HELLENIC
REPUBLIC

MINISTRY OF DEVELOPMENT

ENERGY
OUTLOOK
OF GREECE

FEBRUARY 2009

"Statistics are useful only when they shed light on the human condition"

Paul Krugman, Nobel Prize in Economics, 2008,
In 'The America We Want'

The present publication was elaborated in the context of the project
"An Integrated Information System for Supporting Energy Policy and Planning" of the Operational Programme "Information Society"

CONTENTS

TABLES

FIGURES

PREFACE

The present study reviews and analyses the Greek Energy System, taking into account the current International and European developments in the field of energy. It includes, among others, a detailed presentation of the Greek Energy System evolution for the past 15 years (1990-2006), along with a techno-economic assessment of its prospects while approaching 2020, the milestone year set by the European Union for achieving specific energy targets and taking actions against the climate change.

The working groups established for delivering this study, included scientists and experts in the analysis of energy systems, who came from the following organisations, Centre for Renewable Energy Sources and Saving (CRES), Regulatory Authority for Energy (RAE), Hellenic Transmission System Operator (HTSO), Public Power Corporation (PPC), Hellenic Gas Transmission System Operator (DESFA SA), Institute of Geology & Mineral Exploration (IGME) and Ministry of Development. The data concerning the Green House Gas emissions were obtained by the National Center for the Environment & Sustainable Development.

It is our belief that this study serves as a useful tool for the intermediate monitoring of the national targets set in the framework of the Long Term Energy Planning report. Moreover, it can be employed as a reliable source for any one either expert or individual, who wishes to be informed on energy issues that will have increasing importance and will become key issues for future strategic energy planning.

INTRODUCTION

Energy, in the space of a few years, has acquired a political dimension which had been practically forgotten since the oil crisis of 1985. A few years later however, in 1988, the price of a barrel of oil cost around 10 dollars and the problem at that time was the fact that this low price put the brakes on investments in drilling and production. The sudden jump in prices after 2000, combined with international geopolitical tension and environmental protection initiatives have resulted in the choices of energy sources and energy prices becoming a news item as well as a concern for consumers in the framework of policy development for the society of the future. The recurring crises from 2006 onward, between Russia (main natural gas supplier to Europe) and the Ukraine, obliges us to consider security of supply from a new vantage point.

Energy policy is now called upon to answer basic questions such as:

- what is the price of energy products which will influence the new goals for European energy policy?
- which energy investments must be made in the future?
- what is the operating framework of the energy market?

Greece cannot avoid this discussion. Energy, which is necessary for economic development and citizens' prosperity, must be physically and economically accessible, and at the same time, its use and production must support sustainable development.

The forecasts[1] made for this study allow us to form a definite picture with more or less certainty on the direction energy is taking. The scenarios which were examined assist political leadership in taking the decisions which will allow the desired results to be achieved through an informed energy policy applied to its goals.

[1] The data are derived from relevant sources, which are referred to the associated sections.. In case of not adequate data and not officially verified, data from Eurostat is provided. The most recent available data on energy which were used for analyzing the present status, tracking trends and forecasting, were for the year 2006, which was the most recent year for which an energy balance was published by the Ministry of Development and all necessary data were verified at the time when the present study was done.

1.

The Greek energy sector is defined by an increasingly voracious energy consumption, mainly in the transportation and tertiary-domestic sectors, and by the inability of domestic production to satisfy energy requirements and as a result, by an external dependence which is increasing and costly for the country's economy.

1.1 GENERAL REVIEW

Lignite is the main domestic energy source which is used almost exclusively for electricity production. Four fifths (85,7%) of the total domestic consumption are covered by fossil fuels (petroleum and lignite). Natural gas was imported for the first time in 1996 and renewable energy sources, with the exception of large hydroelectric plants, began to be a non negligible source for energy production towards the end of the 1990's. Greece's energy dependence is much greater than the E.U. average[2] and was approximately 72% in 2006, mainly due to the importation of oil and natural gas.

1.1.1 Greece: An increasingly energy hungry economy

It is important that the development of final energy consumption in Greece is followed and analyzed mainly through the corresponding shares of the domestic and transportation sectors which dominate.

a) Final Energy Consumption increased by 50% between 1990 and 2006 and this is due to the good state of the Greek economy during this period. From 1995 onwards, the Greek economy showed a significant improvement in various economic development indicators. Thus, between 1995 and 2006, the development of the GDP was about 3,9% per year (see Table 1.1).

