the EPA Attiki undertakes an eligibility survey and installs the gas meter. Third parties undertake the gas equipment installation.

As a condition of the concession, EPA Attiki has to develop the low-pressure distribution network in Attika to a length of at least 3 000 km by 2008. In exchange for this investment, EPA Attiki has the exclusive right to supply all residential customers and those with a demand of <10 mcm per year. Customers with a demand of >10 mcm per year are supplied directly by DEPA, or following market opening will be eligible to procure their supply on a competitive basis.

EPA Attiki has the right to create a supply business to operate in the market segments opened to competition and it intends to enter this market. This would mean that it enters into direct competition with DEPA. To prevent barriers to competition in such a case, the operations of EPA Attiki are protected by a Chinese wall and accounting separation from contact with DEPA.

EPA Attiki is procuring its gas under a take-or-pay contract from DEPA. The minimum quantity that EPA Attiki has committed to, under the terms

of its contract with DEPA, is 10 000 GWh of gas by 2010. The annual contract quantity has to be notified to DEPA 19 months in advance, putting considerable pressure on the forecasting abilities of EPA Attiki. In 2002 EPA Attiki had notified 3 300 GWh for 2004, which has turned out to be far too optimistic. EPA Attiki does not expect to go beyond volume sales covered by the contract with DEPA before 2013.

DEPA holds 51% of the shares of EPA Attiki through its wholly-owned subsidiary EDA, but the management of EPA Attiki is undertaken by the consortium of Cinergy and Shell Gas and Power owning the remaining 49%. DEPA has no influence on the operational management of EPA Attiki.

When EPA Attiki was created in its current form, it took over 190 employees from the existing gas distributor, DEFA, and the operation of a network of 500 km commissioned and 700 km non-commissioned low-pressure pipelines. Connected to this network were 8 500 consumption meters, roughly 50% of those supplying central heating installations in apartment buildings, with the remainder in small commercial premises and public buildings. Only 14 customers had an annual demand above 100 thousand cubic metres per annum. A total of 43 mcm of natural gas were sold annually. By the end of 2005, EPA Attiki supplied 30 000 consumption meters in the small consumer category, and around 200 to larger users. The network reached 2 000 active km length in total, of which 800 new km were constructed and 700 km of non-commissioned network were activated. It covered approximately 30% of the potential households on the current active network, while annual sales had reached 125 mcm, an increase of 82 mcm, or 190%, compared to 2002.

The expansion to reach these numbers had only commenced in 2004, with a two-year delay, due to problems in marketing gas connections, which had to be overcome by a large-scale marketing campaign, including incentive campaigns such as "natural gas of a value of EUR 400 for free" or "50% off on connection fees". The number of employees now stands at 300, and by the end of 2005 the company has succeeded in being at break-even operating level with sales of EUR 50 million. Compared to the original business plan, EPA Attiki is roughly 18 months behind schedule, but expects strong growth over the coming three years to 2009. The total potential for EPA Attiki is now estimated at 525 000 metering units, equalling about 1.2 million households, with an annual demand of 1.2 bcm.

Pricing for gas is undertaken on a "competitive fuel" basis, *i.e.* the price for gas is set in relation to the price for competing fuels. The price calculation is based on allowing the recovery of cost for the switch to gas within three years in the case of a block of flats. To allow natural gas to compete in the individual household sector, the removal of the heating period tax break for heating oil is of high importance to EPA Attiki's business plans (see Chapter 3).

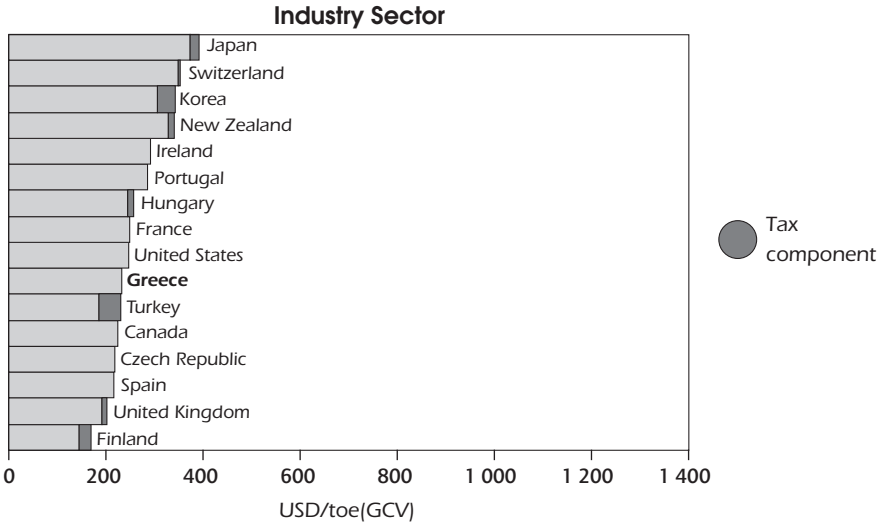
Figure 17

Gas Network in Greece, 2005

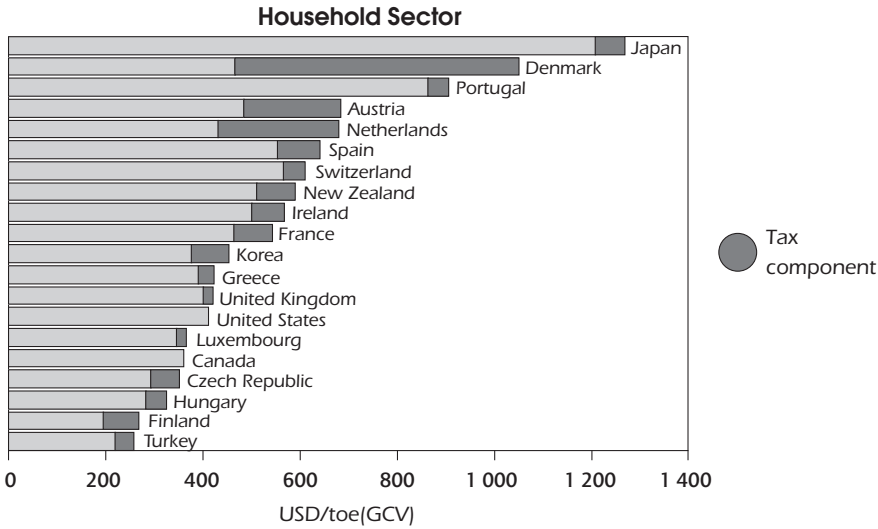
Source: *IEA*

Figure 18

Gas Prices in IEA Countries, 2004



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



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

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

REGULATION AND MARKET LIBERALISATION

The regulation of the gas market in Greece is carried out by the Ministry of Development together with the RAE. The ministry is responsible for decision-making on licences and, together with RAE, for setting access fees in the upstream sector of the market, and exercises the ownership functions of DEPA. The RAE is responsible for the economic analysis, making recommendations to the ministry relating to decisions to be taken by the minister. The RAE is solely responsible for the control of prices proposed by the EPAs.

Greece has benefited from a derogation to the implementation of the 2nd EU Gas Market Directive because of the emerging nature of the Greek gas market. First steps towards liberalisation were undertaken in 2003 with Law 3175/2003. The law opened the market for power producers and co-generation operators with an annual consumption above 25 mcm as of 1 July 2005. This meant that over 60% of the Greek market (by volume sold) had in theory been liberalised.

The law also allowed TPA to the high-pressure gas network on the basis of a published tariff. To achieve real market opening through the law, it would have been necessary to publish the network access tariffs for third-party suppliers, and these were only published in March 2006.

The network access tariffs have been developed by the RAE, and were approved by the Ministry of Development. One tariff is for access to the gas network, and the other for access to the LNG terminal. The proposal submitted by the RAE is for tariffs based on the following characteristics:

- Cost recovery of the regulated asset base and the weighted average cost of capital over 35 years.
- Geographically uniform tariffs, treating Greece as one zone.
- Capacity/commodity split of 90/10[6].
- Transportation system tariff set to recover 100% of transportation and 90% of LNG required revenue[7].
- LNG terminal tariff set to recover 10% of LNG required revenue.

Prices in the downstream segment of the market covered by the EPAs are directly approved by the RAE, and changes have to be communicated to customers on 1 November of any year. Customers then have the right to cancel their contract or refer to the RAE for arbitration. Should price changes become necessary during the year, they also have to be approved by the RAE.

6. This arrangement covers the cost of infrastructure expansion, and reflects the take-or-pay nature of the gas import contracts.

7. This set-up charges most of the cost for the operation of the LNG terminal to all system users and indicates that the LNG terminal plays an important role in balancing the system.

The Law 3428/2005 also sets the framework for the transposition of the EU Gas Market Directive into Greek law. It establishes the timetable for the progress of liberalisation in the Greek market as shown in Table 13 below, and breaks liberalisation into four phases.

The domestic market restricted in phases 2 and 3 refers to consumption below 10 mcm per year, and includes small commercial demand sites. The practical liberalisation of this segment of the gas market will depend on whether a customer is located in the area covered by an EPA. The concessions of the existing EPAs run to 2031, and new EPAs may be given 20-year concessions on similar terms. The existing EPAs already cover a large part of the <10 mcm market in Greece, and once additional EPA concessions have been offered, it is likely that the opening of the <10 mcm market will be mainly a formality, with no real consequences for competition.

Table 13

Timetable for the Liberalisation of the Greek Gas Market

Phase	*Annual demand*	*Date of eligibility*	*Share of market by volume*
1	Power producers and co-generators with demand >100 GWh per year and the new EPAs	Publication of Law 3428/2005	80%
2	Non-domestic customers outside EPA licence and CNG customers for vehicles	15 November 2008	85%
3	All domestic customers not covered by EPAs	15 November 2009	90%
4	All customers	End of the EPA concession period	100%

Source: DEPA.

SECURITY OF SUPPLY

With increasing gas demand, security of gas supply will become of higher importance to Greece. The government has undertaken some steps towards ensuring the security of gas supply through diversification, by the planned construction of a pipeline connection to Turkey through which gas from the Caspian Sea region and/or from Iran will be able to reach Greece. Furthermore, work is progressing on increasing the release capacity of the Revithoussa regasification plant to enable it to contribute more gas flow if required for system balance reasons. Also, regulations are in force obliging gas-fired power generators to have alternative fuel stored on site, to avoid a twin interruption of gas supply and power generation should there be a failure of gas supply.

No procedures are currently in place to govern the disconnection of large interruptible users such as power stations, and to ensure close co-operation between the gas and electricity transmission system operators in the case of such an event.

In terms of storage, Greece is not yet well equipped. Geological storage is difficult in Greece owing to the nature of the country's geology. The only possibility would be the conversion of the exhausted Kavala offshore gas field into a storage facility. This could allow the storage of up to 300 mcm, or roughly 40 days consumption at the expected 2006 demand level. For financial reasons, and because of a lack of immediate need, no work is undertaken on this possibility. An alternative to geological storage would be co-operation with Italy, if the planned Italy-Greece Interconnector (IGI) is realised as a two-way connection. The project is currently in the study phase, and no decision on this has been taken. The main existing storage facility is the Revithoussa regasification plant which consists of:

- Installations for the reception and mooring of LNG tankers with a capacity of up to 130 000 m^3 of LNG.
- Two LNG storage tanks, each with a capacity of 65 000 m^3 (useful volume, minimum to maximum level).

CRITIQUE

Greek demand for natural gas is increasing, driven primarily by gas use in power generation and industry. Demand in the residential and commercial sectors is also increasing, and DEPA, as well as the regional distribution companies, are unable at this stage to satisfy immediately all the demand in terms of connections because of a lack of contractors able to undertake the work. The successful penetration of natural gas into the energy supply in Greece is commendable because it helps to diversify the sources for Greek energy supply, and contributes to a reduced environmental impact of energy consumption.

Gas supply in 2005 was considerably less than was forecast at the time of the last review in 2002, when it was expected that gas supply would reach 4.6 Mtoe by 2005. The reason for this discrepancy is the failure to construct all the licensed natural gas-fired power stations in the intervening period because of the high international prices of natural gas, and a lack of long-term certainty regarding electricity market reforms for potential investors in the market, leaving only a privately-owned peaking plant of 150 MW in Viotia that was commissioned in 2004, the first unit of the Hellenic Petroleum 400-MW CCGT in Thessaloniki that was commissioned on 23 December 2005, and another unit of PPC's 400-MW CCGT in Lavrion (Attika region) commenced operation in May 2006. With the tender for 900 MW of new gas-fired electricity capacity, of which the first tranche has been opened to bidding, it can be expected that natural

gas supply will more rapidly increase in the future, even though the volume predicted for 2005 may only be reached in 2010. The Greek government should consider analysing what barriers led to the shortfall in gas demand compared to the predictions, and remove those barriers it can affect. Particular consideration could be given to the prioritisation of natural gas infrastructure in spatial planning. Increasing regulatory certainty about the future rules and prices in the gas market, *e.g.* for network access, may also bring forward investment in fuel conversion to gas and new gas-fired power generation.

DEPA is procuring its gas under long-term take-or-pay contracts from Russia (pipeline) and Algeria (LNG). A pipeline to Turkey is being constructed to open the possibility to bring in gas from the Middle East and the Caspian Sea. DEPA is also studying the construction of a pipeline connection to Italy which will most likely serve only as a transit pipeline. The effort to diversify supply and increase international interconnections is highly commendable. Care should be taken in ensuring a match of contracted gas supply volume and Greek domestic demand. At the moment, it appears that Greece will have significant overcapacity in import connections, and the Greek government and the RAE should observe the market to ensure that the cost of excess investment in infrastructure is not passed on to consumers, but is borne by the investors in the projects.

Since the last review, Greece has also made commendable progress in laying the foundations for the restructuring of the natural gas market. The Law 3428/2005, which was accepted by the Greek Parliament in December 2005, establishes the basic framework for the future operations of the Greek natural gas market. It is now important for the Greek government and the RAE to focus on the rapid implementation of the provisions of the law and of the previous Law 3175/2003. The full implementation of the liberalisation laws has the potential to increase competition in the Greek gas market for the benefit of Greek consumers, and lead to higher demand for gas.

RAE is the regulator of the gas market, and is responsible for the development and publication of network tariffs. Currently, the gas section of RAE is understaffed, and this has contributed to the significant delay in the development of third-party network access tariffs, which have only just been published with a delay of almost three years. With the increasing liberalisation of the Greek gas market, it is now a matter of urgency to increase the staffing at RAE's gas section to ensure proper regulation of the industry.

To increase the coverage of the low-pressure network, long-term monopoly licences were given to three regional distribution companies (EPAs), meaning that household and small commercial customers in the areas covered by them will not become eligible to switch their gas supplier until the licences run out in 2030. The current licences cover a significant part of all households in Greece, and approximately 10% of gas volume sold in Greece. While a concession approach has clear merits in a developing market, it does effectively shield the

domestic and small consumer market in Greece from being opened for competition while the concessions are valid. Care should be taken that the planned establishment of three new EPAs does not impede the development of retail competition more than is required to ensure the continued growth of the low-pressure gas network.

The EPAs are partially owned by a subsidiary of DEPA. While there is no indication at present that DEPA is influencing the management of the EPAs, the Hellenic Competition Commission, the RAE and the government should exercise vigilance in ensuring that full operational separation is preserved with the progressive opening of the Greek gas market to enable the EPAs to develop into competitors for DEPA in the liberalised segments of the market.

The EPAs are also committed to take gas from DEPA up to a maximum volume. Only beyond this volume are they free to procure their gas on the open market. It is expected that this volume will only be reached after 2013. When setting up the new EPAs, the government should consider keeping these volume commitments low, or not requiring them at all, to ensure that the new EPAs can contribute to the development of competition in the Greek market by being allowed to choose their gas supplier. To ensure that the EPAs can compete against DEPA once the >10 mcm per year segment of the market is opened in Greece, the RAE and the government should set up mechanisms ensuring transparency of price formation for the gas sold from DEPA to the EPAs.

The mostly state-owned electricity company, PPC, holds an option to purchase 30% of the shares of DEPA from government. PPC is also the largest customer of DEPA and a competitor to DEPA's other owner, Hellenic Petroleum, in the electricity market. Future new entrants into the power market, such as Motor Oil Hellas, are required to use natural gas as fuel for their stations under the conditions of the HTSO tender. In this situation, a part-ownership of DEPA by PPC and Hellenic Petroleum gives rise to concern that the incumbents in the power sector would hold control over the fuel supply of their potential competitors. This is particularly problematic in view of PPC's existing extensive rights for lignite mining, because this is the main competing fuel for power generation in Greece. (See also Chapter 9 on Electricity)

PPC also benefits from a "most-favoured customer" clause for its gas supplies from DEPA. This clause is described as a normal commercial arrangement by DEPA, offered to its largest customer (PPC accounts for 70% of DEPA's sales by volume). The clause stipulates that if another customer negotiates a lower price than PPC with DEPA, DEPA will have to offer the same price to PPC. While the clause may have been justified in the past, with the opening of the gas market it will become an impediment to competition, especially if distance-related charges for access to the gas network were introduced. The clause also puts PPC into a position to immediately know the generation fuel cost of any competitor who manages to negotiate a lower price, and may give

it an indication of cost of fuel supply for other competitors. The government, as the major shareholder of PPC and DEPA, should therefore consider a removal of the clause as part of the restructuring of the gas market.

The proposed transportation system tariff is heavily weighted towards the cost of infrastructure. While this adequately reflects the current concerns of the high cost of infrastructure expansion, in the future the situation may change and the tariff may no longer be adequate. The RAE and the government should carefully observe the market development to ensure that the transportation tariff remains adequate to Greek needs. Countries with mature markets, such as Spain, usually apply a 50/50 tariff split to avoid to unduly encourage the use of gas and the building of infrastructure that may not be required.

Gas-fired power plants are obliged under the terms of their electricity authorisations to hold distillate backup fuel supplies for five days of operation. Also, the new Law 3428/2005 provides for the drafting of an emergency plan in the framework of the Network Code. Nevertheless, with the growing importance of gas in the Greek fuel mix, such an emergency fuel switching plan will certainly become necessary in the future. Such an emergency plan should become part of the long-term energy strategy.

Greece currently has no storage facilities other than the two tanks at the Revithoussa regasification plant, and the ability to store gas in the pipelines through pressure adjustment. Greece only has 14 days of gas storage at average demand, which is very low compared to the EU average of 30 days. Gas is, however, not yet widely used in Greece outside the power sector, and if gas demand for power generation is not considered, the tanks of Revithoussa represent 34 days of gas storage at average demand. It is particularly space-heating demand which creates much of the seasonal variation seen in *e.g.* the North of Europe, and this demand is not yet strong in Greece. As the gas market grows, Greece should be vigilant that enough short-term storage is present to satisfy both space heating and peak power demand which will also be met increasingly from gas-fired generation. It is also worth bearing in mind that, as a growing transit country, Greece has some options not available to other countries to obtain flexibility. For instance, it might in future be able to obtain flexible short-term gas supplies from the offtake of relatively small fractions of transit gas.

There are no plans by the Greek government to construct large-scale storage facilities. Studies by DEPA have shown that the geological and seismological conditions of Greece are not conducive to developing storage. One of the potential options would be to convert the depleted offshore gas field at Kavala into a storage facility. Another possible solution that could be considered is to give the proposed IGI pipeline connection to Italy reverse flow capability to allow gas to flow from Italy to Greece, and to then consider the joint development of storage with Italy.