Table 1.1 Economic Development in Greece

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	1995-2006
GDP	2,4%	3,6%	3,4%	3,4%	4,5%	4,2%	3,4%	5,6%	4,9%	2,9%	4,5%	3,9%

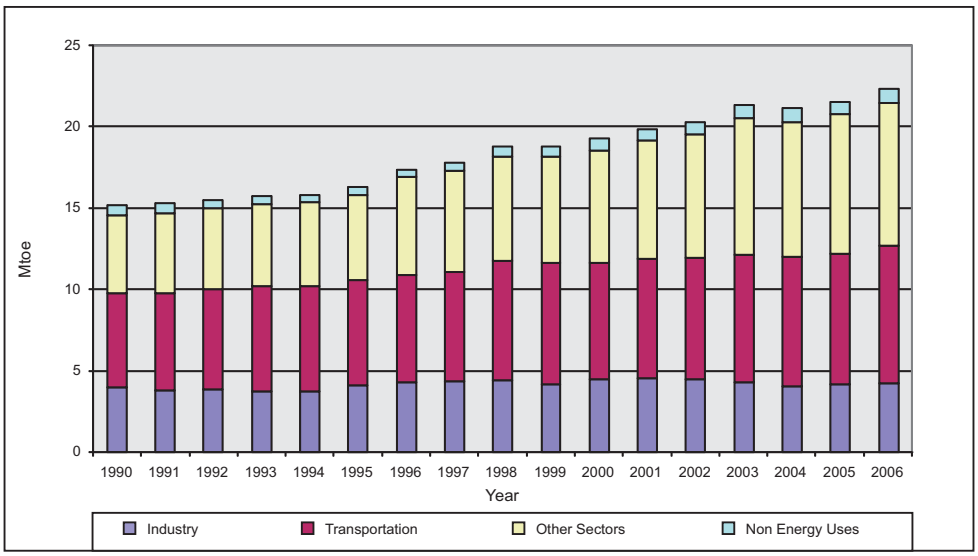
[2] The external energy dependence of the European Union is 57% for the EU(15) and 54% for the EU(27)

In 2006, the **gross inland energy consumption** in Greece reached 31,5 Mtoe (Figure 1.4). This is an increase of 40% over 1990 levels when Gross inland Energy consumption was 22,3 Mtoe, and during the years 1995-2006, the average yearly increase was 2,7%.

Even though final energy consumption remained steady between 1990-1994, amounting to 15 million tons of oil equivalent (non energy uses are the only exception), from 1995 onwards it began to increase. In 1996, it made a leap of around 6,5% with a corresponding increase in economic development of about 2,4%. In 2006, final energy consumption was 21,45 Mtoe (Figure 1.1). It is obvious that economic development has not yet been disconnected from increased energy demand.

Petroleum products have the biggest share, covering 2/3 (68,5%) of demand while electricity amounts to over 1/5 (21%) of final consumption. Solid fuels (1,87%), renewable energy sources (5%) and natural gas (3,2%) cover only small percentages of energy consumption (Figure 1.2).

Figure 1.1 Final energy consumption by sector



The demand for electrical energy in Greece increased at a fast rate from 1990 onwards. The main increase is in the domestic and tertiary sector. Specifically, in 2006, the tertiary sector was the biggest consumer of electrical energy in Greece with a yearly consumption of 17,7 TWh. This is a percentage increase of about 21,6% compared to 1990 levels, when consumption by the tertiary sector was just 5,6 TWh.

Although industry was the biggest consumer of electrical energy in 1990 with a consumption of 12,1 TWh, in 2006 it fell to 3rd place with a consumption of 14,1 TWh and a percentage increase of 14% in relation to 1990 levels. The domestic sector had a consumption of around 17,6 TWh in 2006, in comparison to 9,1 TWh in 1990, showing a 93% total increase and it now consumes more than the industrial sector (Figure 1.3).

b) Energy consumption sectors

The total of the tertiary, domestic, public and agricultural sectors consumed in 2006 46% of the energy, while in 1990 the corresponding percentage was 40%. Industry shows a steady consumption level over the last few years which in 2006 was 4,2 Mtoe, showing an increase of 0,2 Mtoe or 5% compared to 1990. The per capita energy consumption in Greece is at an average level compared to world energy statistics.

Figure 1.2 Final Energy Consumption by Fuel (1990, 2006)

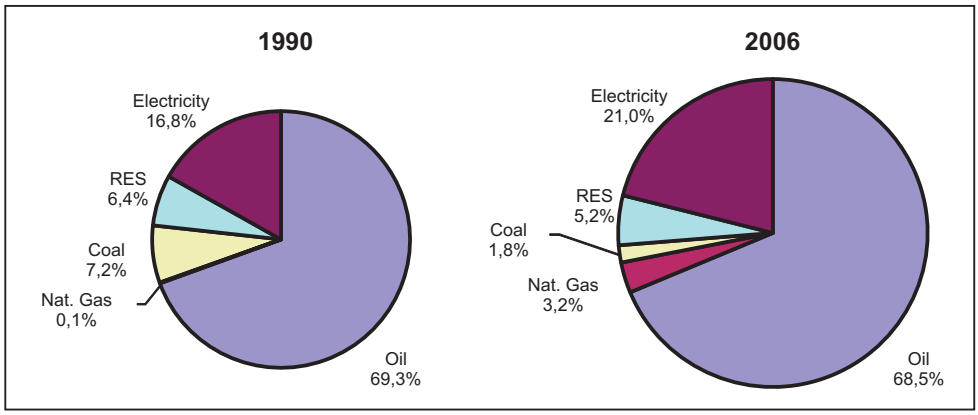
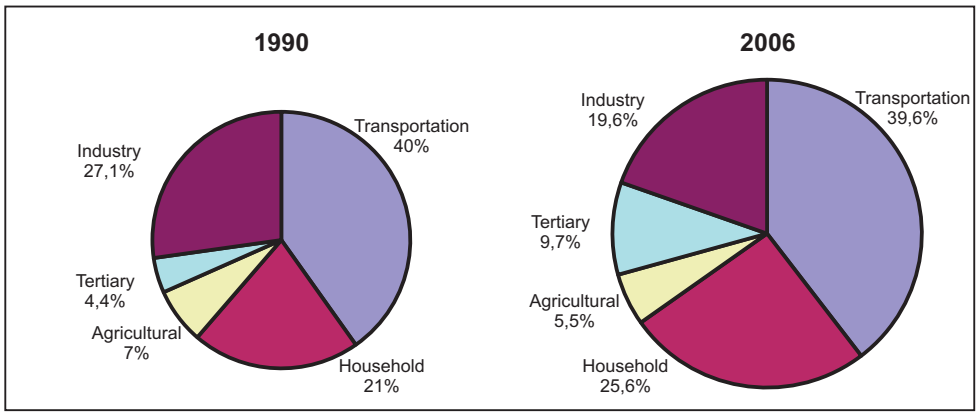


Figure 1.3 Shares in Final Energy Consumption by Sector (1990, 2006)



The development of market shares in consumption sectors in Greece is typical for an economy in post industrial development which is oriented towards a service economy where industry is significantly reduced and the domestic along with the tertiary sector gradually develop their corresponding shares. The tertiary sector more than doubled in 15 years, going from 4,4% to 9,7%. The contribution of these sectors to the GDP confirms this increase, while correspondingly, tourism is the main profitable activity in the country[3].

[3] The contribution of industry to the GDP is around 12% and that of the tertiary sector around 66%.

Transportation

The consumption of energy in the transportation sector comprises 39,6% of the final energy consumption in 2006 and corresponds to 8,5 Mtoe. The energy consumption in the transportation sector continues to increase (+ 46% in relation to 1990) in absolute values, but as a corresponding percentage final consumption remained flat due to the increase in the domestic and tertiary sector.

Industry

In the last few years, industry has undergone intensive modernization. In 2006 industrial consumption was 4,2 Mtoe, remaining almost at the 1990 level. As a result the share of industry in final consumption has fallen by about 7%.

Household Sector

In 2006 households consumed 5,5 Mtoe while consumption in 1990 was 3 Mtoe. (Figure 1.3). The increase in final energy consumption in households was 83% between 1990 and 2006 and the increase in the share of households in final consumption in 2006 is 4,6% compared to 1990 levels.