RECOMMENDATIONS

The government of Greece should:

- *Continue to promote the development of critical gas infrastructure, such as pipelines, by* e.g. *prioritising them in spatial planning.*
- *Study the possibility to introduce zonal access charges to the transmission system.*
- *Strengthen the gas sector regulation division of RAE.*
- *Evaluate the impact of the creation of new distribution monopolies on the introduction of retail competition in the gas sector.*
- *Ensure the independence of the existing EPAs from DEPA to allow them to compete freely once the market is further opened.*
- *Remove the "most-favoured customer" clause between DEPA and PPC.*
- *Establish an emergency plan taking into account the projected demand increases for gas and the role gas will play in power supply in Greece in the future.*

CURRENT AND HISTORICAL PRODUCTION

Renewable energy plays a significant part in Greek energy production, and is primarily based on large-scale hydropower stations operated by the PPC. Renewables contributed 5.7 terawatt-hour (TWh) (or 9.7% of total electricity generation of 59 TWh) in 2004. Supply of combustible renewables and waste is treated as a fixed volume by the Greek government for statistical reasons, and there are therefore no reliable figures available. In 2004, sales of new solar water-heating systems were estimated at a total capacity of 179 kW peak thermal (kWpth), increasing total installed capacity to approximately 2 GWpth, meaning that Greece has the second-highest installed solar thermal capacity in the EU after Germany.

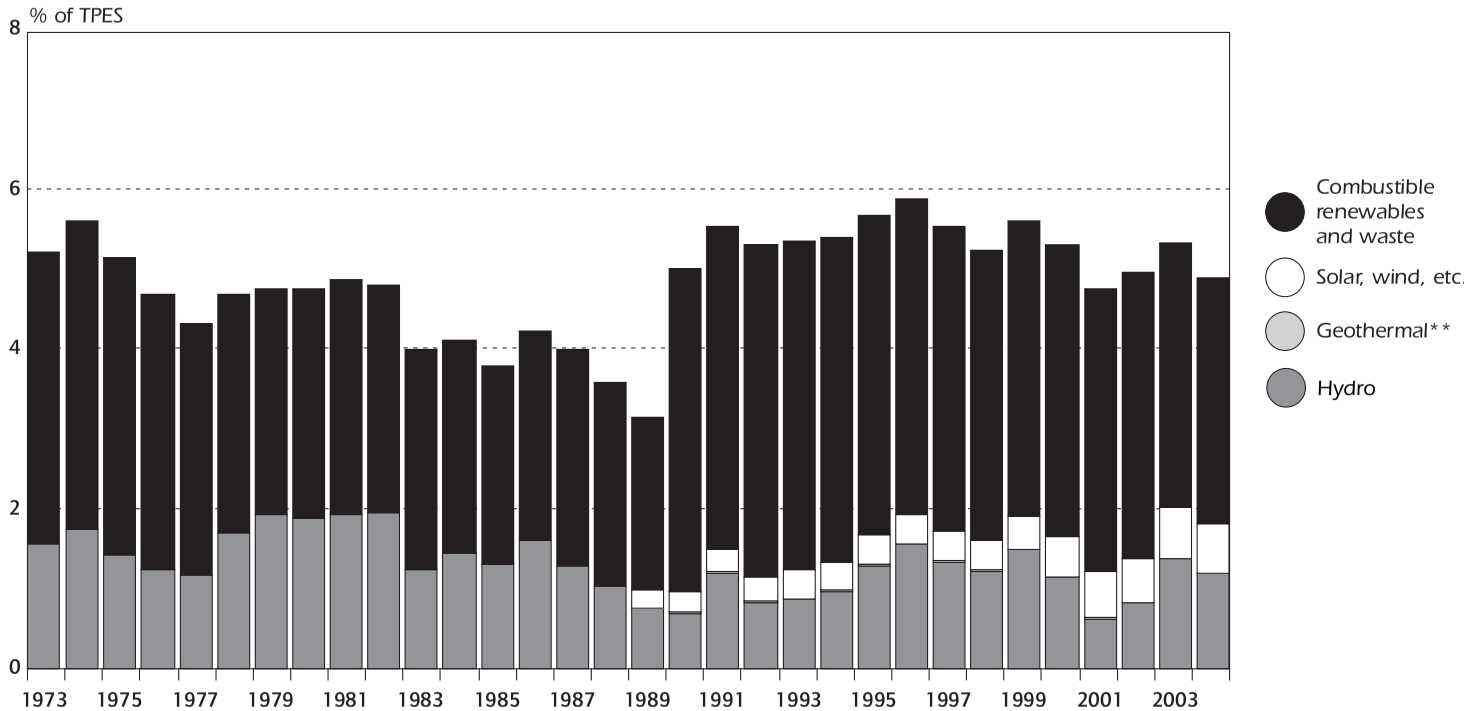
New renewables such as wind, solar, small hydro, and biomass have increased rapidly in recent years, but still contribute only a small share of 1.6 Mtoe to the total energy supply, or 4.9% of 32.74 Mtoe TPES in 2004. The total installed electrical capacity of new renewables in 2006 is 683 megawatts (of which 522 MW is interconnected). Of this, 85% is wind, 11% small hydro and the rest is solar, biomass and PV. Additional installation permits have already been granted for 1 000 MW of capacity (87% of this for wind), and about 20% of this capacity is under construction. The target for installed wind capacity is 3 000 MW by 2008.

Since 1995, the development of renewables in Greece has focused on new renewables, and no new large hydro capacity has been added since the last review. The primary developments are taking place in the wind energy sector where capacity has increased by an average of 30% annually in terms of capacity between 1990 and 2003 (see Figure 19), while almost 30% of total capacity was installed during the period 2004-2005. The PPC runs 15 large-scale and seven small-scale hydroelectric schemes with a combined installed capacity of 3 066 MW and a nominal output of approximately 4.4 TWh per year. The PPC also holds a licence for the development of two fully explored geothermal resource fields with a potential capacity of 170 megawatt of electrical capacity (MW_e), and is expected to develop this capacity in the future. Twenty-four small hydro projects not owned by PPC totalling 18.8 MW and yielding 0.06 TWh per year were in operation in 2004.

Most existing Greek renewable energy projects are relatively small in scale. In 2005, 11 new wind farms were installed, with a total capacity of 100 MW and an average capacity of 9.2 MW. Disregarding two very small developments on non-interconnected islands and four slightly larger

Figure 19

Renewable Energy as a Percentage of Total Primary Energy Supply in Greece, 1973 to 2004*



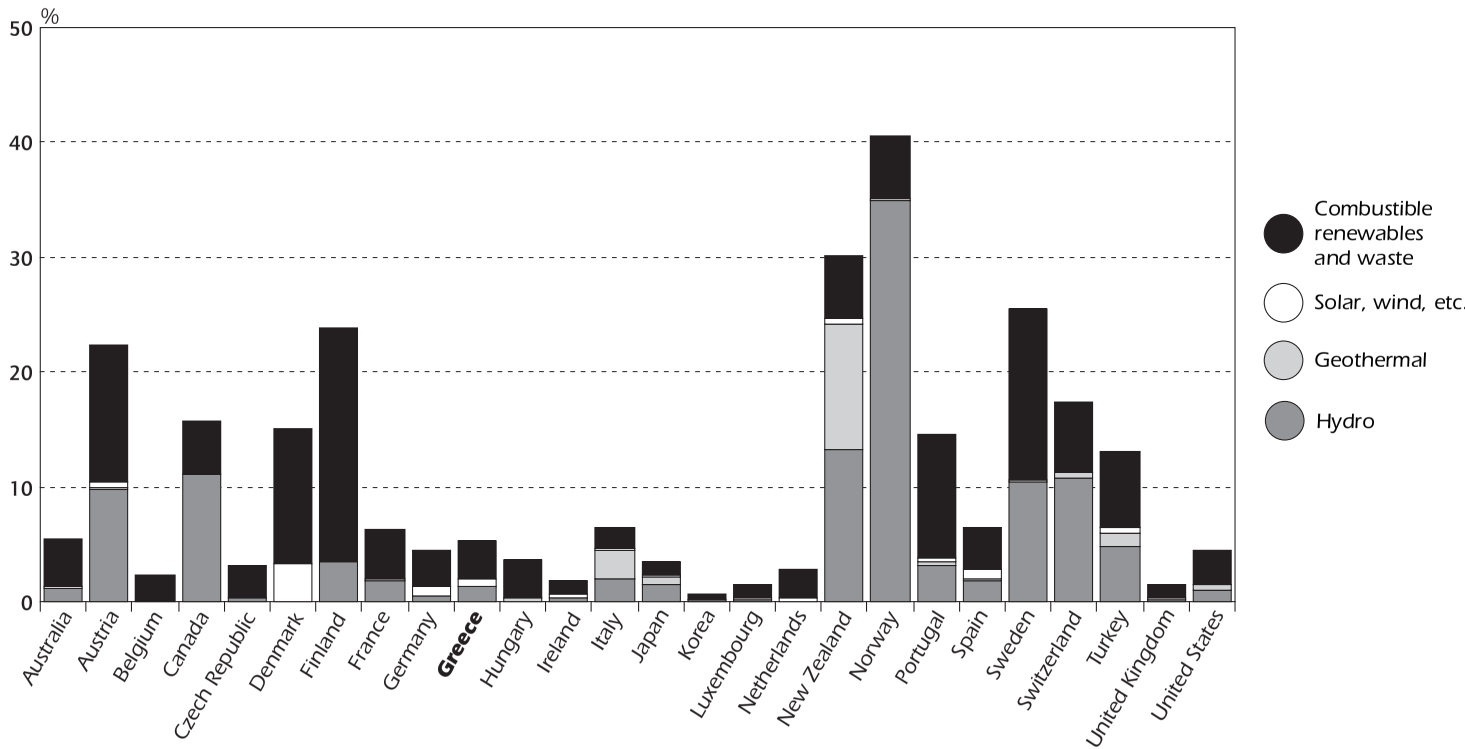
* 2004 = provisional.

** negligible.

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

Figure 20

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Countries, 2004*



* 2004 = provisional.

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

developments on Crete, the average size of wind farms connected on the mainland was 17 MW. The largest wind farm connected in 2005 was at Ermioni with a capacity of 36 MW, and the smallest on the Cyclades islands with 0.6 MW. It has not been legally possible to construct offshore wind farms in Greece until now.

Table 14

Renewable Electricity Capacity and Production, 2004

Type	*Generation capacity in MW*	*Generation amount in GWh*
Electricity only		
Large hydro (excl. pumped storage)	2 377	4 581
Wind	470	1 121
Landfill gas	22	78
Solar	1	1
CHP	57	261
of which:		
Industrial waste	*33*	*139*
Sewage sludge gas	*11*	*29*
Landfill gas	*13*	*93*

Sources: *Renewables Information 2005,* IEA/OECD Paris, 2005; Ministry of Development.

Table 15

Total Wind Deployment in Greece by Region and Capacity, 2006

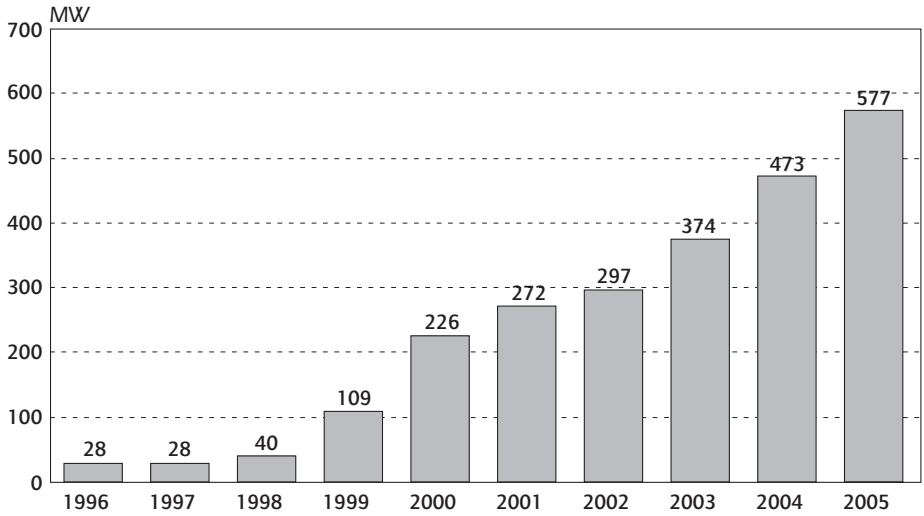
Region	*Capacity in MW*	*Share of total in %*
Mainland		
Peloponnese	37.9	
Euvoia	204.5	35.4
East Macedonia & Thrace	180.4	31.3
Total mainland	**422.8**	**73.3**
Islands		
Crete	105.4	18.3
Aegean Islands and Dodecanese	48.8	8.5
Total Islands	**154.2**	**26.7**
Total	**577.0**	**100.0**

Source: Ministry of Development.

Figure 21

Annual Growth of Wind Generating Capacity in Greece, 1995 to 2005

(in MW)



Sources: Ministry of Development.

GRID CONNECTIONS

Connecting to the grid is on the basis of deep charging. The new generator has to pay all the costs of the connection, *i.e.* the line, changes at the substation, and, if required, reinforcement at the higher level of the grid. The work is carried out by grid owner PPC or by the generator wishing to connect. If reinforcement work leads to capacity improvements in the grid beyond those required by the applicant, a recovery mechanism is in place whereby new connections within five years of the reinforcement are charged even though no reinforcement work is required for them, and the money is then reimbursed to the original developer funding the reinforcement work.

The RAE recently launched a call for tenders concerning a preliminary study on the interconnection options and planning for renewables for the non-interconnected islands, where a high potential for renewables exists. The construction of such connections would enable the addition of further renewables capacity on islands where grid constraints are currently preventing this.

LICENSING

A series of licences and authorisations need to be obtained for the construction and operation of a RES system (see Figure 22). The three basic permits are the

generation, installation and operation permits. The new law for the promotion of renewable energy sources, in combination with the amended joint Ministerial Decree 1726/2003 provide for a simplified, more efficient and accelerated process regarding the issue of new licences, especially the installation permit, where issue could take up to 24 months. In addition, the new law provides for the set-up of co-ordinating bodies, both on a civil service and a political level, aiming at the co-ordination of the licensing process control and the support of the authorities involved.

The RAE undertakes the first evaluation of a generation licence application pursuant to the EU Directive 2001/54/EC, which is the first of the three basic permits in a long series of central government and local authority approvals. The actual issuing of generation licences is carried out by the Minister of Development. It is easy to apply for a licence, but the process of awarding this is more complicated and over 90% of applications fail at the first stage. According to the new law, the evaluation process includes the preliminary environmental impact assessment (which used to be part of the Installation licensing and requires authorisation by several local authorities) and is based on a series of objective criteria such as the investor's technical and financial capability and the project's viability. The RAE formulates proposals to the Minister of Development recommending for or against the issuance of a power generation licence. Once a licence has been issued, the RAE monitors the implementation progress of the projects through quarterly reports and recommends the removal of those investors who are not progressing satisfactorily.

The next step in the licensing process is the acquisition of the installation permit which, according to the project's level of environmental impact, is issued by either the General Secretary of the Region or by the Minister of Development and requires approval of the project's environmental terms and conditions. Last comes the operation permit, following the entering into contract (power purchase agreement) with the system operator.

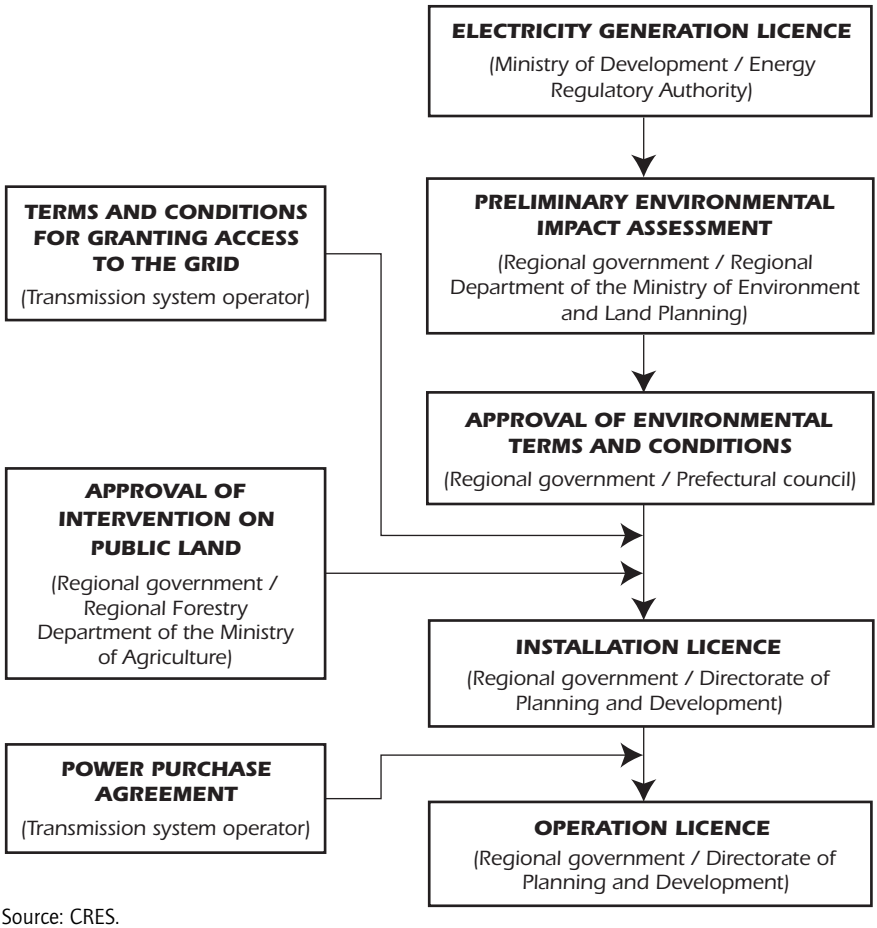
FUTURE DEVELOPMENT

GOVERNMENT TARGET AND POTENTIAL

Greek renewables projects show a low realisation rate of approved projects. Until 2005, only 13% of projects that had received a generation licence from the Ministry of Development had started to generate, and a further 5% had begun construction. Administrative, technical, and cultural barriers have a negative impact on the completion rate of licensed projects, and the licensing of new projects.

Figure 22

RES Licensing Procedures and Jurisdictions



Source: CRES.

The target set by the EU Renewables Directive 2001/77/EC for Greece is to produce 20.1% and 29% of its electricity from renewables by 2010 and 2020, respectively, more than doubling its current production, even if overall electricity demand stays unchanged. This new renewables target has been transposed into Greek legislation.

Modelling undertaken by the CRES indicates that the target may not be achieved, with the margin of failure depending on the specific climatic conditions in 2010, especially in terms of rainfall feeding the hydropower stations, and the pace at which new wind capacity can be added by 2010. In the most pessimistic scenario, the modelling predicts that total electricity

production from new renewables in 2010 may likely reach 14.9% under conservative assumptions, 18.1% under medium assumptions, and 19.8% under optimistic assumptions. The variables leading to different outcomes are related to the completion of already licensed projects, the upgrade of the electricity grid, and the increase of interest in renewables outside the current areas of deployment, as well as the future development of renewable energy technologies.

Separate modelling undertaken by the Ministry of Development for its most recent report on renewables in Greece indicates that by 2010 the new renewable electricity contribution will be 4.3 TWh, or 7% of total electricity consumption expected for 2010 (wind 5.5%, small hydro 0.6% and biomass 0.2%). Large hydro may provide a further 8% of the total consumption. Combined renewables may therefore be generating 14.4% of the total electricity consumption, or 70% of the EU target (see Table 16).

On a longer-term basis, modelling undertaken for the *Third National Report on Penetration of Renewables,* published by the Ministry of Development in 2005, indicates that the additional technical potential for renewable electricity supply (RES-E) in Greece is very high, and that almost one-third of the predicted electricity demand in 2020 could be covered by renewables (see Table 16 below). This is a purely technical potential study, however, not taking into account constraints such as grid capacity, economic feasibility, and political resistance against such an increase in renewables supply.