Tertiary Sector

The tertiary sector showed the greatest increase in energy consumption between 1990 and 2006 (Figure 1.3), reaching 2 Mtoe in 2006, that is a tripling of consumption compared to 1990 levels and an average rate of increase of 7,2% per year. As a result, the share of the tertiary sector was about 9,7% in 2006, compared to 4,4% in 1990.

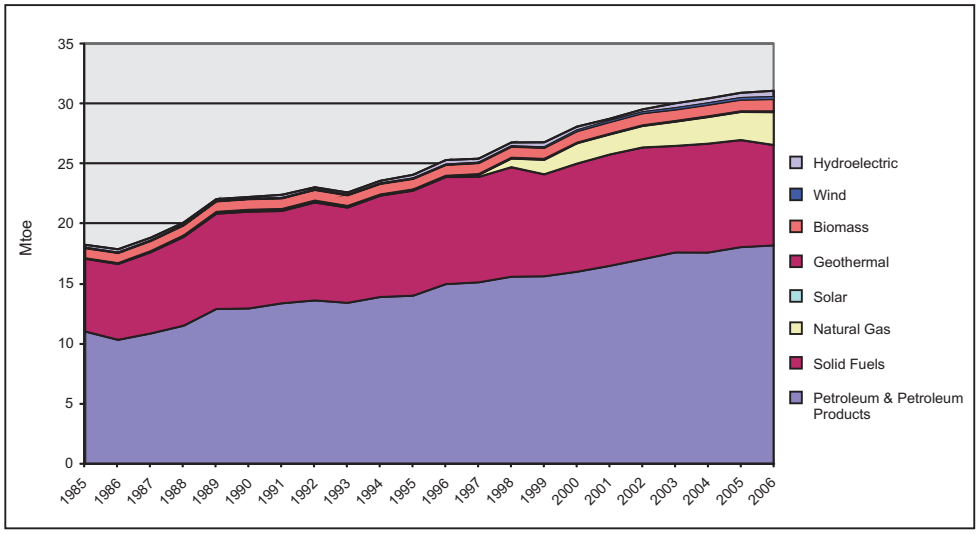
Agricultural Sector

Consumption by the agricultural sector was 1,1 Mtoe in 2006, remaining at 1990 levels and its share has been reduced by 1,5%.

1.1.2 Domestic Energy Production is Insufficient

Solid fuels (mainly lignite) were 8 Mtoe in 1990 (36% of Total Inland Energy Consumption) and reached 8,4 Mtoe (26,6% of GIC) in 2006. The share of oil remained steady from 12,9 Mtoe (57,8%) in 1990, to 18,2 Mtoe (57,8%) in 2006. Gas fuels increased from 0,14 Mtoe (0,6%) in 1990 to 2,74 Mtoe in 2006 (8,7%). The share of renewable energy sources remained steady at around 5-5,5% between 1990 (1,1 Mtoe) and 2006 (1,8 Mtoe) and show small fluctuations which reflect the use of large hydroelectric plants.

Figure 1.4 Total Gross Inland Energy Consumption



In 2006, Greece had a total **Gross Inland Energy Consumption** of 31,5 Mtoe. The production of primary energy was 10 Mtoe and net imports correspond to about 24,85 Mtoe and consumption by seagoing vessels was 3,2 Mtoe.

1.1.3 International Dependence: Increased Costs for the Greek Economy

Greece's energy dependence is shown in Figures 1.5 and 1.6, where forecasts for the year 2020 are included according to current trends (Reference Scenario, Chapter 2). The consequences of this large energy dependence are that between 2004 and 2008 the value of imported crude oil increased twofold. Given that the price of natural gas is connected to the price of oil, the value of imported natural gas is affected accordingly.

European solidarity and the continuous improvement in the GDP reduce the dangers connected with Greece's heavy energy dependence. The Russo-Ukrainian crisis demonstrated, however, the ability of the Greek energy system to manage a supply interruption by its natural gas main supplier, without affecting consumers.

Figure 1.5 Development of the distribution of imports by fuel

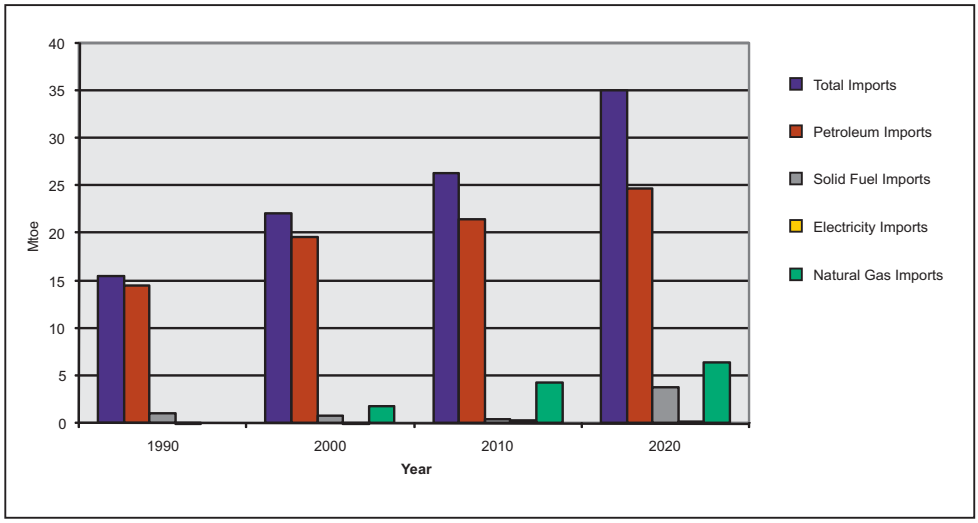
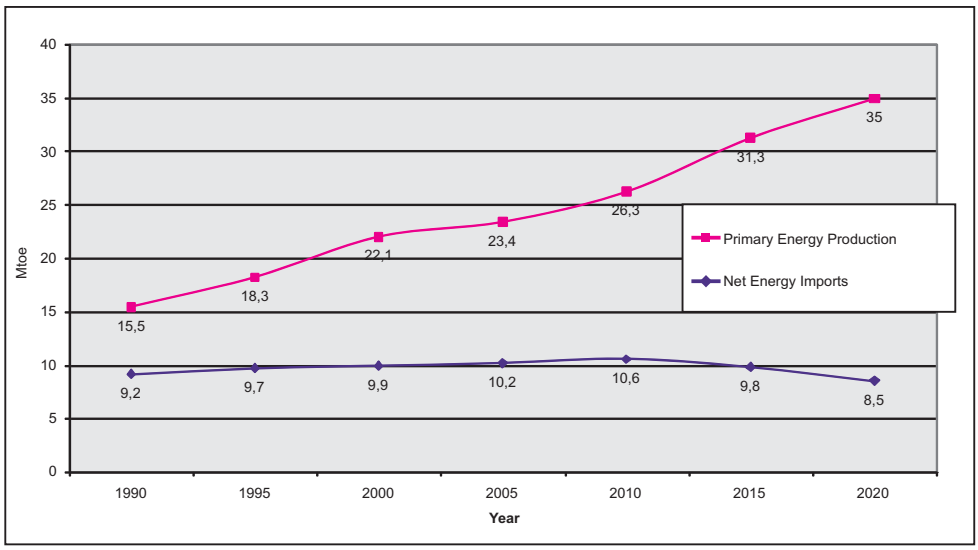


Figure 1.6 Development of domestic energy production and energy imports



1.

1.2.1 Solid Fuels: Concentrated in Electricity Generation

The use of solid fuels in Greece is mainly focused on the production of electricity.

Lignite is the only indigenous source of solid fuels. Lignite, a fuel of low-calorific value that ranges between 900-2000 kcal/kg with an average value of 1300 kcal, is used exclusively for power-generation whenever certain requirements are satisfied regarding its reserves and the location of the deposit according to the surface.

Only certain quantities of lignite are used as fuel in metallurgy, greenhouses, home heating, as well as in the improvement of the topsoil for cultivation. Under the current conditions and taking into consideration the fact that the smallest size of a lignite Steam Turbine Power Plant is around 320 -350 MW which consumes roughly 3 million tons of lignite during a 30-year lifespan, the exploitable lignite deposit should be around 100 million tons.

The exploitation of smaller lignite deposits for power generation is also feasible when their production already supports Steam Turbine Power Plant operation, like in the case of the PPC power plant in western Macedonia. Various smaller lignite deposits are scattered across Greece in total accounting for some 350 million tons, 150 million tons of which are located in the regions of Kozani and Servia.