Table 16

CRES Modelling of Renewables Capacity by Technology and Scenario, 2006 – 2010

	Capacity	*Additional capacity (MW)*			*Total capacity 2010 (MW)*		
	2006Q1 (MW)	*Baseline scenario*	*Conserv. scenario*	*Optimistic scenario*	*Baseline scenario*	*Conserv. scenario*	*Optimistic scenario*
Wind	622	2395	1 482	2 645	3 017	2 104	3 267
Small hydro	100	152	111	152	252	211	252
Large hydro	3 018	307	307	407	3 325	3 325	3 425
Biomass	24	47	35	47	71	59	71
Geothermal	0	8	5	38	8	5	38
PV	1	9	6	39	10	7	40
Total	**3 765**	**2 918**	**1 946**	**3 328**	**6 683**	**5 711**	**7 093**

Source: CRES.

Table 17

Government Target for Renewables in 2010 by Technology

	Capacity installed MW	*Electricity generation TWh*	*Planned contribution to target %*	*Estimated contribution 2010 %*	*Estimated gap 2010 TWh*	*Contribution 2004 TWh*	*Gap planned 2010-2004 TWh*
Wind	3 372	7.1	10.4	5.5	3.7	1.0	6.1
Small hydro	364	1.1	1.6	0.6	0.73	0.06	1.05
Large hydro	3 325	4.6	6.7	8.0	–0.35	4.7	–0.1
Biomass	103	0.8	1.2	0.2	0.7	0.25	0.55
Geothermal	23	0.1	0.13	0	0.1	0	0.1
Solar PV	18	0.02	0.03	0	0.02	n/a	n/a
Total	**7 205**	**13.7**	**20.1**	**14.3**	**4.9**	**6.0**	**7.7**

Source: *Third National Report on Renewable Energy,* Ministry of Development, 2005.

Table 18

Achieved and Technical Potential for RES-E in Greece, 2004 and 2020

(in TWh)

Technology	*Achieved (end of 2004)*	*Additional potential technically (2020)*	*Total in 2020*	*Potential as share of 2020 realisable total in %*
Biogas	0.16	1.44	1.6	90
Solid biomass	0	6.22	6.22	100
Biowaste	0	0.44	0.44	100
Geothermal electricity	0	0.22	0.22	100
Large-scale hydro	3.28	1.36	4.64	29
Small-scale hydro	1.26	0.21	0.37	57
Solar PV	0	1.04	1.04	100
Solar thermal electricity	0	2.63	2.63	100
Tidal & wave	0	4.01	4.01	100
Wind onshore	1.12	7.81	8.83	88
Wind offshore	0	2.63	2.63	100
RES-E total	4.62	28.01	32.63	86
RES-E as share of gross electricity consumption 2004	7.4%	44.5%	n/a	n/a
RES-E as share of expected gross electricity consumption 2020	5.3%	31.9%	n/a	n/a

Source: European Union.

GOVERNMENT POLICY AND SUPPORT MECHANISMS FOR RENEWABLE ELECTRICITY

LEGISLATIVE SUPPORT

To achieve the EU target, the Greek government has set up a support system for renewable electricity based on a feed-in tariff and direct investment subsidies through the Operational Programme for Competitiveness (OPC; see Chapter 3), and will introduce preferential spatial planning for important renewables developments.

In a first step to address the issue of administrative barriers, the joint Ministerial Decision 1726/2003 was adopted to act as a forerunner of the "one-stop shop" system recommended in the last review. The decision for the first time established a list of all authorities that were required to give an opinion, thereby clarifying the licensing path for project developers. It also prescribed the exact content of the opinions to be given by each authority, and set a maximum time limit of 90 working days for the issuing of an opinion, excluding the electricity generation licence. Since the decision was adopted, however, it has not been possible to enact it owing to lack of appropriate authorisation in the legal framework. As a consequence, the decision was amended by two new joint Ministerial Decrees that were issued in parallel to the recently voted law on renewables, aiming at tackling the above legal inconsistency and to speed up the licensing procedure and reduce the time required for obtaining the installation permit.

A new law regarding the Promotion of Electricity Generated from Renewable Energy Sources was introduced in June 2006. The measures foreseen by the law try to achieve a range of objectives. They include:

- The simplification of the licensing procedures which should decrease the time needed for all the authorisations.
- Allowing for the licensing of offshore wind farms and hybrid plants on the non-interconnected islands.
- A new set of feed-in tariffs for electricity generated from renewables, placing more attention on solar and PV technologies, where substantial increases were given.
- The creation of special cross-ministerial committees for RES and CHP.
- The implementation of the Guarantees of Origin Directive of the EU for electricity produced from RES.
- The exemption from the obligation of acquiring the generation, installation and operation permits for low-capacity renewable energy plants.

- In addition, until the end of 2006, a special spatial plan for RES in areas of high wind potential will be issued, in order to tackle problems that arise during the installation phase.

The RAE can recommend legislative measures for the further deregulation of the electricity market within which critical RES issues can be addressed (as is the case of hybrid plants) to the Minister of Development. On a more long-term basis, the RAE is expected to consider the potential for an introduction of green certificates and the establishment of a network of greatly dispersed energy production, even though at present the Greek government has not considered activating a green certificates trading system.

FEED-IN TARIFF AND PRIORITY DISPATCH

Under the old Law 2773/99, the HTSO is obliged to give priority dispatch to new renewable electricity producers up to 50 MW in capacity and to enter into a ten-year renewables contract (power purchase agreement) for the purchase of electricity at the published buy-back rates (feed-in tariff). Following the passing of the new law, the 50-MW limit has been eliminated and the duration of the power purchase agreement has been extended to a period of 12 years, with an optional renewal of 8 years.

The new feed-in tariffs for power generated from renewables constitute an integral part of the law (prices are stated in the law) and are no longer connected to electricity retail tariffs as shown in Table 19.

The tariff for new renewable electricity is also split geographically, with one tariff applying to the non-interconnected islands and the other in the interconnected system covering the rest of Greece. The old law was also split by type of producer, with a lower tariff applying to surplus autoproducers (with less than 35 MW of installed capacity) than to independent producers. In the interconnected system, independent producers are expected to always be connected to the medium- or high-voltage levels of the system. They received a capacity payment for being available and a feed-in tariff payment based on the amount of energy they deliver. Surplus autoproducers received a payment based on the voltage level they connect at, and those connected at the high-voltage level were paid a feed-in tariff differentiated by the load condition that applied when they exported their surplus production. Independent producers received a higher payment than surplus autoproducers in any comparable situation. The total cost of the feed-in tariff was estimated to be EUR 0.8/MWh for all electricity delivered in Greece, equivalent to approximately EUR 40 to 45 million per year. Under the new law, the conditions have changed, with independent and autoproducers now being treated equally, and the removal of the distinction by connection level and load condition. The cost of the new feed-in tariff has not been estimated yet.

Table 19

Changes in the Feed-in Tariff for Renewable Electricity in Greece

(in EUR per MWh)

2005 feed-in tariff	*Non-interconnected islands*	*Interconnected system*		
	All voltage levels	*Low voltage*	*Medium voltage*	*High voltage*
Surplus autoproducers	63.56	63.56	51.42	Peak: 33.57 Medium: 23.26 Low: 17.26
Independent producers	81.72	66.11	66.11	66.11

2006 feed-in tariff for electricity produced from:	*Energy price (€/MWh)*	
	Interconnected system	*Non-interconnected islands*
Wind farms	73	84,6
Offshore wind farms	90	
Hydroelectric energy (plants with less than 20 MW of installed capacity)	73	84,6
Solar energy generated by photovoltaic units (with less than 100 kW of installed capacity)	450	500
Solar energy generated by photovoltaic units (with more than 100 kW of installed capacity)	400	450
Solar energy generated by other than photovoltaic units (with less than 5 MW of installed capacity)	250	270
Solar energy generated by other than photovoltaic units (with less than 5 MW of installed capacity	230	250
Geothermal energy, biomass or biogas	73	84,6
Other RES	73	84,6
CHP (high yield)	73	84,6

Sources: Ministry of Development; RES Law, *Government Gazette*.

Compared to other IEA member countries with feed-in tariffs, such as Germany and Spain, the old Greek feed-in tariff was lower, and is distinguished by being uniformly applicable to all technologies[8]. Greek producers also benefited from lower capital expenditure requirements than those in Spain and Germany, because of the possibility of funding through the OPC, and the economic development law.

8. For example, when first introduced in 2002, the feed-in tariffs for wind power in Germany were set at EUR 0.091 per kWh for at least the first five years of operation after commissioning. Thereafter, depending on the quality of the site, the rate is reduced to EUR 0.0619 per kWh. These rates have been subject to annual reductions of 1.5% for new installations; in Spain, the feed-in tariff for wind energy is set at EUR 0.088 to EUR 0.101 per kWh with no digression. In both Germany and Spain the feed-in tariff for solar PV is considerably higher, while that for biomass is considerably lower.

SUPPORT THROUGH THE OPC

The OPC uses funds from the EU's 3rd Community Support Framework to provide aid to renewables projects and energy saving, substitution and other energy-related projects, with a budget of up to EUR 1.2 billion (see also Chapter 3). Public aid can be up to a maximum of 45% of the eligible cost of the projects and may reach 50% in the case of transmission lines that will be constructed for the connection of RES plants with the grids. On the basis of the approved projects, it is expected that installed capacity from new renewables and co-generation will increase by up to 930 MW. This would correspond to an annual energy yield of 3.4 TWh. The annual decrease of CO_2 emissions will amount to a total of 4 Mt CO_2.

CAPITAL GRANT SUPPORT, TAX INCENTIVE AND SPECIAL TAXATION

Overall, the Greek government is aiming at a stable long-term framework to ensure investor confidence in the market. It is, therefore, not considering the introduction of market-based support mechanisms, such as green certificates, at this time.

The Development Law 3299/2004 supports investment activities (including energy investments) of private companies (investment subsidy of about 35 to 55% depending on the geographic region or 100% tax deduction on all RES investment costs for a 10-year period).

A special 2.5% cent (3% after the first 5 years of commercial operation) tax on the pre-VAT revenue is levied on renewable electricity production by the prefecture where the installation is located. The aim of this tax is to provide an income to communities where renewable developments are based, to allow them to share the benefits of the developments, and to thereby overcome local resistance to renewables.

BIOFUELS FOR TRANSPORT

Greece has adopted the target of the EU Biofuels Directive of 5.75% of transport fuel requirements to be supplied by renewable fuels in 2010. Support for biofuels or other renewable fuels for transport has been introduced in Greek legislation (Law 3243/2005), and full tax exemption for the use of biodiesel has been granted to encourage the growth of the sector. The tax exemption applies up to the following volume limit of biodiesel per year: 51 000 cubic meters (cm) for 2005, 91 000 cm for 2006 and 114 000 cm for 2007. The feedstock for the biodiesel currently produced is imported, and the production from the plants is used as feedstock in Greek refineries, with no direct sales taking place. There are as yet no other biofuels in use in Greece.

On the basis of the forecasted transport sector TFC, achieving the EU target would imply a biofuels supply of 560 ktoe per annum. The current production capacity of the biofuels sector in Greece is 80 to 100 ktoe of biodiesel, equal to approximately 1% of total annual transport fuel demand, which means that the indicative EU target for a 2% production in 2005 has not been achieved, and the EU has commenced infringement procedures against Greece regarding this failure.

CRITIQUE

Greek renewables development is positively affected by the country's very good resource potential for renewables deployment, especially for wind and solar, as well as a favourable support system comprising both a feed-in tariff and direct capital grants. For example, the high level of solar irradiation has led to significant capacity of solar water-heating systems being installed in Greece. The Greek renewables sector is also seen as an attractive opportunity by multinational energy companies, and has seen significant investment from companies like the French EDF or Spanish Iberdrola in recent years.

The Greek government's target under the EU Directive for Renewable Electricity is 20.1% of total electricity to be produced from renewables by 2010. Estimates by the government show that this target will not be met at the current pace of deployment, which would only lead to a contribution of 14% to 18% by 2010, even allowing for reduced electricity consumption growth due to enhanced energy efficiency. The wide range of the estimate is explained by the potential of the numbers to fluctuate significantly year on year depending on the importance of hydro generation.

The primary development in new renewables in Greece is in the wind sector, where a good resource exists. Care should be taken to ensure that other renewable sources are developed where this is appropriate, and where they provide an economical alternative. Such support for alternative renewable energy technologies should, however, be undertaken taking cost-effectiveness into account.

Despite the commendable progress made since the last review, and despite the favourable support system in place, Greece still has a significant untapped potential to further develop its renewable energy sources, notably for electricity production.

An area of serious concern is the low completion rate of developments that have already completed the licensing process, and have received the electricity generation licence from the Ministry of Development. So far, less than 20% of these projects have been commissioned or are under construction, indicating that there are significant barriers to the deployment of renewables in Greece that will have to be overcome to achieve the EU target adopted by the Greek

government. An analysis of why individual projects have failed, conducted in the UK three years ago to identify the most important barrier, could help the government in deciding where to focus the effort of removing barriers. Nevertheless, a number of barriers are apparent, those experienced by the developers of renewable capacity in Greece, and the government should consider addressing these as a matter of priority.

A significant barrier to the development of new renewables capacity is an absence of sufficient grid capacity in locations with good renewables potential, and the development of new grid infrastructure is also suffering from legal challenges. This has combined to restrict the development of new wind capacity to a level much below the technical and economic potential. From 2003 onwards, no new renewables capacity could be connected in the Greek regions with the highest economic potential for wind generation because of insufficient grid capacity. The economic potential for these regions is estimated at 1 000 to 1 500 MW capacity by the Greek Association of Renewable Electricity Producers. While HTSO and the PPC have developed plans to reinforce the grid in these regions, projects for grid reinforcement are themselves subject to lengthy delays due to licensing and local resistance. It is uncertain when and if these projects will go ahead owing to legal challenges and the absence of an identification of projects of particular value in planning documents. The Greek government should very quickly consider identifying priority projects in the relevant legislation, to ensure that they can be completed on an accelerated schedule in order to have a better chance to overcome legal challenges.

Local resistance against new developments, in particular wind, is strong, and is conducted both through political and judicial means. A number of rulings on challenges brought against proposed developments at the Greek Supreme Council of State (SCS), the highest court in Greece, are found against renewable and other energy developments such as grid extensions. The local resistance is aided by the ease with which challenges to a project can be filed at the SCS. Appealing to the SCS usually has the immediate effect of halting any work on a development, even if all licences and permits have been issued, until a decision by the SCS has been reached. This takes on average three years, resulting in many cases in the project being abandoned with the complete loss of funds invested in the development stage. The government could attempt to overcome the negative public perception leading to such challenges by conducting a publicity campaign highlighting the benefits of increased renewables deployment in terms of security of supply, fuel diversification and climate change mitigation.

Another serious barrier to the deployment of additional renewables encountered is administrative. A multi-layered approval system and complex bureaucratic processes lead to lengthy licensing procedures. A number of ministries and local or regional authorities are required to give their assent to

a proposed development, in some cases requiring that prior assent from another body has already been received before considering the application. A licensing process of at least two to three years is currently expected by developers, and in some cases licensing has taken so long that the technology on which the original application was based is no longer available owing to rapid technological progress in wind turbine manufacturing. A first attempt in 2003 to simplify the process through a ministerial decision has not had the expected success. The new renewables law may remedy some of the licensing problems.

The administrative barriers are compounded by the absence of spatial planning. This enables local opposition to developments to succeed more easily in challenging an energy project, since it is difficult for the developer to show in court how the project is in the public interest. The government should consider the establishment of a land-use plan clearly identifying priority renewables and renewables-related projects.

While addressing barriers to renewable energy projects, the government should also consider how to make the current scheme more cost-effective. The current costs of the support scheme to the Greek economy are limited by EU structural funds support, and the low completion rate of projects. Once EU support is reduced, and/or the completion rate of projects eligible for the feed-in tariffs increases, the cost to the economy will also increase.

The feed-in tariff has been instrumental in promoting wind power sources. The old system commendably did not have a differentiated feed-in tariff for different types of renewable energy and the risk of "picking winners" by the government is low, but this has changed with the new law. The old level of the Greek feed-in tariff was lower than in other IEA member countries, such as Germany or Spain, but was seen as sufficient by the Greek renewables industry.

With the new renewables law, the support system was fundamentally changed, introducing a more generous level of the feed-in tariff, differentiated by technology. The government should continue to be attentive to the possibility of oversubsidisation while continuing to ensure the confidence of investors through long-term stability of the support framework.

Nevertheless, in trying to further the introduction of renewables in locations with a good resource but weak network capacity, such as the isolated islands, the Greek government could continue to monitor the situation of renewables development, and be prepared to consider the introduction of a special feed-in tariff supporting those developments, in case the new law does not lead to increased deployment.

Given the very good wind resources in Greece, the government should analyse the optimal level of support. In areas with very good wind resources, the current level of the feed-in tariff may be too generous. For example, New

Zealand, where there are good wind resources, does not have any mandatory scheme, such as a feed-in tariff. Furthermore, given the rapid development and cost reduction of wind technologies, the level of the feed-in tariff should be gradually reduced, capturing the benefits of the learning curve. In considering the appropriate level of the feed-in tariff, care should be taken that the support level from other schemes, such as capital grants or tax incentives, should also be taken into account. Introduction of the EU-ETS will improve the competitiveness of wind power, which may also make it necessary to adjust the level of the feed-in tariff. While the contract duration for independent renewables developers is currently set at 12 years, this can be renewed once for 8 years. Guaranteeing prices after amortisation will result in over-subsidisation.

The risk of oversubsidisation could be further reduced by incorporating more market-oriented elements into the support scheme. For example, Denmark has moved from the (fixed) feed-in tariff system to the premium tariff system where the renewables producers receive the wholesale market price plus a fixed premium (which is lower than the fixed feed-in tariff). This premium level is lowered depending on the time of commissioning. A more market-oriented approach is the tradable green certificate scheme used, for example, in Sweden, or the UK, where the support level is calculated on the difference between the production cost and the wholesale market price. Such experiences of other countries should be examined for the future development of the support schemes in Greece.

The introduction of biofuels for transport touches on many policy areas and may have implications for climate policy as well as for security of supply, agriculture, employment and the economy. Two production plants for biodiesel with a capacity of 80-100 ktoe per year (approximately 1% of annual fuel demand in transport, compared to a 2% target by 2005) have been established or are in the planning stages. The feedstock for biodiesel production has so far been imported. A strategy to identify the most cost- and resource-efficient alternatives for the introduction of biofuels in the Greek transport sector, including the use of imported biofuels, may enable Greece to take advantage of the possible benefits of biofuels to a greater extent.

RECOMMENDATIONS

The government of Greece should:

- *Reduce administrative barriers to renewables development by in particular:*
  - *Putting in place a one-stop shop for licensing renewables projects.*
  - *Establishing clear guidelines for authorisation procedures with a clear attribution of responsibilities to all institutions involved.*

- *Establishing pre-planning mechanisms that require regions and municipalities to assign locations for renewables (spatial planning).*
- *Introducing more simplified procedures for small projects.*

- *Ensure grid access and infrastructure availability.*
- *Optimise the current feed-in tariff scheme to improve cost-effectiveness, with a view to reflecting the technology learning curve and limiting the duration of the subsidy, while ensuring investor confidence.*
- *Consider incorporating more market-oriented elements in the national renewables support scheme, taking into account the experience of other countries.*
- *Develop renewables other than wind that could be appropriate for Greece, in particular geothermal, biomass, photovoltaics and biofuels, paying attention to their cost-effectiveness.*
- *Formulate a comprehensive strategy and policy framework for the introduction of biofuels in order to take advantage of their possible benefits.*

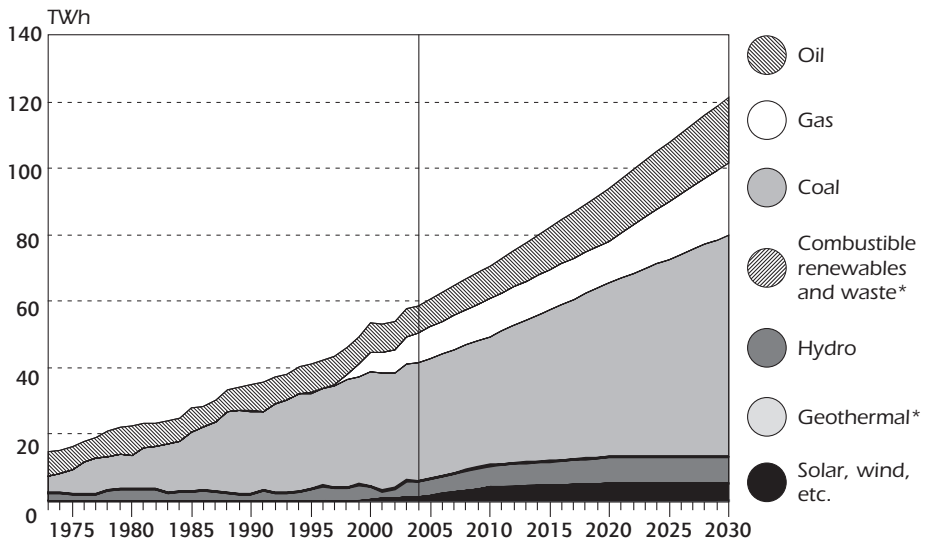
DEMAND AND SUPPLY

SUPPLY

Greek electricity generation has expanded rapidly since 1990, when it stood at 35 TWh. In 2004 it reached 59 TWh (gross), a total increase of 69% from 1990, at an annual average rate of 3.8%. The main increase came from coal (lignite) power stations, which contributed 25 TWh in 1990, and 36 TWh in 2004, an increase of 41%. The most important change in the fuel mix was the introduction of gas-fired generation, which did not exist in Greece in 1990, and contributed 9 TWh in 2004. Oil and hydro generation, a strong increase in net imports, as well as the development of new renewables such as wind, contributed the remainder of the growth in supply. Throughout the period, Greek electricity supply has become much more diversified, with the share of lignite falling from 72% of total gross generation in 1990 to 61% in 2004.

Figure 23

Electricity Generation by Source, 1973 to 2030

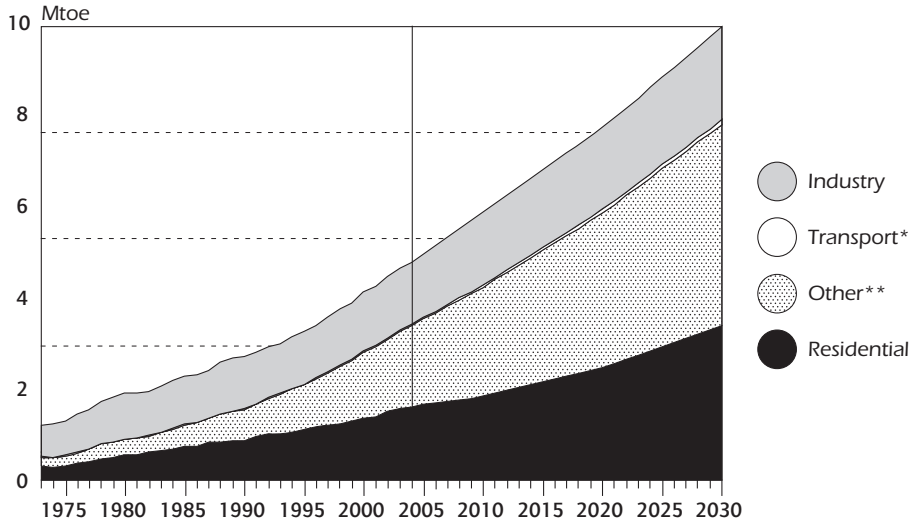


* negligible.

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

Figure 24

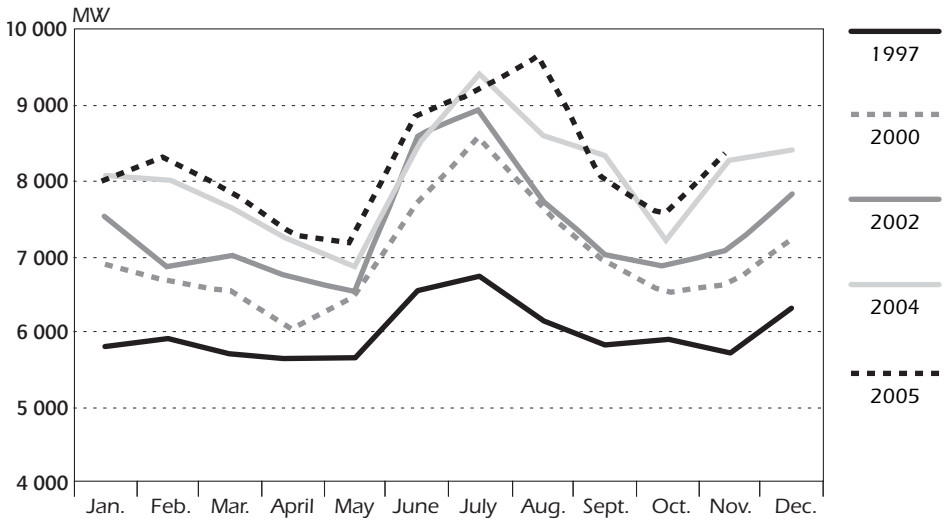
Final Consumption of Electricity by Sector, 1973 to 2030



* negligible.
** includes commercial, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries,* IEA/OECD Paris, 2005 and country submission.

Figure 25

Hourly Peak Electricity Demand by Month, 1997 to 2005



Source: HTSO.

Table 20

Peak and Annual Electricity Demand Forecast for the Interconnected System, 2006 to 2011

	Low scenario		*Basic scenario*		*High scenario*	
Year	*Peak load MW*	*Demand MWh*	*Peak load MW*	*Demand MWh*	*Peak load MW*	*Demand MWh*
2005	9 800	52 500	9 800	52 500	9 800	52 500
2006	9 936	54 057	10 126	54 586	10 397	55 112
2007	10 301	55 679	10 501	56 496	10 786	57 316
2008	10 672	57 349	10 882	58 473	11 183	59 609
2009	11 048	59 070	11 270	60 519	11 586	61 993
2010	11 431	60 842	11 664	62 636	11 997	64 473
2011	11 820	62 667	12 066	64 828	12 416	67 052
Growth 2005/2011	**21%**	**19%**	**23%**	**23%**	**27%**	**28%**

Source: HTSO.

DEMAND

Greek electricity demand has increased rapidly since 1990. The main increase was experienced in the residential and the other (commercial, public service, agriculture) sectors, where demand increased. In 2003, the residential sector was the largest consumer of electricity in Greece, with 16.4 TWh of annual consumption. This is an increase of 81% compared to 1990 when it stood at 9.1 TWh. While industry was the highest consumer in 1990, with 12.1 TWh, it had fallen to third place in 2003, when it consumed 14.2 TWh, an increase of 17% over the period. In 2003, the commercial sector overtook the industrial sector to become the second-largest consumer of electricity in Greece. It consumed 15 TWh, compared to 5.6 TWh in 1990, an average annual increase of 8%, and a total increase of 167% over the period, reflecting the changes in the Greek economy over the period.

A particular feature of the Greek electricity system is the unusual mid-day summer peak characteristic (see Figure 25) that usually occurs in July. The shift to a summer peak occurred in 1992, and the development has since then become more pronounced, with an increasing spread between peak and base demand. The increase in peak demand has led to supply problems during the summer, including a large blackout in the Athens area in 2004 (see Security of Supply section below).

In 2003, practically 100% of the electricity supply was undertaken by the Public Power Corporation PPC (see box). Less than five out of 7 500 eligible customers had a small part of their load (329 GWh) covered through imports. It is expected that this number will increase with the commissioning of more non-PPC power stations, together with an increase in the number of customers becoming eligible to select their suppliers.

INDUSTRY STRUCTURE

The Greek electricity industry is dominated by the vertically integrated, majority state-owned Public Power Corporation (PPC). In 2004, the PPC generated and supplied 97% of the country's electricity, owns the transmission network, and owns and operates the distribution network and supply.

Other companies involved in the industry are, for example, Hellenic Petroleum which commissioned a 400-MW CCGT in December 2005, and Motor Oil Hellas, which plans to construct a CCGT at their Corinth refinery site when it is connected to the gas supply. Nine supply companies were selling electricity imported via the interconnectors and/or generated by non-PPC generators in the industrial and commercial markets in Greece, accounting for 4% of the electricity sales between them. Some multinational companies are operating wind farms in Greece, *e.g.* EDF or Iberdrola.

Companies involved in the electricity industry need to have a licence from the Ministry of Development, unless they are small-scale autoproducers (*e.g.* owners of small CHP units) or renewables producers. Production units need to be registered with a generating unit register maintained by the RAE to be able to sell electricity, and need a production licence. Supply licences give the right to buy, sell, resell, transit, import, and export electricity. Eligible customers are considered self-supplying, and have the right to either import electricity directly, to choose their supplier, or purchase electricity on the wholesale market. Licences are issued by the Ministry of Development, which is being advised by the RAE on issuing licences.

The Public Power Corporation (PPC)

The PPC, with its headquarters based in Athens, is a vertically integrated electricity company with approximately 28 000 employees. PPC SA was established in its current form in 2001 by converting the state-owned PPC, which was formed in the 1950s, into a company quoted on the Athens and London stock exchanges. Following three public offerings, 51% of its shares is now owned by the Greek government, and 45% by the general public and institutional investors. A further 4% is held by PPC's employee

insurance. PPC is currently structured into four divisions: mining, generation, transmission, and distribution/supply. Of these, only the mining division has been fully accounting separated.

The *mining division* produces 95% of all lignite in Greece in two opencast mining regions, in Western Macedonia and the Peloponnese. Lignite produced by the division is used solely in PPC power stations. A special tax is levied on the mining operations to fund social development and projects in communities affected by the mining operations.

The *generation division* operated 98 power stations with a total capacity of 12 224 MW in 2004, employing approximately 8 000 persons. The main fuel for power generation is lignite supplied from the mines division, and a privately-owned mine in the case of the new Florina power station. The second most important generation technology is hydro, followed by natural gas and oil.

The *transmission division* maintains and develops the transmission network which is operated by the HTSO (see below), which is charged by the PPC transmission division for the provision of its services, while the PPC generation and supply divisions pay a usage fee to the HTSO.

PPC is the only distributor of electricity in Greece, and will keep sole ownership of the distribution and transmission networks under current government plans. The distribution network will be split into a separate company which will be owned by the PPC and operated by the HTSO, in a structure mirroring the current arrangement for the high-voltage grid. The *distribution division* is the main employer within the PPC, employing approximately 12 000 people. It manages the networks, metering, and the supply accounts of all Greek customers on the medium- and low-voltage networks.

PPC also has subsidiary companies, the largest of which is renewables. Two separate companies have been established to carry out the development and operation of new generation stations on Crete and Rhodes, respectively. PPC is also the owner of a telecommunications business.

PPC has been profitable in the past, with a financial operating margin of approximately 15% in 2003 and 16% in 2004. In 2005 this has been halved by the need to provide for the purchase of CO_2 emission credits to cover increased generation from lignite stations and by the increasing market prices for natural gas and fuel oil, which are important fuels on the non-interconnected islands. PPC's profitability is directly dependent on the government's decisions regarding the electricity tariff, since its ability to recover its costs depends on which level of tariffs the government allows it to charge to its captive consumers. Under current government proposals, the dominant position of the PPC in the Greek electricity industry will only be reduced gradually over the coming years. No radical measures for restructuring are planned by the Greek government.

Geography

Mainland

The Greek mainland is supplied through a well-developed electricity system with international interconnections to all neighbouring countries except Turkey, where a connection is under construction. Generation facilities are predominantly in the north of the country, while very little generation is located, especially in the Attika peninsula. Mountain ranges along the borders to the north, and sparse population to the south and on the Peloponnese peninsula are specific challenges to the supply of electricity. A number of islands are connected to the mainland system, the largest among them is the island of Cephalonia in the Ionian Sea, as well as some islands of the Cyclades in the Aegean Sea. Power generation and power demand are regionally unbalanced on the mainland. While 68% of the power generating capacity on the mainland is located in western Macedonia in the north of the country, 33% of the total Greek demand is located in the Attika peninsula, where few generation facilities exist.

Non-interconnected islands

Greece has a significant number of islands in the Aegean Sea that are not connected to the main electricity system, and these islands account for approximately 8% of total Greek electricity demand. The government is pursuing a policy of connecting more of these islands where this is technically and economically feasible. The cost of generation, distribution and supply on the islands is very high, compared to operations on the mainland, but is spread across all Greek consumers by applying the same tariff as on the Greek mainland.

Generation

In 2005 the PPC supplied 97% of Greek power demand. Independent power producer (IPP) capacity rose to 540 MW thermal, 405 MW renewables and 850 MW import capacity over interconnectors during the year. The first significant independent power station was the 150-MW gas-fired Eron SA plant connected in 2004. At the end of 2005 the 400-MW Hellenic Petroleum Thessaloniki CCGT followed. In total, IPP capacity, including interconnectors, is now about 20% of the total mainland generating capacity in pure capacity terms, while market-relevant capacity (thermal plants, interconnectors used for imports) is probably 10%.

The main fuel for power generation in Greece is lignite, which is mined in opencast mines in western Macedonia, and in the Megalopolis area of the Peloponnese (see also section on lignite below). Other important fuels on the mainland are oil, natural gas, hydro, and wind power. Oil-fired power stations on the mainland are gradually being converted to natural gas, to reduce the

environmental impact and generation costs. Hydro stations operate with annual load factors between 10 and 20%, depending on precipitation levels. Greek power generating capacity by fuel is: lignite (60%); oil and gas (15% each); hydro (10%); and new renewables (0.1%).

The share of oil in the Greek generation mix is very high, with 17%, providing 15% of all electricity generated in 2003. The primary reason for this high share is the use of fuel oil in independent power systems on the Greek islands, where oil is the fuel for 99% of the 4.6 TWh generated by the PPC. On the mainland, oil provides 7% of the 48.3 TWh generated by the PPC. The Greek government also supports new renewables through a feed-in tariff (see Chapter 8). There are no nuclear power stations in Greece and no plans to construct them in the future.

Greece is lacking generating capacity, and there are plans to add significant capacity over the next few years. Lack of generating capacity has led to the need to implement demand reduction programmes, especially during the summer peak demand time (see Chapter 5 on Energy Efficiency and below).

The PPC is currently in the process of increasing the efficiency of its older lignite stations through a capital investment programme, but there are no plants for capacity expansion of these stations. The average efficiency of the older plants is very low, estimated at below 33% conversion efficiency. The latest lignite power station, at Florina in Macedonia, is the first super-critical plant with an efficiency of approximately 38%. In the daily electricity market. Florina has bid the lowest prices of all thermal generating stations in Greece, reflecting the low fuel cost of lignite, and the comparatively high efficiency of Florina.

All non-interconnected islands are supplied by the PPC. Electricity generation on the non-interconnected islands is primarily based on fuel oil. A small share of Greek renewables capacity is also installed on the islands, with further developments held back by insufficient network capacity. The largest of the non-interconnected islands, Crete, is considered large enough to be capable of sustaining the introduction of competition in supply and generation at the same time as it occurs on the Greek mainland.

Although 21 generation licences for private power stations were issued in 2001, most of these have not been exercised because of problems in arranging financing and obtaining further licences. To bring forward new capacity, the HTSO can conduct capacity auctions exclusively for new generation, up to approximately 1 200 MW which will be secured against debt capacity payment (corresponding up to 900 MW of total capacity). The auction will be split into three tranches, and it will be restricted to natural gas-fired plants located in the south of Greece. The tender for the first auction has already been announced. The tender volume is equivalent to approximately 8% of

Table 21

Greek Interconnected Electricity Generation, 2005

(in MW)

Type	*Installed capacity*
Lignite	5 288
Oil	750
Natural gas	2 076
Total thermal	*7 602*
Large hydro	3 060
New renewables	ca. 600
Total	**11 774**

Source: Ministry of Development.

Table 22

PPC Non-interconnected Installed Capacity by Source, 2004

(in MW)

Region	*Fossil capacity*		*Renewables capacity incl. hydro*		*Total capacity*	
	Capacity	*Number of stations*	*Capacity*	*Number of stations*	*Capacity*	*Number of stations*
Crete[1]	730	3	18	4	748	7
Rhodes	206	1	0	0	206	1
Autonomous power system of the islands[2]	581	30	13	unknown	594	30+
Total	**1 517**	**34**	**31**	**unknown**	**1 548**	**38+**

1. One fossil station of 100 MW under construction.
2. Covering all non-interconnected islands with the exception of Crete and Rhodes.

Source: PPC.

Table 23

Generation Licences Awarded by March 2006

(in MW)

Technology	*Capacity*
Combined-cycle natural gas (Independent producers)	5 190
Open-cycle gas turbines (1 plant)	220
CHP plants by autoproducers	520
Total large power plants	**5 930**

Source: Ministry of Development.

total mainland capacity, and would lead to a doubling of non-PPC capacity. The winning bidders will benefit from an income guarantee from the HTSO, to cover their fixed cost where they fail to obtain at least 75% of those costs. The already commissioned gas-fired plants by the PPC, Eron S.A. and Hellenic Petroleum, were not built under this regime. The winner of the tender will be decided by the HTSO.

The PPC is not allowed to participate in this tender, but will be allowed to participate in the bidding for up to 50% of the possible follow-on tender for 400 MW, and is free to bid for any capacity tendered thereafter. PPC also has the right to refurbish 1 600 MW of oil-fired capacity to run on natural gas, increasing availability and efficiency of the plant. Following 2008, the EU's Large Combustion Plant Directive (2001/80/EC) will restrict the remaining operating time of the Megalopolis I and II units (lignite) to 20 000 hours, equivalent to a load factor of 45%. The northern lignite plants are not affected by SO_2 restrictions thanks to the presence of a natural catalyst in the fuel that reduces SO_2 emissions.

The PPC has added the 400-MW Komotini CCGT in 2004 and a 385-MW CCGT unit at Lavrios in 2006. Two of the PPC's power projects were held back by judicial intervention. The completed Messochora hydro plant (162 MW) is awaiting a new environmental licence after the original licence was invalidated by the Greek Supreme Court in 2000, and the tender for the construction of the Lavrio CCGT (385 MW) was delayed for a time because of an investigation by the EU into irregularities in the tendering process. The PPC now estimates that the Messochora plant will be commissioned in 2009.

The RAE and the government rejected the opening of a new lignite plant and mine by a new power producer owing to a variety of reasons, including concerns about the fuel resources at the proposed site, the financial capabilities of the applicant, and the environmental concerns about lignite mining and combustion, despite the government's desire to increase non-PPC capacity in power generation. The PPC is still considering applying for the construction of a new lignite station.

Electricity Grid in Greece

The Greek electricity grid is split into a high-voltage transmission network of 149-kV to 400-kV lines on the mainland and 66-kV submarine connections to some islands, and a low-voltage distribution network. The transmission network has a length of 11 300 kilometres. It is based on three double-circuit 400-kV lines, and is centrally managed. The distribution network has 7 million metering points and a length of 203 600 kilometres. The losses in the Greek networks are low, considering the country's geography. In the transmission system above, 149-KV losses run at 3%, in the distribution system at 6.5%, and non-technical losses are 0.5%.