The proprietary status of the lignite deposits in the country is divided as follows:

1. Lignite deposits that have been granted to the PPC in two regions: One in Western Macedonia (Ptolemais-Amynteo-Florina) and a second one in the Peloponnese (Megalopolis)
2. Lignite deposits leased to private companies or individuals. The most important one of this group of deposits is the one in Achlada in the prefecture of Florina
3. Lignite deposits that are the property of the State such as the ones in Elassona and Drama

The current lignite production of the PPC mines is in the order of 65-67 million tons per year. It is used as the fuel input for 5289 MW of Steam Turbine Power Plants whereas the production of the private mines ranges around 36 million tons, out of which approximately 90% comes from the Achlada mine and the rest from the mine of Servia in the prefecture of Kozani which supplies the LARKO smelting plant.

Table 1.2 shows an estimation of the exploitable lignite deposits by late 2008 based on technical and financial criteria. The bulk of these deposits was located in northern Greece. Small amounts of coal, around 0,8-1,0 million tons, are imported mainly for use in the cement industry.

Lignite will continue to be the "national fuel" for power generation in Greece, however, its participation in overall power generation will increasingly decline by 2050 when the last lignite plant will cease operations. The incorporation of gas emission costs (emissions trading), as well as the structure of international natural gas prices could affect the future of lignite power plants in the country.

Table 1.2 Estimate of lignite reserves (2008)

Area of Mine	Location	Remaining Exploitable Deposits (Mt)
Ptolemaida (PPC)	Western Macedonia	1220
Amyntaio (PPC)	Western Macedonia	130
Megalopolis (PPC)	Peloponnese	210
Florina (PPC)	Western Macedonia	140
Drama	Western Macedonia	900
Elassona (PPC)	Central Greece	155
Komnena (PPC)	Western Macedonia	95
Privately owned mines	Western Macedonia	170
TOTAL		**3020**

The remaining operational years of the lignite power plants based on the lignite deposits, are as follows:

1) Amynteo. Annual production of 8 million tons. A gradual closure of the plants is planned by the years 2023-2024. The lignite deposits at Amynteo will last for another 16-18 years
2) Florina. Annual consumption of 2,3 million tons. The deposits, according to the owners of the Achlada mine are around 90-100 million tons and according to the PPC 70-80 million tons. Yet another plant is scheduled to come into operation in Florina (Meliti) by 2014. This plant will consume 2,5-2,6 million tons of lignite annually. The Florina plant will be also supplied by the private mine of Achlada, as well as the one at Vevi (run jointly by private investors and the PPC). The deposits will last for another 30-50 years with the support of two small PPC mines elsewhere in the prefecture of Florina (Meliti Hills and Klidi)
3) Ptolemais. The lifespan of these deposits will depend mainly on the operation of the PPC Ptolemaida V unit which is planned to be constructed in Ptolemais, with a generating capacity of 650 MW that will require 7 million tons annually, as well as on when the plants Ptolemais I, II and III will shut down. According to current estimates, these deposits will last for another 25-30 years
4) Megalopolis. The Steam Turbine Units Megalopolis I, II and III have an annual consumption of 7,5 million tons. They will shut down sometime between 2012

and 2024 when the deposits will be exhausted. Megaloplis IV will be operational till 2042

5) Drama. There is no lignite consumption. Deposits of 900 million tons. Lower calorific value of lignite between 900 – 950 kcal/kg
6) Elassona. The deposits can support two plants of 350 MW each (6,5 mill tons/year) for 20-24 years
7) Komnena. There are lignite deposits, but they are not being exploited

1.2.2 Petroleum Products: Concentrated in Transportation

The Greek petroleum market consists of 4 refineries (Table 1.3), about 50 commercial companies and a large number of retail outlets. Crude oil is almost exclusively imported. The refining capacity of the four refineries is enough to cover the demand of the domestic market and surplus amounts are exported in the form of international sales or sales to airlines and seagoing vessels. The refining capacity of Greek refineries is about 20 million metric tons a year. The average amount of crude which has been refined over the last few years in Greece is about 18-20 million metric tons per year.

In 2006, the total consumption of petroleum products was 18,2 Mtoe, an amount which corresponds to 57,8% of gross domestic consumption, which is almost 100% imported. The percentage, 57,8% was the same in 1990 (the numbers refer to the primary supply of crude oil energy, feedstocks and petroleum products).