The improvement of the distribution and transmission system is ongoing. A range of expansion measures are planned by the HTSO and the Ministry of Development based on the new "Electricity System Development Plan 2006-2010", to increase reliability and availability of the system. These include the connection of a 400-kV line in the north-east for an interconnection with Turkey; new high-voltage transformer centres in the south at Patra, Rouf, Korinthos, and Argyroupoli; the expansion of the 400-kV grid to the Peloponnese peninsula in the south; the interconnection of all the Cycladic Islands to the substation in Lavrio via submarine cables of 150 kV or a DC link; and enhanced reactive power compensation to better handle peak air-conditioning demand.

SYSTEM OPERATION

Transmission System Operation and Charging

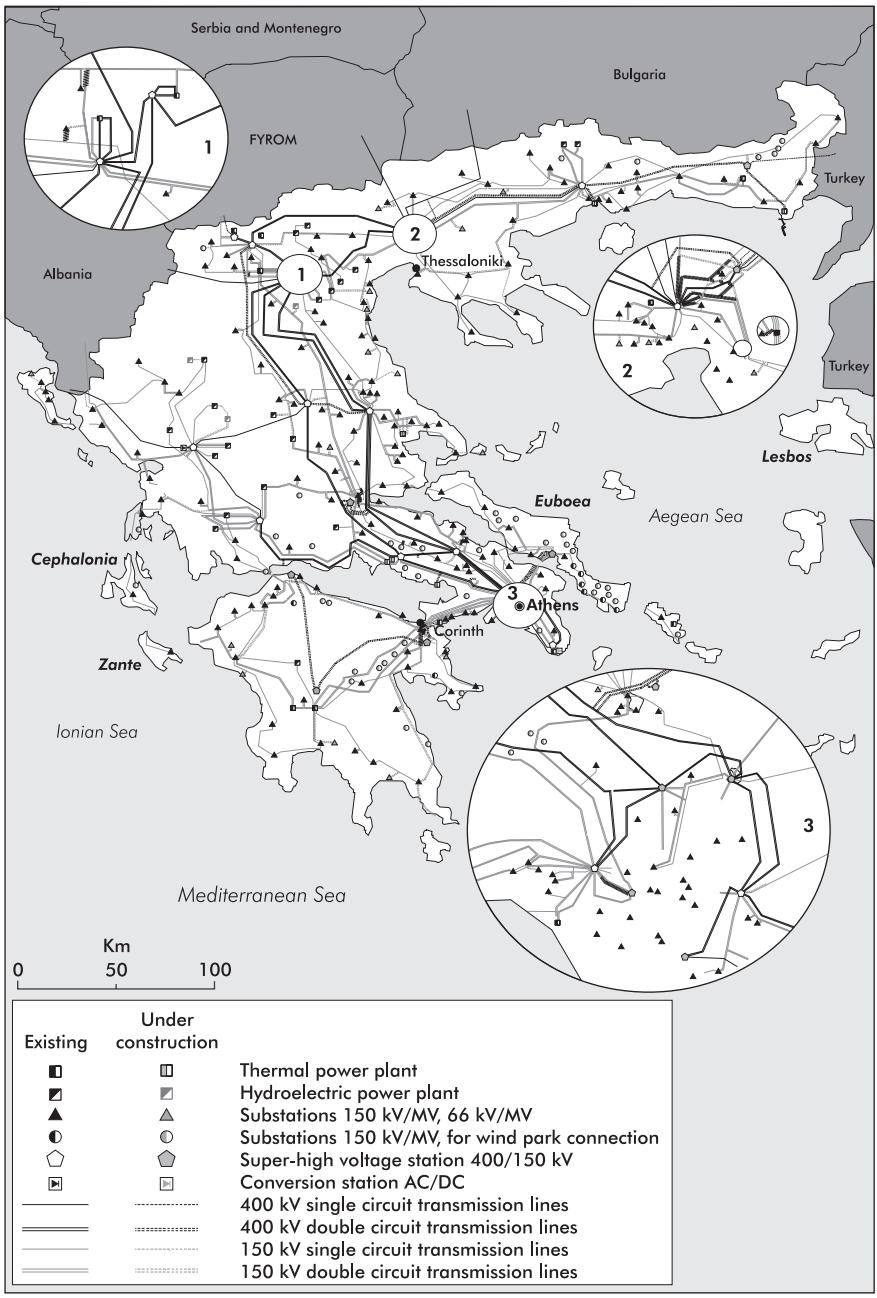
HTSO is in charge of planning the future development of the transmission system and annually issues a mandatory rolling five-year expansion plan to the PPC's transmission division. This plan is a public document, enabling potential new entrants into the generation market to plan their investment according to the information contained in the plan. The transmission expansion plan is prepared by the HTSO. Following its preparation, RAE expresses an opinion on the plan, and it is then approved by the Minister for Development who issues a ministerial decision to that effect.

The high-voltage transmission network continues to be owned and maintained by the PPC. An annual charge of EUR 220 million (2005) is made by the PPC to the HTSO for the use of the network. HTSO's operating costs are recovered by the administration fees, which are approved by the RAE, on an annual basis. Generation/import load has to carry 15% of the charge, while demand/export load has to carry 85% of the charge. For generation/import, the charge is applied at three different levels, reflecting the current geographical imbalance of generation and demand load in Greece. The charge is set at zero for the Attika peninsula, a medium charge is applied for generators on the Peloponnese, and a high charge for generators in northern Greece, in particular in Macedonia.

New generators have to pay full cost for their connection, including any reinforcement that might be necessary to the system (see also Chapter 8 on Renewables). HTSO or other operators can construct assets independently of the PPC, but these assets will, on completion, become the property of the PPC and will be added to the asset base of the PPC at zero value.

Figure 26

Map of the Greek Electricity Grid



Source: HTSO.

HTSO

The Greek electricity transmission system is operated by the Hellenic Transmission System Operator HTSO (Greek: DESMIE). The Greek government owns 51% of HTSO, and 49% are owned by the PPC. Until the passage of Law 3426/2005, it was planned that the share of PPC will be reduced to allow other generation owners a proportionate ownership share of the HTSO. The new law cancelled this provision, and it is now expected that the 49% share will remain with the PPC regardless of the increase of non-PPC power generation.

To safeguard the independence of the HTSO, members of the board of directors should not be related in any way to any enterprise in the electricity production or supply sector, and only two can be nominated by the PPC. The RAE is responsible to ensure the independence of the non-PPC board members.

According to the new Law 3426/2005, HTSO will have the right to operate, exploit, maintain and develop the distribution grid, which means in practice that the solution of operator/owner split for the transmission system will be extended to the distribution system. If HTSO undertakes the tasks of transmission and distribution system operator, it is likely that a large number of PPC staff will have to be transferred to HTSO, even if PPC carries out physical work on the distribution system under contract for the HTSO.

Currently the total number of staff at HTSO is 220, which is below the requirement.

International Trade

Greece has interconnectors to Albania, FYROM, Bulgaria, and to Italy through a 400-KV connection. (technical capacity 500 MW rated at 150/250 MW export/import). A high-voltage direct current (HVDC) connection to Turkey which is under construction will be operational by the end of 2007; a second connection with FYROM is being constructed and a second transmission line with Bulgaria has been planned.

Interconnector capacity is allocated by auctions conducted once a year by the HTSO, and the right to interconnector capacity can be traded. The auction price achieved in the 2005 auction was EUR 40 000 per MW for a one-year access for imports into Greece, and EUR 1 000 per MW for a one-year access for exports from Greece. A total of 13 suppliers participated in the auction. In terms of regulation and system operation, interconnector exports are treated as demand, and imports as generation.

Greece imported 4.2 TWh of electricity in 2003, an increase of 2.4 TWh or 141%, compared to 2000 when 1.7 TWh was imported. The main supplier is Bulgaria, which exported 3.3 TWh to Greece. The country's other main supplier is the FYROM, which exported 0.83 TWh. Very small amounts are imported from Italy and Albania (0.05 TWh each). Greece is exporting electricity to Italy (1.1 TWh), Albania, (0.7 TWh) and the FYROM (0.2 TWh). Greece has usually been a net importer of electricity since 1990, with annual variations driven by the availability of hydro generation, and a marked increase in net imports since 2001.

Distribution Network

Under Article 12 of Law 3426/2005, a shift in the responsibilities regarding the distribution network is foreseen. HTSO will acquire not later than 1 July 2007 the additional role of the distribution network operator. The exact way in which this shift will be implemented has yet to be determined. The PPC will retain ownership of the network and, in accordance with Article 11 of Law 3426/2005, will continue to take applications for connection to the network; run the network, ensure the technical integrity of the network and develop and maintain the network according to the HTSO's directions in a framework similar to the transmission system. The PPC has the task, under Law 3426/2005, to set up within its organisational structure, no later than 22 June 2006, a unit that will acquire all responsibilities of the distribution network operator outlined below. This unit will be transferred to the HTSO by 1 July 2007.

Table 24

International Interconnector Capacity of Greece, 2004

(in MW)

Interconnector	*From Greece*	*To Greece*
Greece – FYROM	300	600[1]
Greece – Albania	250	
Greece – Bulgaria	400	
Greece – Italy	150	250[2]
Total	**1 100**	**850**

1. Total permissible through the northern interconnectors of Greece (with Bulgaria, Albania and FYROM) based on the technical criteria applied by HTSO and approved by RAE.
2. Total permissible through Greece-Italy interconnector according to the agreement on the allocation of the available transmission capacity for the year 2004 on the interconnection at the Italy-Greece border between the two system operators (GRTN and HTSO), which is approved by the Italian regulator AEEG and RAE.

Source: Government submission.

The number of employees that will be working in this unit is not yet known but preliminary estimates are that around 100 are required for these tasks. The exact situation will be known as soon as PPC sets up the distribution operator unit. The responsibilities of the HTSO regarding the distribution system will be to ensure the following:

- Security of network.
- Technical soundness and economic efficiency of network.
- Quality of voltage and supply reliability.
- Access to network.
- Connection to network.
- Measurement system and measuring.
- Informing users of network.
- Co-operation with the airport operator.
- Contracting with the network owner (PPC) for the development of the network.

Market Operation

Structure

The Greek electricity market model consists of two separate markets, a wholesale electricity market, and a capacity assurance market. The market is open to producers registered with the generation unit and holding a supply licence, to suppliers holding a supply licence and to self-supplying customers.

Daily market

The market has been in operation since mid-2005. It is a mandatory pool that consists of four elements:

- Day-ahead scheduling and market clearing.
- Day-ahead/intra-day dispatch scheduling.
- Real-time dispatch.
- *Ex post* imbalance settlement.

The market clearing produces a single system marginal price (SMP) for the country, even if the market is split because transmission constraints arise between northern and central/southern Greece. In such a case, two marginal generation prices are established, and the SMP will be a weighted average of the two marginal generation prices, providing an incentive to locate generation in the zone with a shortfall while keeping to the principle of having a single price for the whole of Greece. Further technical aspects taken into account are generation unit constraints and reserve requirements. New renewables and some hydro schemes are treated as must-run and are prized at zero. The dispatch period is one hour, and the SMP is established for each hour. Offers made at day-

ahead scheduling are firm, and if they are not fulfilled they expose the generator making the offer to a penalty payment for non-delivery in the form of the *ex post* imbalance price. While real-time dispatch takes place and can account for physical imbalances by rescheduling, there are no real-time financial transactions that mirror this dispatch.

Capacity assurance market

The capacity assurance market ensures that suppliers of electricity can back up their supply with generation or import capacity. Generators are issued annual capacity availability certificates (CACs) in one-MW steps reflecting their net generating capacity and import rights. Suppliers have to purchase these CACs to cover their supply obligations plus a security margin. Additionally, the HTSO can tender for new capacity through an *ad hoc* mechanism when it perceives a capacity shortfall based on a study undertaken by the RAE. Such a tender will be run during 2006.

REGULATION AND MARKET REFORM

Liberalisation

The first grid code was published in 2001, with the intention to demonstrate that it would be possible to operate the transmission system independently of the generation and distribution systems. In May 2005, the RAE issued a revised grid code, aiming to liberalise the electricity market. The government has no plan for the further privatisation or structural changes to generation, transmission or distribution assets in the near future.

Role of the Regulator

The RAE has a number of important functions in the electricity sector. It advises the Ministry of Development on issuing generation licences; conducts generation adequacy studies to establish whether HTSO should issue tenders for new generating capacity; provides a consenting opinion to the government on price setting for captive customers and various tariffs; is responsible for the unbundling of the PPC; advises the Ministry of Development on the appointment of board members of the HTSO; sets the price for the use of the networks by the HTSO; and approves the methodology for tariff setting.

The RAE is also responsible for the conduct and monitoring of the unbundling of the PPC's operations. By law, all integrated electricity enterprises in Greece (*i.e.* the PPC) now have to keep separate accounts for mining, production, transmission, distribution and supply to eligible customers, supply to non-eligible customers and public service obligations. The PPC has provided the

data on the unbundled accounts regarding production, transmission, distribution, supply, lignite mining and the activities in non-interconnected islands for 2001-2003 to RAE. 2004-2005 data will be provided within the first half of 2006, enabling the RAE to develop the new tariff structure for administratively-set tariffs. PPC must establish unbundled accounts for all its activities related to mining, generation, transmission, distribution, supply and the operations in the non-interconnected islands.

PPC's mining operation was the first part of the PPC to become accounting unbundled. PPC staff working in the unbundled divisions are obliged to keep confidential any data obtained during the exercise of their duties and to act in a non-discriminatory way towards non-PPC clients. Following progress in 2005, the RAE now expects that during 2006 PPC will have accounting unbundled its operations into the following businesses:

- Lignite mining.
- Generation.
- Transmission.
- Distribution.
- Supply.
- Activities in non-interconnected islands.

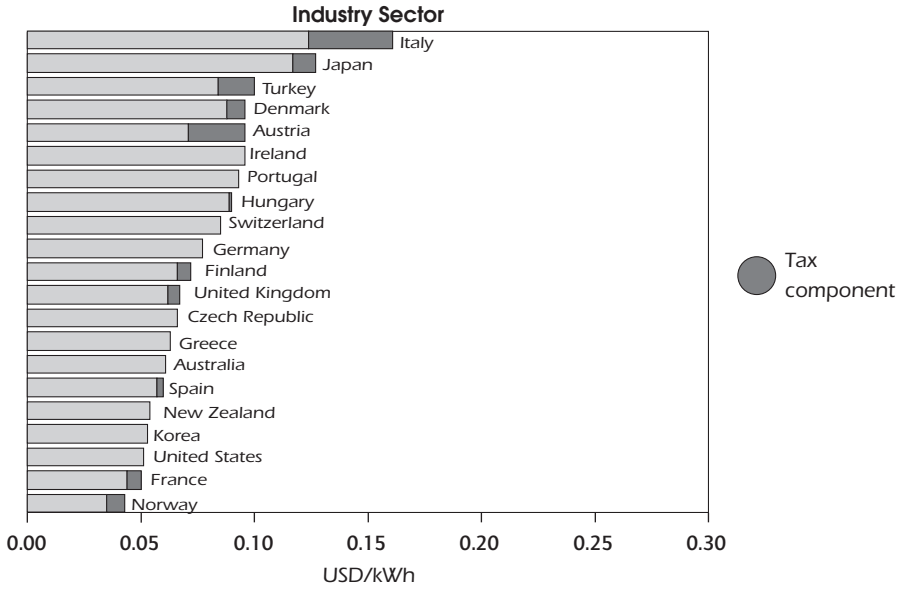
Law 3426/2005 also provides for the unbundling of the distribution system operation from PPC and introduces the combined transmission and distribution system operator (DSO) concept. HTSO will undertake the tasks of the distribution system operator by 1 July 2007, but the ownership of both the distribution and transmission networks will remain with PPC. The RAE is responsible for overseeing the HTSO, including transmission tariff development and approval of the network expansion plan.

Prices and Tariffs

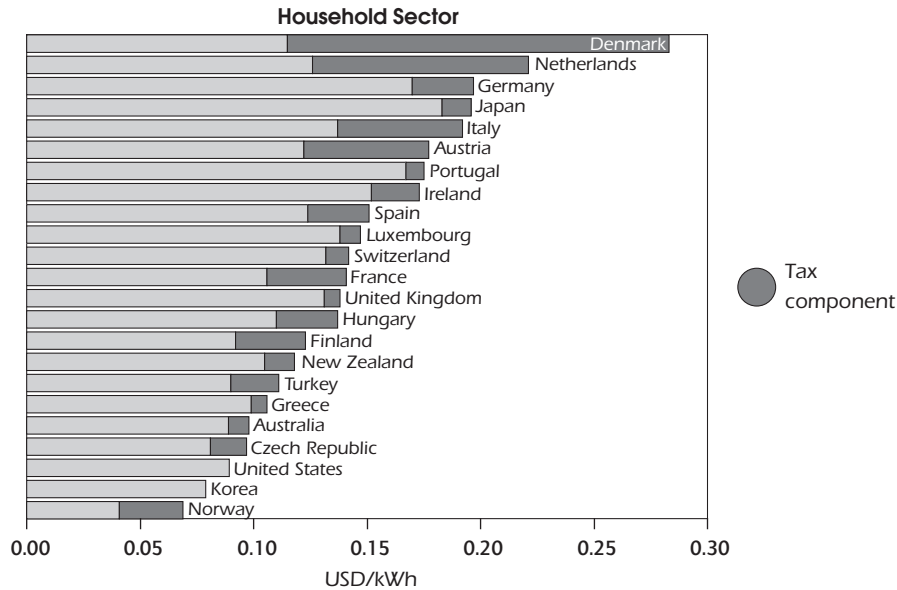
Greece has the lowest household (lowest in EU-15) and industrial electricity prices than most other IEA countries (see Figure 27). Customer prices for eligible customers are set by bilateral agreements between producers/importers and customers, unless the supply is undertaken by the PPC, in which case the published tariffs apply. All non-domestic customers are eligible, but only 2.8% of supply by volume were undertaken outside the PPC. Currently, PPC's end-user tariffs are approved by the Minister of Development. The RAE is restricted to providing an opinion on the tariffs before approval by the minister. The system marginal price is set by the market on an hourly basis and shown on the HTSO website but does not reflect a commercial index.

Figure 27

Electricity Prices in IEA Countries, 2004



Note: Price excluding tax for the United States. Tax information not available for Korea. Data not available for Belgium, Canada, France, Luxembourg, the Netherlands, Norway, Sweden and the United States.



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

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

The current tariff structure is almost 40 years old, and the RAE is planning to replace it in 2006. It does not cover the recovery of exceptional cost items such as *e.g.* the purchase of CO_2 certificates by generators, and, as a consequence, the financial situation of PPC is deteriorating, with margins falling to 8 or 9%, from 15% in the last two years. The cost of natural gas and CO_2 certificates brought a burden of about EUR 200 million (around EUR 4 per MWh) to PPC for the first 9 months of 2005, which resulted in a 40% drop in PPC's profit. The RAE expects that the tariffs are going to be fundamentally revised in 2006. During the transition phase towards a more liberalised market, PPC's retail tariffs will remain regulated until the market share of the PPC falls below 70% of all electricity supplied in Greece. Current tariffs are only differentiated by the voltage level of connection, with some customer groups, such as farmers or PPC employees, receiving preferential tariffs.

To promote efficient use of electricity, tariffs can be increased during peak demand times in summer, and following the introduction of an automatic metering system, of which 8 000 have already been installed for high- and medium-voltage customers covering 40% of the total electricity demand by volume, multi-zonal tariffs could be implemented. There are no reduced tariffs for interruptible customers.

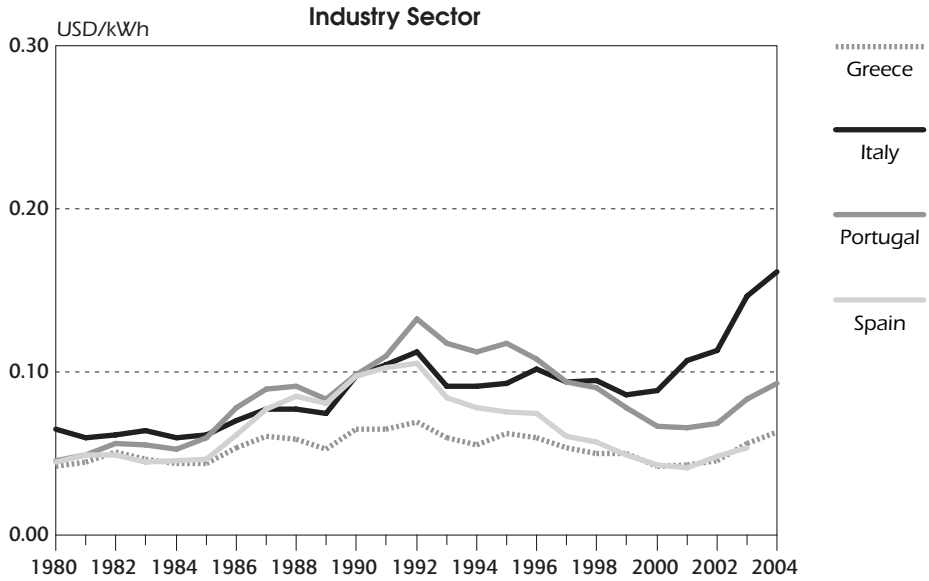
The following prices and tariffs are regulated by the government with approval required by the RAE:

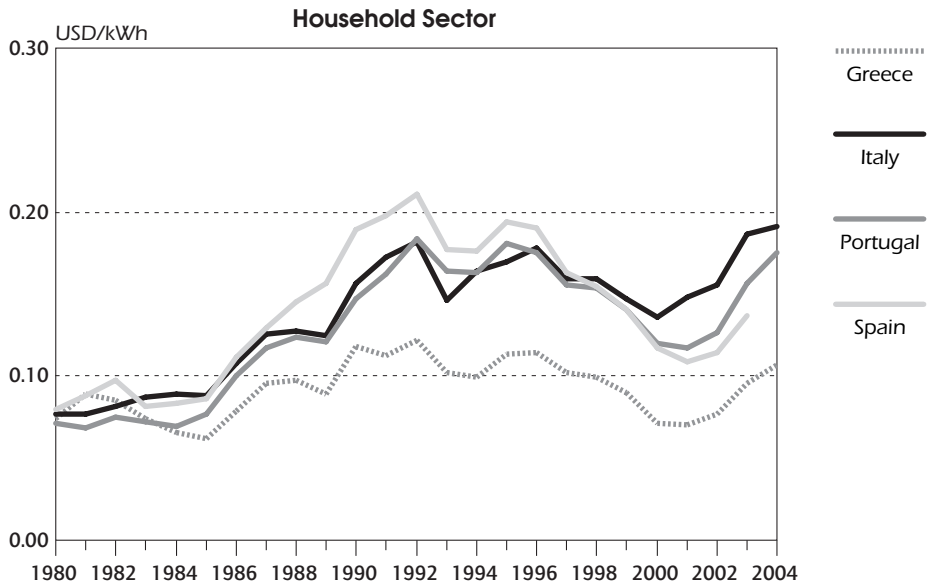
- Use of transmission system charges.
- Use of distribution network charges.
- Connection to the transmission system charges.
- Connection to the distribution system charges.
- Allocation of public service obligation costs.
- Allocation of remuneration of renewable energy sources (feed-in tariff) cost.
- Retail tariff of the PPC as long as the market share of the PPC does not fall below 70% of total energy supply.

According to the System and Power Exchange Code, transmission prices and tariffs are regulated as follows: each year, HTSO carries out the initial calculations, the RAE expresses its opinion to the government and the Minister of Development issues a ministerial decision. The tariff for third-party access to the transmission grid reflects the charge made by the PPC to the HTSO for the use of the transmission system. The charge is allocated to generation/import load and demand/export load on a 15/85% split, with the generation charge again divided by location. The charge reflects a 30-year period for the recovery of the cost of capital, plus an 8% annual rate of return under a cost-plus approach.

Figure 28

Electricity Prices in Greece and in Other Selected IEA Countries, 1980 to 2004





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

System Reliability

Greece has experienced outages on both the transmission and distribution levels of the electricity system. The HTSO records outages of the transmission system, and identifies lines, line bays and substation buses as the main reason for failures. Not all outages lead to lost load, and according to HTSO, interruptions of load followed after approximately 30% of the outage hours reported. In 2003, 557 hours of outages were reported across the system, while in 2004 the number was 441 hours.

For the distribution system, data for 2003 are the latest available, and they are collected by the PPC. All the figures correspond to cumulative yearly duration of medium- and low-voltage interruptions per customer, generally referred to as System Average Interruption Duration Index (SAIDI). The PPC identifies substation transformers and breakers as the main reason for outages. In 2003, 195 minutes of outage measured according to the SAIDI occurred, broken down as follows:

- Faults of medium-voltage network: 95 minutes
- Faults of low-voltage network: 13 minutes
- Programmed MV interruptions for maintenance and construction:79 minutes
- Programmed LV interruptions for maintenance and construction: 8 minutes

Table 25

Greek Generation Reserve Margin Development, 2000 to 2005

(in MW)

Interconnected system 2000-2005	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Peak load (MW)	8 529	8 598	8 922	9 040	9 285	9 586
Net available capacity (MW)	9 306	9 306	9 306	10 091	10 191	10 231
Reserve margin (MW)	777	708	384	1 051	906	645
Reserve margin	8.35%	7.61%	4.13%	10.42%	8.89%	6.30%
Reserve margin with interconnections (total 1 100 MW)	18.04%	17.37%	14.26%	19.22%	17.77%	5.40%

Source: Ministry of Development.

2004 Athens Blackout

On 12 July 2004, voltage instability caused by a lack of generating capacity during peak demand time caused a major disruption affecting the southern part of the system. A total of 4 200 MW of instantaneous demand was lost (about 44% of the system load at the time of interruption) and by the time of full restoration, 10 GWh had been lost. Partial system restoration started within 30 minutes following the interruption, and within 75 minutes, approximately 1 900 MW (primarily major loads) were restored. Restoration of load was completed within 285 minutes after the interruption.

To avoid a repeat of the blackout in 2005, the Ministry of Development took stringent measures. These measures were successful in that no blackout occurred during the summer of 2005, despite a 6% increase in peak demand compared to 12 July 2004. These measures consisted mainly of the cutting-off of the PPC's lignite mines, reduced operations of agricultural irrigation systems between 10 am and 5 pm, and the semi-voluntary reduction (with pricing benefits) in electricity-intensive industries, mainly the metals processing sector. An extensive mass media campaign requested the participation of the general public in trying to reduce energy consumption. Industrial consumers who did not want to participate in this reduction were required to decrease their consumption during peak periods by 10% compared to their previous year's consumption, or to pay a penalty. Rebates on the monthly power bill were given to all customers affected by this measure.

As a long-term measure, a ministerial decision, published in May 2005, made it compulsory for all public buildings of southern mainland Greece to upgrade their electrical installations. The aim is to increase the reactive power factor from 0.85 to 0.95 to relieve the peak pressure on the system. This measure is also planned to be gradually extended to the industrial and housing sectors. The ministry is continuing to review further potential measures. The HTSO is also planning transmission system upgrades to enable the system to cope better with the geographical divergence of demand and generation load in Greece.

CO-GENERATION

Greece has a small co-generation sector, with the majority of CHP plant capacity installed in oil refineries. The other significant contributors are CHP plants in the chemical and petrochemical sector. Aluminium de Grèce holds a licence to install 198 MW CHP at its sites, and is expected to commission this capacity by 2008. A CHP plant is also planned to be installed at the Revithoussa regasification plant near Athens.

Two of the PPC's lignite power stations also recycle waste heat into local heat distribution systems serving nearby communities. In 2003 these stations produced approximately 280 GWh of heat and 2 300 GWh of electricity,

Table 26

Greek CHP Plants by Owner, 2005

(in MW)

Company	*Sector*	*Net installed capacity (MW)*
Motor Oil Hellas	Refinery	49.1
Aluminium de Grèce	Non-iron metals	11.6
Phosphoric Fertilisers Co.	Chemicals	33.0
Hellenic Petroleum S.A.	Refinery	50.1
Hellenic Sugar Industry S.A.	Sugar production	56.0
Kavala Oil S.A.	Petroleum & natural gas production	16.5
Total		**216.3**

Source: Ministry of Development.

reaching a combined efficiency of approximately 42%, compared to 30-33% for lignite plants operating without heat recovery. The PPC plans to extend this measure to other generating plants.

Co-generation, excluding the two lignite stations, is contributing around 1 TWh per year, or less than 2% to the total Greek electricity supply. The Greek government estimates that the potential for co-generation in Greece is approximately 700 MW installed capacity.

LIGNITE

Demand and Supply

Greek coal reserves are exclusively in the form of lignite, which is mined in opencast mines since the 1950s, and used for power generation in mine-mouth power stations. Small amounts of coal are imported for industrial use. Reserves are estimated to last another 50 years at current consumption levels. The quality of Greek lignite in terms of energy yield is low. Northern lignite from the field in western Macedonia has low-sulphur emissions when burned thanks to the presence of a natural catalytic element.

The main holder of mining rights is the PPC. It holds 60.5% of mining rights for exploitable deposits, and mines approximately 95% of lignite. Rights could extend to 94% of exploitable deposits if the Greek government extends further exploitation licences. A private mining operation is supplying the new lignite power station at Florina with parts of its fuel requirements, and a tender for the exploitation of a large lignite field in Drama will soon be launched. The PPC produced 70 million tonnes of lignite in 2004. PPC is

subject to a special levy for lignite-generated electricity equal to 0.4% of the annual turnover. This levy is collected in a special fund and allocated to the prefectures where lignite power plants are located.

The PPC estimates that the remaining lignite reserves are sufficient for 50 years of production. Out of a total 3.7 billion tonnes of lignite, 1.5 billion tonnes have been produced since mining began in the 1950s. Operating mines are in the lignite centre of western Macedonia (Main Field, South Field, Kardia Field, and Amindeon Field incorporating the PPC's Florina mine) which produced 55.5 million tonnes in 2004 and holds 1.88 billion tonnes, and in the lignite centre of Megalopolis (Peloponnese) which produced 14.5 million tonnes in 2004 and holds 251 million tonnes. Power stations in Macedonia have a capacity of 4 438 MW and are located within 12 kilometres of the mines, while those of Megalopolis have a capacity of 857 MW and are located within two kilometres of the mines.

Unopened exploitable deposits are at Drama in eastern Macedonia (900 million tonnes) and Elassona in south-western Macedonia (169 million tonnes).

Table 27

Production and Reserves of Major Lignite Fields, 2005

Mining area	*Location*	*2004 production (Mt)*	*Exploitable reserves (Mt)*	*Remaining years of operation at current production level*
Ptolemais (PPC)	Western Macedonia	46.08	1 280.7	28
Amyndaion (PPC)	Western Macedonia	8.52	165.3	19
Megalopolis (PPC)	Peloponnese	14.44	251.1	17
Florina (PPC)	Western Macedonia	0.86	138.4	161
Drama	Eastern Macedonia		900	
Elassona (PPC)	Central Greece		169	
Komnina (PPC)	Western Macedonia		100	
Privately-owned mines	Western Macedonia	2.02	191	95
Total		**71.92**	**3 195.5**	**44**

Source: Ministry of Development.

CRITIQUE

There have been a number of commendable developments since the last review. Market reform has progressed with the unbundling of the PPC's mining operations, and legislation to support further reforms is now in place. The first

privately-owned power stations were opened, helping to address the shortage of generating capacity and the share of gas in the generation mix has increased. An interconnector to Turkey is under construction, and existing interconnectors to other neighbouring countries are being upgraded. Nevertheless, there remain significant challenges for the Greek energy policy in the electricity sector.

The main challenge for the Greek electricity policy is the dominance of the incumbent supplier, the PPC. Commendable progress has been made in setting the framework for the reduction of PPC's dominance in the future. This includes confirmation of the exclusion of the PPC from the bidding for new capacity that HTSO will put to tender during 2006, the unbundling of the distribution system, the further unbundling of the PPC's accounts and the introduction of a new grid code. The Law 3426/2005 passed in December 2005 codifies the next steps to be taken.

However, these measures are not likely to develop sufficient competition in the Greek market. The HTSO is planning a tender for 1 200 MW of new gas-fired generating capacity, but even including the potential follow-on tender for another 400 MW, this is unlikely to have more than a limited impact on PPC's dominance in the generation market in the foreseeable future, since it will only offer the equivalent of approximately 13% of current mainland generating capacity to new entrants. Without further measures than the currently foreseen tenders for new generating capacity, it is unlikely that the PPC's share of generation will drop below 80% before 2010. Given that effective competition in generation has not emerged since the last review, despite the issuing of generation licences to new entrants, the government may have to consider extending the restriction of tendering for new capacity by the PPC beyond the currently foreseen tenders. Another possibility to increase the share of non-PPC generation is to offer the Megalopolis I and II units – which are to be decommissioned between 2008 and 2012 – to investors willing to prolong the life of the plant. This would add 250 MW of non-PPC generating capacity.

According to the new Law 3426/2005, the PPC has the right to refurbish a total capacity of 1 600 MW. PPC is planning to make use of this right by replacing old units with new CCGTs and one new-technology lignite-fired unit. While such a refurbishment would lead to further fuel diversification, care should be taken that such a measure does not further cement the dominant position of the PPC in the generation market.

The RAE has led commendable efforts to achieve progress in unbundling the accounts of the PPC as a prerequisite for further liberalisation. However, the independence of HTSO, the company managing the transmission system and the market, from PPC may not be sufficient under the current arrangement. The transmission system continues to be owned by the PPC, which also owns 49% of the HTSO, and has seconded 154 staff members out of 220 to the HTSO. This raises questions about the HTSO's independence from the PPC. To

ensure the independence of HTSO, the RAE is enforcing rules on the appointment of board members as is provided for by the EU Directive 2003/54. While this is commendable, a better solution to ensure independence may be to consider the complete ownership separation of the HTSO and the PPC by taking 100% of the HTSO into government or private, non-PPC ownership. Also, the solution with a split in ownership and operation of the transmission grid is unique in Europe, and can lead to problems in managing grid extension projects and cost allocation. Consideration should be given to transferring ownership of the transmission system to the HTSO, in a similar set-up to that chosen for DEPA and DESFA in gas transmission.

The creation of an independent distribution system operator as foreseen in Law 3426/2005 is a commendable step to further reduce the dominance of the PPC. The new structure will allow full TPA to the distribution network, significantly increasing the potential for smaller generators to connect, and enhancing the transparency of the distribution system operation.

As discussed in Chapter 3, the government and the RAE need to survey the development of competition in the electricity market and should consider taking stronger measures to address the PPC's dominance, while further strengthening integration with neighbours. The role of regulation to ensure reasonable competition in the sector will be critical while competition is developing.

To reduce concerns about security of supply, new generating capacity needs to be added in Greece. Despite the commissioning of some new generating capacity since the last review, the capacity margin problem in Greece has not been solved. It is foreseen that the major increase in power generating capacity will be in gas-fired and renewable power generation. The planned refurbishment of 1 600 MW of PPC generating capacity will positively affect the environmental impacts from power generation in Greece, and lead to further fuel diversification.

The 2005 peak demand of 9 800 MW was considerably below the theoretical capacity of the generation and import available to the Greek system, but this does not take into account that a considerable amount of generating capacity is hydro, operating at low load factors, and wind capacity which is not always available when required. Additionally, analysis of the capacity margin has to take transmission bottlenecks into account, which are of serious concern in Greece. Although the annual electricity demand increase is only around 2%, the reserve margin is becoming smaller and the necessary measures to increase generating capacity should be taken urgently. According to the RAE's technical assessment, a new 400-MW power plant should be installed every year for the next four to five years, but the current plans for adding capacity falls short of this goal. Other IEA member countries, such as Spain, have been able to cope with much higher growth rates of electricity demand by providing a secure long-term framework for

private investors through privatisation, liberalisation, and the reduction of government involvement in the industry, leading to significant capacity additions of gas-fired and renewable generation, whose example Greece may benefit from studying.

Apart from the restriction of PPC's participation, the tender is also restricted both by region of the country (to southern Greece) and by fuel use in future power stations (to natural gas). Such a restriction on the fuel choice for generation may be too much of an intervention in the market. This may also hamper fuel diversification. The HTSO and RAE should consider allowing bidders a wider fuel choice.

Appropriate investment in transmission and distribution is also essential for security of supply. HTSO has been faced with difficulties in some regions while constructing new transmission lines owing to the long environmental licensing procedures and the reactions of the local communities. Measures should be taken to overcome this, especially on the non-interconnected islands, because reinforcement of the system is especially necessary to increase the usage of renewables on these islands. Also, the current system in which any new infrastructure has to be given to the PPC for free at the time of connection to the grid may create disincentives to the construction of transmission and distribution assets by the private sector.

The new Grid and Power Exchange Code published in May 2005 introduces a model consisting of two markets: a wholesale energy market and a capacity assurance market. This code was the first real opening for competing investments in generating capacity in Greece.

All electricity, except for ancillary services, will be traded through the day-ahead market. The establishment of a wholesale energy market under the new grid code has introduced a new model for capacity assurance through capacity availability certificates (CACs) issued by the generators or importers and bought by the suppliers, replacing the prior requirement for suppliers to own generating capacity sufficient to cover their sales. This is another measure to address security of supply. CACs provide a possibility to the investors to recover some of their capital investment, regardless of the fluctuations of the daily market, and they should contribute to overcome the capacity shortage in Greece. It is a commendable development, even if capacity-based mechanisms in fully competitive markets are still widely debated and fraught with problems. For the long term, such a capacity assurance market may not foster efficient investment. The regulator and the government should carefully review the impact of CACs on the electricity market, and be prepared to remove the mechanism once the generation shortage has been overcome.

The new code is also a commendable development in terms of market liberalisation. It will be implemented gradually up to 2008, and contains the series of rules that will facilitate the liberalisation of the electricity market,

promoting new entry and reducing the PPC's role. According to these rules, the HTSO, on the one hand, plans, operates and develops the transmission system, and on the other hand, operates the daily electricity market, with compulsory participation of all market players. The new code will provide for more transparency of generating prices, leading to a better ability by the RAE and the government to develop tariffs accurately reflecting the Greek situation.

The introduction of market splitting in the daily market is a sensible step because it provides appropriate incentives to locate generation near demand, and to increase grid capacity. In terms of capacity additions, the commissioning of 1 000 MW of new private and PPC power stations since 2004 is to be praised, as are the measures taken to decrease the voltage volatility such as the placement of capacitors and transformers in the transmission and distribution lines in crucial areas, the upgrading of capacitors and the construction of new substations. These purely technical measures will need to be accompanied by market incentives, however, to further reduce the likelihood of blackouts in southern Greece.

At the moment, there is no incentive in the tariff structure to reduce consumption in order to help the system operator during peak demand times. Industry consumers were forced to cut their consumption for a certain period of time during the summer of 2005, or to pay penalties. Such a measure can only be seen as an emergency measure, and should at the earliest opportunity be replaced by the introduction of interruptible tariffs reflecting the value of lost load (VOLL) and the loss of load probability (LOLP). Full demand-side participation by load customers in the daily market should be enabled urgently. An analysis of the effectiveness of these measures during the summer of 2005 would, however, be of great interest to help the RAE with the development of a tariff structure introducing systematic and efficient incentives to reduce power demand at peak load. In terms of market response, the RAE and the government should, therefore, urgently consider the development of interruptible tariffs, and tariffs enabling the use of modern metering infrastructure in a market framework, instead of relying on direct appeals and the threat of penalties to electricity users to reduce their consumption. Studying the experience of the Nordic electricity market during the precipitation shortage may be particularly useful in developing new approaches for Greece. Curbing demand growth and peak demand is also essential to facilitate effective competition because it is impossible to see when the share of the PPC will fall below 70%, under the current rapid growth of electricity demand of 2% per year, unless the PPC were barred completely from constructing new power stations.