In final consumption the share of petroleum products was 14,7 Mtoe in 2006, which is 68,5% and remains at the same levels as 1990 (69%). The transportation sector consumed 57% of the petroleum products in final consumption, the domestic sector 20%, the tertiary sector and the agricultural sector 10% each and industry 13%.

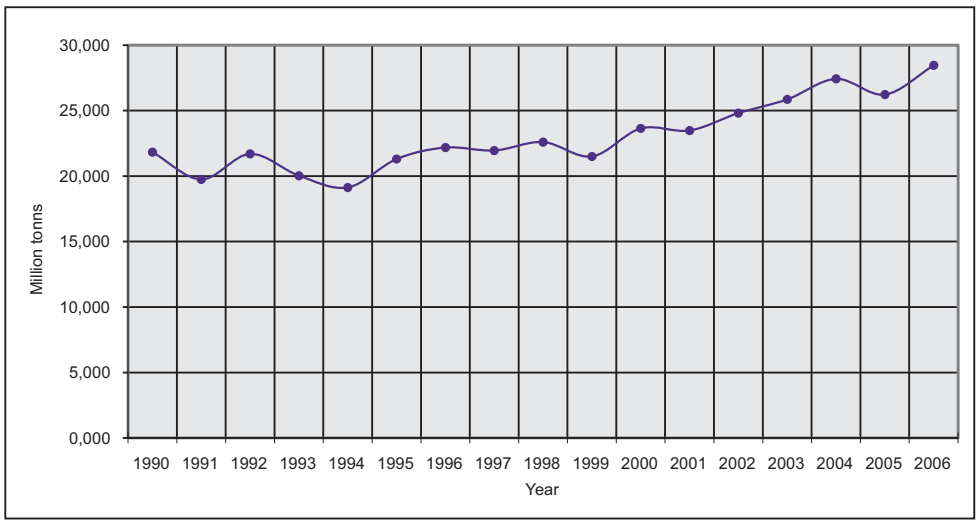
Table 1.3 The Four Greek Refineries

OWNER	HELLENIC PETROLEUM	HELLENIC PETROLEUM	HELLENIC PETROLEUM	Motor Oil Hellas
Name	Aspropyrgos Refineries	Thessaloniki Refineries	Elefsina Refineries	Motor Oil Hellas
Location	Aspropyrgos	Thessaloniki	Elefsina	Aghioi Theodori
Capacity: mt/year bbl/d	 6,7 135	 3,45 75	 5,0 100	 4,5 100
Type of Refinery - Processes	Crude refining, Vacuum distillation, Catalytic reforming, Isomerization of Light Naphtha, Viscolysis, Petroleum Desulfurization Unit, VGO Desulfurization Unit	Crude refining, Vacuum distillation, Catalytic reforming, Isomerization of Light Naphtha, Petroleum Desulfurization Unit	Crude refining, Petroleum Desulfurization Unit	Catalytic and thermal conversion, Isomerization, MTBE Production of high octane number compounds, Atmospheric distillation Petroleum Desulfurization Unit
Year of Construction	1958	1966	1972	1972

The share of petroleum in the Greek energy balance is very high and this is due to the extensive use of petroleum in transportation and also to the fact that the electricity generating system in the non connected islands is fuelled mainly by petroleum products.

Greece imports oil from the Middle East and to a lesser extent, from former Soviet Union countries. A small oil deposit in Northern Greece provides about 0,6% of the demand for oil in Greece. However, it is anticipated that the increased penetration of natural gas over the next few years will reduce the amount of petroleum used in final consumption.

Figure 1.7 Petroleum Imports 1990-2006



1.2.3 Natural Gas: Steady Dynamic Development

The supply of natural gas in Greece increased from 7.160 TJ in 1997 to 115.022 TJ in 2006. (Figure 1.8).

Natural gas covered 8,7% of gross inland consumption in 2006 and it is expected to surpass 14% in 2010, due to consumption in all economic sectors on the one hand, and on the other, to extensive use in electricity generation (about 70% of the present consumption of natural gas).