The island communities of Greece present another specific challenge to the Greek energy policy. A part of Greek capacity is installed on autonomous, non-interconnected islands, all of which (according to the 2003/54/EC Directive), apart from Crete, qualify as "micro-isolated systems". For these islands, because of special conditions and their small size, the Greek government has asked for

a derogation from the EU market directive's provisions, and they are not expected to be opened up to competition even when markets in mainland Greece are opened. Almost all of the generation on the islands is operated by the PPC, and these islands consume approximately 8% of net electricity demand in Greece. The government pursues a policy of connecting as many islands as is economically possible. The current power generation plants on the islands use mostly oil, and the cost of generation is high. A limited amount of renewables plants has been installed on the islands. The PPC is concerned about the system stability. This restricts future increases of renewables capacity. The islands are under special regulation regarding the future market opening. With the exception of Crete, they are not expected to be opened up to competition when markets in mainland Greece are opened.

The inhabitants of the non-interconnected islands are paying the same electricity tariffs as the rest of Greece despite the much higher cost of supply, and the cost for these lower tariffs is spread across all electricity consumers in Greece. Because of this tariff structure, the incentive to develop less costly solutions to supply them, such as more efficient use of electricity and increased penetration of renewables, is lowered. The cost of this social service obligation is estimated at EUR 4 per MWh of electricity. Special tariffs also apply to agricultural users, and large families. The requirement of geographically uniform tariffs, reinforced by the existence of sector-specific rebates, constitutes a cross-subsidy between different categories of consumers. While it is important to pursue social objectives such as even regional development, it is less certain whether the electricity tariff is the right means of doing so. Other measures, such as *e.g.* the taxation system, are often less distorting, both in economic and environmental terms. The government could, for example, consider the introduction of more cost-reflective tariffs on the islands, using other means to compensate the inhabitants for the higher cost of electricity supply and to help keeping the island communities viable. Such a move would increase the incentive to seek alternative supply solutions on the islands, reducing the cost of the social service obligation to all consumers in Greece, and reducing the environmental impact from electricity generation on the islands.

Lignite constitutes the main domestic fossil fuel resource of Greece, and for this reason it will continue to play a major role in the country's fuel mix. Greek lignite is a competitive fuel for power generation in the current environment, but this may change once full CO_2 costs have to be taken into account. Further cost pressure on the PPC may lead to a reduced allocation of funds for future remedial action in areas affected by mining. The government and the regulator should take care that the funds required for the restitution of mined land continue to be set aside.

CO_2 prices have already had an effect in stimulating the PPC to carry out a large-scale efficiency improvement programme at the existing lignite power

stations, and the youngest station at Florina is incorporating modern boiler technology to reach significantly higher efficiency than older plants. This is a commendable development. Further potential exists to increase lignite generating capacity, and the government and the regulator should consider the introduction of further advanced generation technology through retrofits or in new lignite power stations, where it is economically feasible.

Lignite mining and use has a high environmental impact, and requires significant capital investments in mining and power generation assets when a new mine is opened. An application by a private developer to open a new mine and power station was refused by the government on the advice of the RAE because of concerns about the financial viability of the applicant, the extent of the lignite reserves, and the environmental impact of a new station and mine. Two lignite deposits in northern Greece have not been opened at this stage, and the PPC has indicated its intention to open a new power station and mine at one of these. It is uncertain at this time whether it will be allowed to do so. In terms of further developing competition, it may be an option for the government to consider allowing another operator to construct a power station using lignite from these deposits, either transferring mining rights, or using PPC's mined lignite. Regardless of who operates a new lignite power station, the government and the regulator should consider requiring the use of the best available technology to reduce the environmental impact from the plant.

RECOMMENDATIONS

The government of Greece should:

- *Consider transferring ownership of the transmission and, later, the distribution network from PPC to HTSO.*
- *Consider an option to further restrict PPC bids in future tenders for capacity in order to reduce its dominance.*
- *Ask PPC to offer plants scheduled for retirement to investors willing to prolong their life, where this is practicable.*
- *Ensure the availability of sufficient capacity at peak demand times by the preparation of a policy framework, including* e.g. *long- and short-term measures to reduce demand in peak load situations and increase grid capacity between northern and southern Greece.*
- *Ensure continued full cost transparency of the operation of the transmission grid.*
- *Consider leaving open the choice of fuel for power generation in future tenders for capacity.*

- *Carefully analyse the capacity development and adjust the CAC mechanism to reflect VOLL and LOLP in the future.*
- *Develop tariffs for interruptible customers and full demand-side participation in the daily market.*
- *Ensure cost-reflective electricity pricing eliminating cross-subsidies among consumers, and evaluate the negative effects of geographically uniform tariffs.*
- *Ensure that future liabilities from environmental restoration continue to be taken into account in the price of lignite.*
- *Consider whether modern environmental control technologies for mining and using lignite in power stations allow the opening of new mines and power stations, and follow the development of such control technologies.*
- *Ensure full information disclosure of the costs of the lignite produced by PPC to increase transparency in electricity price formation, and allow potential non-PPC power station operators full access on commercial terms to PPC's lignite deposits.*

ENERGY TECHNOLOGY AND R&D

OVERVIEW

ORGANISATION

The Greek energy research and development (R&D) administration is managed centrally by the General Secretariat for Research and Technology (GSRT), which belongs to the Ministry of Development. It is the main authority responsible for the development and implementation of R&D policy. The key policy R&D objectives are formulated by the GSRT and are reflected in the design of the Operational Programme for Competitiveness (OPC) (see Chapter 3), which is the main funding instrument for R&D activities in Greece. The GSRT does not develop specific R&D policies beyond the overall framework, but instead relies on the reflection of its objectives in the thematic priorities in different national programmes, such as the OPC.

The objectives of general Greek R&D are:

- Increasing the demand for knowledge and research results in Greece.
- Reorganisation of the research system and knowledge production in Greece.
- Opening-up of the Greek research system to the European Union and the world.
- Development of state-of-the-art R&D infrastructure.

The Greek R&D policy objectives are closely linked to the targets of national energy policy. The energy policy targets are to increase the penetration of natural gas in the energy system, for electricity, heat and transport; to support clean coal technologies for electricity; to foster renewable energy sources for electricity, heat and transport; and to support the more efficient use of energy.

Research for high-priority fields, to which energy belongs, is conducted through "R&D Consortia in Sectors of National Priority". These aim to promote co-operation between research and production through long-term R&D projects in order to produce innovative products, processes or services and to respond to social or cultural needs affecting the competitiveness of the economy. Among these projects, renewable energy sources and energy efficiency were identified as priorities.

Taking into account the Kyoto commitments and domestic energy legislation, the Greek government sees a strong need to further support energy R&D. Particular drivers are the European energy directives such as those for renewable electricity (Directive 2001/77/EC), liquid biofuels (Directive 2003/30/EC), energy performance of buildings (Directive 2002/91/EC), emissions trading (Directive 2003/87/EC and 2004/101/EC) and co-generation (Directive 2004/8/EC).

INSTITUTIONS

The particular tasks of the GSRT include supporting the R&D activities of both the scientific research institutions (public research centres and universities) and those of the private sector, through the launching of a broad spectrum of national programmes. It focuses on key areas for the national economy and the improvement of the quality of life. It should also promote the transfer and dissemination of advanced technologies throughout the country's private sector, ensuring early utilisation of the results of research activity, and contribute to the reinforcement of the country's human resources in R&D. The GSRT represents Greece in the European Union's research-related institutions and promotes co-operation with other countries and international organisations. The GSRT is also providing and accounting for the budgets of the country's public research and technological centres. It has the task to establish new institutes and technological centres for research in areas of high priority for the development of the Greek economy, and to support the dissemination of R&D information throughout the country and internationally.

Regional authorities have not yet developed specific R&D policies according to the needs of their regions; but they launch and finance regional activities according to the programmes and priorities identified at a national level. Regional R&D activities are also managed by the GSRT.

The National Research and Technology Council advises the government on the national R&D priorities. Industry is involved in the policy-making process through the National Competitiveness Council, an advisory body to the Minister of Development, formally created in 2003, including participants from the main employers' associations and trade unions and also on an *ad hoc* basis through participation in various committees, or through responding to consultations.

Two public research centres are considered as the main bodies in identifying specific energy R&D policy priorities and in implementing energy R&D research activities:

- The Centre for Renewable Energy Sources (CRES) (see box) is the Greek national centre for renewable energy sources, rational use of energy and energy saving. CRES is identified as the national co-ordination centre in its areas of activity by Law 2244/94 (Production of Electricity from Renewable Energy Sources) and Law 2702/99.
- The Centre for Research and Technology Hellas (CERTH), with two Institutes active in energy:
  - The Chemical Process Engineering Research Institute (CPERI) conducts R&D and innovation activities in the field of science related to energy conversion.
  - The Institute for Solid Fuels Technology and Applications (ISFTA) is the main Greek organisation for the promotion of research and technological development aiming at the improved and integrated exploitation of solid fuels and their by-products.

Activities in the field of energy are also carried out at the National Centre for Scientific Research "Demokritos", the National Observatory of Athens (NOA), several universities and higher education Technological Institutes (TEI) and some private firms.

The Centre for Renewable Energy Sources (CRES)

CRES was founded in September 1987 by Presidential Decree 375/87. It is a public institute based in Athens, supervised by the Ministry of Development, General Secretariat of Research and Technology, and has financial and administrative independence. The main goal of CRES is the promotion of renewables and energy efficiency applications at a national and international levels, as well as the support of related activities, taking into consideration the environmental impacts on energy supply and use.

CRES also has a strong role in supporting the development of wider Greek energy policy by the creation of powerful information systems and energy models for Greek energy policy makers, and the maintenance of Greek energy statistics.

CRES is one of the strongest energy R&D players in Greece. The objectives of CRES in this area are the planning, co-ordination, realisation and assessment of applied research and technology development and demonstration projects in the field of renewable energy technologies and energy-saving technologies, along with the commercial exploitation of the new knowledge produced from the above activities to support market development with specific high-quality products and services. In the R&D sector, CRES is active in the following thematic areas: wind energy, biomass, geothermal energy, solar thermal, PV technology and distributed generation, water technologies (small hydro and ocean-tidal), hydrogen technologies in connection with renewables and solar panels in buildings.

CRES aims to be the connecting link between production (industry and SMEs) and the basic research developed in the Greek universities in an attempt to develop and promote high-quality products exploiting the know-how acquired through the co-operation of those three strategic partners (industry-CRES-universities). To achieve that, CRES combines a mix of activities, from research (applied research mainly) and demonstration to standardisation and certification. Key issues to meet these goals are:

- The access to full-scale laboratories and large research infrastructure.
- The systematic update of scientific–technical knowledge of CRES's human resources through their participation in cross-cutting RD&D programmes and human networks.

CRES currently has approximately 170 employees, the majority of which are working on research projects at least partially financed through EU structural funds. The majority of the researchers have a technical background.

PRIORITIES

Greek energy research is covering a range of research sectors, with a focus on renewables, energy efficiency, and transport. The R&D priorities for Greece are in the area of supplying isolated energy systems, and in reducing the environmental impact from burning lignite as a fuel for power generation.

The Greek energy R&D priorities were expressed during the consultation for the thematic priorities of the forthcoming European Framework 7 Programme and they are set out below. It is expected that the priorities will be unchanged in the short/medium and medium/long term of the research programme:

- Control of the energy consumption in the building sector and compliance with the European Directive on the Energy Performance in Buildings, including technologies of "energy optimised buildings" and active renewables-based systems for heating and cooling.

- Control of carbon emissions by developing new and advanced power plant concepts such as the "zero-emission power plant". R&D efforts are concentrated in the areas of components development, alternative fuel use, CO_2 capture, transport and storage.

- Increasing the flexibility and capacity of electrical networks to match renewable and other decentralised energy sources, in particular by developing storage solutions and advanced network management.

- Developing hydrogen solutions, in particular related to production (with the priority on hydrogen production from renewables), infrastructure and safety.

- Technological development of fuel cells for both stationary applications and transport.

- Polygeneration, including hybrid concepts with renewables.

- Renewables, with particular priority on:
  - Solar energy (PV and solar thermal, including heating and cooling applications).
  - Wind energy with emphasis on wind turbine technology for deployment in complex terrain (poor infrastructure) and offshore applications.
  - Geothermal energy, including applications and exploitation of low- and medium-temperature direct uses, and high-temperature power generation.
  - Biomass (complete chains) for heat, power and for fuel production.
  - Other renewables with longer-term potential (ocean, tidal, etc.).

OPERATION

Programmes

A programme for the development of human research potential called PENED is supported by the OPC to ensure the training of young researchers such as university graduates or post-graduates in priority sectors. Another programme, called "Integration of PhD Researchers from Abroad in Greece's R&D System", the ENTER programme, is also supported by the OPC. Renewables and energy saving are included in the thematic priorities of the programme.

The majority of the research programmes launched by the GSRT are either industry-oriented or promoting co-operation between industry and the academic sector. Consequently, most emphasis is given to applied and industrial research, the exploitation of research results, the promotion of technological innovation and to technology transfer. Basic research can be supported through the programmes "R&D Consortia in Sectors of National Priority", the PENED programme and the Programme for Bilateral Co-operation, while applied research is mostly supported through the OPC. The energy-related research priorities identified in the OPC are as follows:

- "R&D consortia in the field of renewable energy sources and energy saving "

  Renewable energy sources:
  Wind energy
  Photovoltaic systems
  Active solar systems
  Biomass
  Geothermal energy
  Fuel cells and hydrogen technologies
  Integration of renewable energy sources into energy systems

  Energy saving:
  Energy saving in transport and industry
  Energy saving in buildings

- "Energy-related R&D consortia in the field of natural environment"

  Protection of the atmospheric environment
  Recycling and desalination.

Funding

According to IEA statistics, the total energy R&D budget in 2002 was EUR 9.5 million. The energy R&D budget per thousand units of GDP in 2002 was 0.06, the sixth-lowest among 17 European countries for which data were available. No total energy R&D budget figure is available since 2003. The main source of funding for Greek energy R&D are EU Framework projects, where Greece benefits from being an Objective 1 country. Special programmes exist to increase the capacity of Greek research by widening the human resource pool.

The Ministry of Development funds energy R&D activities through the GSRT in different ways, including global budget funding for the institutes under its supervision, matching funds for the public institutes participating in international (mostly European) research activities, research infrastructure (mostly from structural funds), and the national R&D programme. Individual funding streams are:

- Government budget appropriations for 2004 and 2005 (provisional), based on the identified socio-economic objectives.
- Funding of energy R&D activities included in the different programmes of the "Operational Programme for Competitiveness 2000-2006". In particular, 11 projects were funded under the "R&D Consortia in Sectors of National Priority" and 20 under the PENED programme. Five industrial research projects were funded, plus two research projects on infrastructure.
- GSRT is allocating the regular institutional funding to the CRES and CERTH. In 2004 the regular funding of CERTH stood at EUR 2 339 970 and of CRES at EUR 540 000.
- General tax incentives are available for R&D expenditure in the form of an exemption of up to 50% of the R&D expenditures from profits, under Laws 3296/2004, Article 9 and 2992/2002, Article 10.
- Further financial support for energy R&D is provided through the regional operational programmes which are managed by the GSRT.

The GSRT manages a broad spectrum of horizontal, non sector-specific measures to exploit research results, and to enable technology transfer and innovation. All these schemes are open to energy-related R&D.

Support of commercial exploitation of research results is carried out through the PRAXE programme for the creation of spin-off companies. At a first stage, financial support is provided as seed capital for investment preparation activities, such as the development of industrial standards, business plans, investors search, etc. If that stage leads to successful results, investment is directly supported at the second stage of the programme. So far, ten first-stage PRAXE projects have been supported in the field of energy.

Other support by the GSRT has been for two projects of laboratories co-operating with enterprises and users of research results through the AKMON programme; support for R&D parks and incubators (ELEFTHO programme); support of liaison offices and technology brokers; and support of demonstration projects.

The OPC is also providing direct support. Under measure 4.5 "Collaborations for Research and Technological Development in Sectors of National Priority" 13 projects were approved under the calls issued so far. Their total budget was EUR 18 236 million, including EUR 7 573 million or 41.5% of public funding.

Research funds for CRES are acquired mainly from national and European framework programmes. CRES's extensive research infrastructure is mainly funded from structural funds. In recent years, CRES has had a strong involvement in commercial projects, exploiting its R&D results. CRES's annual R&D budget for 2004 is approximately EUR 2 million. Around 8% is funding directly from GSRT, while nearly 45% originates from the EU for collaborative research in the EU's fifth and sixth Framework Programmes. The remainder is co-funding of European projects (matching funds) and national projects supported by the Ministry of Development.

International Research Collaboration

Bilateral co-operation projects in the field of energy are also supported jointly with China, Poland, France, Serbia, Germany, Albania, Hungary and Cyprus.

Furthermore, renewable energy and hydrogen technologies were identified as major priorities in a national programme supporting co-operation of Greek teams with counterparts in technologically advanced countries outside the EU (the United States, Canada, Japan, Australia, etc.).

Greece participates in five IEA Implementing Agreements, which is the second-lowest level of participation among IEA countries. These are:

- Demand-side Management.
- Energy Conservation in Buildings and Community Systems Programme (ECBCS).
- Energy Technology Systems Analysis Programme (ETSAP).
- Fluidised Bed Conversion.
- Wind Energy Systems.

OUTPUT

Over the years Greece has developed research capabilities in many R&D fields related to sustainable energy development, including renewables, energy efficiency in buildings, clean coal technologies and, more recently, hydrogen technologies.

The outputs of Greek energy R&D are primarily used to support the national and European industry with new knowledge aimed at enhancing the innovative character of their products, and to support energy technology end-users in Greece with know-how and best practices for the assimiliation and application of new technologies

Monitoring

The most important national programme in the field of energy ("R&D consortia in the field of renewable energy sources and energy saving") has not yet been assessed.

CRITIQUE

The Greek R&D energy programme is centrally monitored by the General Secretariat for Research and Technology (GSRT) within the Ministry of Development. The major R&D stakeholders are relevant national research institutes operating under the supervision of GSRT, mostly active in applied research, and the country's universities mostly active in basic research.

It is cause for concern that reliable and consistent energy R&D data seem to be missing in Greece. For example, there are no updated figures on total government energy R&D spending and its allocation since 2002. It may be because various national research institutes and universities are involved in energy R&D, but the lack of a collective picture could hamper effective planning and implementation of national energy R&D programmes. This situation does not allow the proper assessment of the impact of energy R&D in Greece, and the government should consider improving the situation.

While the government's priorities on energy R&D are expressed during the consultation for the thematic priorities of the forthcoming European Framework 7 Programme, they cover a very wide range of areas, from energy efficiency, renewables, zero emissions technology, to hydrogen and fuel cells. With relatively limited government resources, it may be necessary to further sharpen priorities to maximise the cost-effectiveness of government energy R&D programmes. For example, in Australia, depending on its needs and capacities, a broad range of energy technologies have been grouped into three categories, "market leader" where Australia can play a leading role in international R&D efforts, "fast follower" where Australia has a strong position in quickly following international developments, and "reserve" where Australia monitors international developments and follows as needed. Such a differentiated approach may enable more focused prioritisation. An obvious area to be considered as "market leader" in Greece could be solar thermal technology.

In addition, it is not clear how the government intends to evaluate the performance of its R&D programmes. While the R&D consortia in the field of renewable energy sources and energy savings (the most important portion of the Greek energy R&D programme) has not been monitored and evaluated, the government should develop criteria against which it is evaluated.

While participation of the private sector in R&D activities is strongly encouraged, it has not yet reached the desirable levels, and the technological level of most Greek firms in the energy sector, with the exemption of solar heaters, is generally seen as low. While the R&D programme aims to be industry-oriented, it is unclear which, if any, internationally competitive energy technologies are produced in Greece.

Despite its high renewables potential, Greece is still heavily dependent on solid fuels, but this is not sufficiently reflected in its research efforts. R&D activities developing renewable energy sources, energy optimisation and

saving, as well as the development of clean technologies and other environment-friendly technological solutions for the optimal use of solid fuels and their by-products, are seen as priorities. A stronger focus on increasing the efficiency of fossil fuel conversion could contribute significantly to reducing the environmental impact from power generation in Greece.

An institutional reform, which will generate major changes in the overall R&D administration system in Greece, is expected to take place in the near future. A high-level committee has been set up to develop suggestions for the reform. Reducing the complexity of the administration is desirable in small countries in order to create an efficient R&D environment.

Greece has a successful and commendable record of participation in the EU framework programmes for research, technological development and demonstration, especially in the field of energy. Such international collaboration has contributed to the development of new innovative products and has facilitated the introduction of new technologies into the Greek energy system by creating the necessary knowledge base for such developments. The long-term involvement of the Greek research groups on the international R&D scene has also led to the formation of unofficial national thematic networks where the research institutes, universities and private companies co-operate in a stable and complementary way quite efficiently. There are several such examples, *e.g.* addressing wind energy, distributed energy resources, hydrogen technologies, or green buildings. The development of such clusters is commendable, but the absence of private-sector involvement in them is a cause for concern in terms of the relevance of the research results in the market place.

Compared with Greece's active involvement in the EU programmes, its participation in the IEA's Implementing Agreements is the second-lowest among IEA member countries. Greece may consider opportunities for more participation in Implementing Agreements which are in line with its R&D priorities.

RECOMMENDATIONS

The government of Greece should:

- *Develop and provide a detailed overview of priorities, funding, and actors in line with Greece's energy policy objectives.*
- *Develop clear criteria with which government R&D programmes are evaluated.*
- *Improve the collection of data on government R&D funding.*
- *Encourage the increase of the R&D capabilities of the private sector.*
- *Strengthen the research focus on reducing the environmental impact of fossil fuel use and increasing energy efficiency.*
- *Consider opportunities in joining IEA Implementing Agreements.*

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2003	2004P	2010	2020	2030
TOTAL PRODUCTION		**2.33**	**9.20**	**9.92**	**10.35**	**11.88**	**14.70**	**16.20**
Coal[1]		1.69	7.12	8.18	8.61	9.85	12.27	13.54
Oil		–	0.84	0.13	0.12	–	–	–
Gas		–	0.14	0.03	0.03	0.05	0.05	0.05
Comb. Renewables & Waste[2]		0.45	0.89	0.98	1.00	0.93	1.00	1.10
Nuclear		–	–	–	–	–	–	–
Hydro		0.19	0.15	0.41	0.39	0.55	0.67	0.67
Geothermal		–	0.00	0.00	0.00	0.06	0.17	0.28
Solar/Wind/Other		–	0.06	0.19	0.20	0.45	0.54	0.55
TOTAL NET IMPORTS[3]		**11.12**	**12.74**	**19.08**	**21.21**	**23.75**	**26.97**	**31.51**
Coal[1]	Exports	0.02	–	0.07	0.04			
	Imports	0.47	0.92	0.49	0.53	0.79	0.78	2.34
	Net Imports	0.45	0.92	0.42	0.49	0.79	0.78	2.34
Oil	Exports	4.95	7.56	6.04	5.79			
	Imports	16.51	21.87	25.72	27.32	22.39	25.83	27.81
	Bunkers	0.89	2.55	3.20	3.23	3.88	4.51	5.23
	Net Imports	10.67	11.76	16.48	18.30	18.50	21.32	22.59
Gas	Exports	–	–	–	–	..	..	..
	Imports	–	–	2.00	2.17	4.11	4.52	6.24
	Net Imports	–	–	2.00	2.17	4.11	4.52	6.24
Electricity	Exports	0.00	0.05	0.18	0.18			
	Imports	0.01	0.11	0.36	0.42	0.35	0.35	0.35
	Net Imports	0.00	0.06	0.18	0.24	0.35	0.35	0.35
TOTAL STOCK CHANGES				**-1.10**	**0.24**	**0.89**	**1.18**	**-**
TOTAL SUPPLY (TPES)		**12.36**	**22.18**	**29.89**	**32.74**	**35.63**	**41.67**	**47.70**
Coal[1]		2.10	8.07	8.91	9.19	10.64	13.05	15.88
Oil		9.61	12.81	17.19	19.48	18.50	21.32	22.59
Gas		–	0.14	2.03	2.23	4.16	4.57	6.28
Comb. Renewables & Waste[2]		0.45	0.89	0.98	1.00	0.93	1.00	1.10
Nuclear		–	–	–	–	–	–	–
Hydro		0.19	0.15	0.41	0.39	0.55	0.67	0.67
Geothermal		–	0.00	0.00	0.00	0.06	0.17	0.28
Solar/Wind/Other		–	0.06	0.19	0.20	0.45	0.54	0.55
Electricity Trade		0.00	0.06	0.18	0.24	0.35	0.35	0.35
Shares (%)								
Coal		*17.0*	*36.4*	*29.8*	*28.1*	*29.8*	*31.3*	*33.3*
Oil		*77.7*	*57.8*	*57.5*	*59.5*	*51.9*	*51.2*	*47.3*
Gas		*–*	*0.6*	*6.8*	*6.8*	*11.7*	*11.0*	*13.2*
Comb. Renewables & Waste		*3.6*	*4.0*	*3.3*	*3.1*	*2.6*	*2.4*	*2.3*
Nuclear		*–*	*–*	*–*	*–*	*–*	*–*	*–*
Hydro		*1.5*	*0.7*	*1.4*	*1.2*	*1.5*	*1.6*	*1.4*
Geothermal		*–*	*–*	*–*	*–*	*0.2*	*0.4*	*0.6*
Solar/Wind/Other		*–*	*0.3*	*0.6*	*0.6*	*1.3*	*1.3*	*1.2*
Electricity Trade		*–*	*0.3*	*0.6*	*0.7*	*1.0*	*0.8*	*0.7*

P: provisional.

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

Please note: Imports represent net imports

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2003	2004P	2010	2020	2030
TFC	**9.21**	**15.47**	**21.59**	**23.49**	**24.27**	**27.75**	**30.95**
Coal[1]	0.52	1.20	0.60	0.59	0.83	0.79	0.80
Oil	7.15	10.75	15.26	17.00	15.44	16.94	17.48
Gas	0.00	0.11	0.51	0.53	1.69	2.02	2.55
Comb. Renewables & Waste[2]	0.45	0.89	0.91	0.95	0.90	0.90	1.00
Geothermal	–	0.00	0.00	0.00	–	–	–
Solar/Wind/Other	–	0.06	0.11	0.11	0.10	0.11	0.12
Electricity	1.09	2.45	4.18	4.29	5.28	6.95	8.94
Heat	–	–	0.02	0.03	0.03	0.04	0.06
Shares (%)							
Coal	*5.6*	*7.8*	*2.8*	*2.5*	*3.4*	*2.8*	*2.6*
Oil	*77.6*	*69.5*	*70.7*	*72.4*	*63.6*	*61.1*	*56.5*
Gas	*–*	*0.7*	*2.4*	*2.2*	*7.0*	*7.3*	*8.2*
Comb. Renewables & Waste	*4.9*	*5.8*	*4.2*	*4.0*	*3.7*	*3.2*	*3.2*
Geothermal	*–*	*–*	*–*	*–*	*–*	*–*	*–*
Solar/Wind/Other	*–*	*0.4*	*0.5*	*0.5*	*0.4*	*0.4*	*0.4*
Electricity	*11.9*	*15.8*	*19.4*	*18.2*	*21.8*	*25.0*	*28.9*
Heat	*–*	*–*	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*
TOTAL INDUSTRY[4]	**3.49**	**4.70**	**5.15**	**5.42**	**4.97**	**5.28**	**5.97**
Coal[1]	0.46	1.18	0.60	0.59	0.83	0.79	0.80
Oil	2.39	2.18	2.69	2.94	1.71	2.08	2.26
Gas	–	0.10	0.45	0.45	0.80	0.60	0.88
Comb. Renewables & Waste[2]	–	0.19	0.20	0.23	0.20	0.20	0.20
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	0.63	1.04	1.22	1.21	1.43	1.62	1.83
Heat	–	–	–	–	–	–	–
Shares (%)							
Coal	*13.1*	*25.0*	*11.6*	*10.8*	*16.7*	*14.9*	*13.4*
Oil	*68.7*	*46.5*	*52.1*	*54.3*	*34.5*	*39.4*	*37.9*
Gas	*–*	*2.2*	*8.8*	*8.3*	*16.1*	*11.4*	*14.7*
Comb. Renewables & Waste	*–*	*4.1*	*3.9*	*4.2*	*4.0*	*3.8*	*3.3*
Geothermal	*–*	*–*	*–*	*–*	*–*	*–*	*–*
Solar/Wind/Other	*–*	*–*	*–*	*–*	*–*	*–*	*–*
Electricity	*18.2*	*22.2*	*23.6*	*22.4*	*28.7*	*30.6*	*30.6*
Heat	*–*	*–*	*–*	*–*	*–*	*–*	*–*
TRANSPORT[5]	**2.70**	**5.95**	**7.98**	**9.08**	**9.74**	**11.45**	**12.54**
TOTAL OTHER SECTORS[6]	**3.03**	**4.82**	**8.46**	**8.99**	**9.55**	**11.02**	**12.44**
Coal[1]	0.04	0.03	0.01	0.01	–	–	–
Oil	2.08	2.63	4.63	5.02	4.14	3.58	2.87
Gas	0.00	0.01	0.05	0.06	0.78	1.32	1.59
Comb. Renewables & Waste[2]	0.45	0.70	0.71	0.72	0.70	0.70	0.80
Geothermal	–	0.00	0.00	0.00	–	–	–
Solar/Wind/Other	–	0.06	0.11	0.11	0.10	0.11	0.12
Electricity	0.46	1.40	2.94	3.05	3.80	5.26	7.01
Heat	–	–	0.02	0.03	0.03	0.04	0.06
Shares (%)							
Coal	*1.4*	*0.5*	*0.1*	*0.1*	*–*	*–*	*–*
Oil	*68.6*	*54.5*	*54.7*	*55.8*	*43.3*	*32.5*	*23.0*
Gas	*0.1*	*0.1*	*0.5*	*0.7*	*8.1*	*12.0*	*12.8*
Comb. Renewables & Waste	*14.9*	*14.6*	*8.4*	*8.0*	*7.4*	*6.4*	*6.4*
Geothermal	*–*	*0.1*	*–*	*–*	*–*	*–*	*–*
Solar/Wind/Other	*–*	*1.2*	*1.2*	*1.2*	*1.0*	*1.0*	*0.9*
Electricity	*15.0*	*29.0*	*34.8*	*33.9*	*39.8*	*47.7*	*56.4*
Heat	*–*	*–*	*0.3*	*0.3*	*0.3*	*0.4*	*0.4*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2003	2004P	2010	2020	2030
ELECTRICITY GENERATION[7]							
INPUT (Mtoe)	**3.34**	**8.90**	**12.57**	**12.63**	**14.81**	**18.72**	**23.53**
OUTPUT (Mtoe)	**1.27**	**2.99**	**4.98**	**5.05**	**6.07**	**8.09**	**10.44**
(TWh gross)	14.82	34.78	57.91	58.69	70.64	94.02	121.39
Output Shares (%)							
Coal	*35.5*	*72.4*	*60.7*	*60.6*	*54.7*	*55.6*	*54.8*
Oil	*49.5*	*22.3*	*15.1*	*14.0*	*13.8*	*16.9*	*16.4*
Gas	*–*	*0.3*	*13.8*	*15.3*	*16.2*	*13.5*	*17.8*
Comb. Renewables & Waste	*–*	*–*	*0.4*	*0.4*	*0.2*	*0.1*	*0.1*
Nuclear	*–*	*–*	*–*	*–*	*–*	*–*	*–*
Hydro	*15.0*	*5.1*	*8.2*	*7.8*	*9.1*	*8.3*	*6.4*
Geothermal	*–*	*–*	*–*	*–*	*0.1*	*0.2*	*0.3*
Solar/Wind/Other	*–*	*0.0*	*1.8*	*1.9*	*5.8*	*5.4*	*4.2*
TOTAL LOSSES	**3.14**	**7.00**	**8.81**	**9.53**	**11.37**	**13.92**	**16.76**
of which:							
Electricity and Heat Generation[8]	2.07	5.91	7.57	7.56	8.71	10.59	13.03
Other Transformation	0.44	–0.23	–0.75	0.03	0.38	0.58	0.60
Own Use and Losses[9]	0.64	1.31	1.99	1.95	2.28	2.75	3.13
Statistical Differences	**0.00**	**–0.28**	**–0.51**	**–0.29**	**–**	**–**	**–**

INDICATORS

	1973	1990	2003	2004P	2010	2020	2030
GDP (billion 2000 USD)	68.88	90.04	128.15	133.27	159.14	213.86	287.42
Population (millions)	9.08	10.34	10.98	11.05	11.21	11.50	11.79
TPES/GDP[10]	0.18	0.25	0.23	0.25	0.22	0.19	0.17
Energy Production/TPES	0.19	0.41	0.33	0.32	0.33	0.35	0.34
Per Capita TPES[11]	1.36	2.15	2.72	2.96	3.18	3.62	4.05
Oil Supply/GDP[10]	0.14	0.14	0.13	0.15	0.12	0.10	0.08
TFC/GDP[10]	0.13	0.17	0.17	0.18	0.15	0.13	0.11
Per Capita TFC[11]	1.01	1.50	1.97	2.13	2.16	2.41	2.63
Energy-related CO_2 Emissions (Mt CO_2)[12]	34.4	70.6	94.1	..	..	..	..
CO_2 Emissions from Bunkers (Mt CO_2)	4.5	10.5	12.5	..	..	..	..

GROWTH RATES (% per year)

	73–79	79–90	90–03	03–04	04–10	10–20	20–30
TPES	4.4	3.0	2.3	9.5	1.4	1.6	1.4
Coal	8.7	8.0	0.8	3.2	2.5	2.1	2.0
Oil	3.5	0.7	2.3	13.3	–0.9	1.4	0.6
Gas	–	–	23.0	10.0	10.9	0.9	3.2
Comb. Renewables & Waste	–	6.4	0.7	2.1	–1.3	0.8	1.0
Nuclear	–	–	–	–	–	–	–
Hydro	8.2	–6.2	7.9	–4.6	5.9	2.0	–0.0
Geothermal	–	–	–8.1	–	96.2	11.5	5.3
Solar/Wind/Other	–	–	9.8	4.7	14.4	1.9	0.1
TFC	4.0	2.6	2.6	8.8	0.5	1.4	1.1
Electricity Consumption	7.0	3.7	4.2	2.6	3.5	2.8	2.6
Energy Production	8.3	8.5	0.6	4.4	2.3	2.2	1.0
Net Oil Imports	2.5	–0.4	2.6	11.0	0.2	1.4	0.6
GDP	3.3	0.7	2.8	4.0	3.0	3.0	3.0
Growth in the TPES/GDP Ratio	1.1	2.3	–0.4	5.3	–1.5	–1.4	–1.6
Growth in the TFC/GDP Ratio	0.7	1.9	–0.1	4.6	–2.4	–1.6	–1.8

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 and industrial 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 Includes non-energy use.

5 Includes less than 1% non-oil fuels.

6 Includes residential, commercial, public service and agricultural sectors.

7 Inputs to electricity generation include inputs to electricity and CHP. Output refers only to electricity generation.

8 Losses arising in the production of electricity and heat at main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 100% for hydro.

9 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.

10 Toe per thousand US dollars at 2000 prices and exchange rates.

11 Toe per person.

12 "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.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The 26 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 IEA members wish to retain and improve the nuclear

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

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

5. **Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

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

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

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

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

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

GLOSSARY AND LIST OF ABBREVIATIONS

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

AOPC	Association of Oil and Petroleum Companies
bbl	barrel
bcm	billion cubic metres
CAC	capacity availability certificate
CCGT	combined-cycle gas turbine
CHP	combined production of heat and power; sometimes when referring to industrial CHP, the term "co-generation" is used
cm	cubic metres
CNG	compressed natural gas
CRES	Centre for Renewable Energy Sources
CSF	Community Support Framework
CSFTA	Centre for Solid Fuels Technologies and Applications
DEPA	Greek Public Gas Corporation
DESFA	Gas Transmission System Operator
DSO	Transmission and Distribution System Operator
EC	European Commission
EPA	gas distribution company
ESCO	energy service company
ETS	EU–Emissions Trading Scheme
EU	European Union
FYROM	former Yugoslav Republic of Macedonia
GDP	gross domestic product
GHG	greenhouse gas

GSRT	General Secretariat for Research and Technology
GW	gigawatt, or 1 watt × 10^9
GWh	gigawatt-hour, or 1 gigawatt × 1 hour
HCC	Hellenic Competition Commission
HTSO	Hellenic Transmission System Operator
HV	hight voltage
IEA	International Energy Agency
IGI	Italy–Greece Interconnector
IGT	Interconnector Greece-Turkey
IPP	independent power producer
kt	thousand tonnes
kV	kilovolt, or 1 volt × 10^3
kWh	kilowatt-hour, or 1 kilowatt × one hour
LNG	liquefied natural gas
LOLP	loss of load probability
LPG	liquefied petroleum gas
LV	low voltage
m^2	square metre
m^3	cubic metre
mbbl	million barrels
Mboe	million barrels of oil equilavent
mcm	million cubic metres
MOS	monthly oil questionnaire
m/s	metres per second
Mt	million tonnes
Mtce	million tonnes of oil equivalent (1 Mtce = 0.7 Mtoe)
Mtoe	million tonnes of oil equivalent; see toe
MW	megawatt, or 1 watt × 10^6
MW_e	megawatt of electrical capacity
MW_h	megawatt-hour, or 1 megawatt × one hour
NAP	National Allocation Plan
NOA	National Observatory of Athens

OASA	competent body for public transportation in Athens
OECD	Organisation for Economic Co-operation and Development
OPC	Operational Programme for Competitiveness
PPC	Greek Public Power Corporation
PPP	purchasing power parity
PV	photovoltaic
RAE	Regulatory Authority for Energy
R&D	Research and development, especially in energy technology; may include the demonstration and dissemination phases as well
RES	renewable energy sources
SAIDI	System Average Interruption Duration Index
SCS	Greek Supreme Council of State
SMP	system marginal price
TFC	total final consumption of energy
TJ	terajoule, or 1 joule x 10^{12}
toe	tonne of oil equivalent, defined as 10^7 kcal
TPA	third-party access
TPF	third-party finance
TPES	total primary energy supply
TSO	transmission system operator
TW	terawatt, or 1 watt x 10^{12}
TWh	terawatt-hour, or 1 terawatt x 1 hour
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax
VOLL	value of lost load

IEA PUBLICATIONS, 9, rue de la Fédération, 75739 PARIS CEDEX 15
PRINTED IN FRANCE BY STEDI MEDIA
(61 2006 05 1P1) ISBN : 92-64-10973-0 – 2006