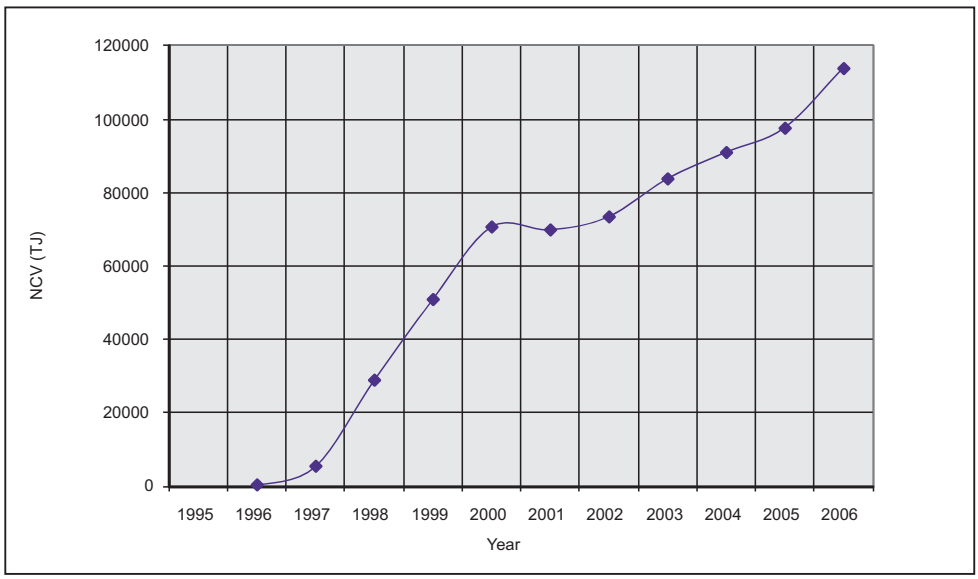
The penetration of natural gas in final energy consumption increased in 2006 by 132% over the year 2000 levels (Table 1.4). The rate of increase of the penetration of natural gas over the last five years is around 18%.

Figure 1.8 shows the development of natural gas imports. Greek natural gas is imported mainly from Russia by pipelines and is imported in smaller quantities from Turkey and in liquid form from Algeria. Security of supply is ensured at present, by long term contracts of the Public Gas Corporation with Russia, Turkey and Algeria.

Table 1.4 Natural Gas Sales (million Ncm), 1997-2006

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
ELECTRICITY GENERATION	62	489	997	1.439	1.432	1.506	1.669	1.809	1.812	2.175
INDUSTRY	86	291	410	439	366	385	446	477	537	526
GAS SUPPLLY COMPANIES		11	13	28	75	116	159	215	304	400
SPECIAL COMMERCIAL CONSUMERS		0	0	0	9	14	14	12	16	16
FINAL CONSUMPTION	86	302	423	467	450	515	619	704	857	942
GROSS INLAND CONSUMPTION	**148**	**791**	**1.420**	**1.906**	**1.883**	**2.021**	**2.287**	**2.514**	**2.670**	**3.117**

Figure 1.8 Natural Gas Imports



1.2.4 Renewable Energy Sources: A Difficult[4] Beginning[5]

The contribution of RES to the national energy balance was about 5,3% in 2006, on the level of total **Gross Inland Energy Consumption** and around 18%, on the level of primary energy production. Primary energy produced from RES in 2006 was 1,8 Mtoe, while at the beginning of the 1990's it was 1,2 Mtoe. Of this, 702 ktoe (39%) is due to the use of biomass in households, 230 ktoe to the use of biomass in industry to cover its own requirements (total percentage of biomass: 52%), 536 ktoe (30%) from hydroelectric generation, 146 ktoe (8,1%) from wind energy generation, 109 ktoe (6%) from solar thermal systems, 11 ktoe from geothermal energy and 33 ktoe from biogas, mainly for electricity generation.

[4] Renewable Energy Sources can be used for generation of electricity, heat or as biofuels in transportation. RES are inexhaustible and of a great variety. Generally we refer to Wind Energy, Solar Energy, Hydraulic Energy in Hydroelectric Plants, Biomass, Biofuels and Geothermal Heat Pumps.

[5] According to a report in 2007 from the IEA, RES account for 13,1% of global primary energy and 17,9% of global energy generation (including large hydroelectric plants).

Electricity generation from conventional RES in Greece (large hydroelectric plants not included) has been significantly increased in recent years and accounts for around 3,3% of gross domestic electricity consumption. It concerns mainly wind and small hydro and to a lesser extent, biomass and photovoltaics.

Taking large hydroelectric plants into consideration, electricity generated from RES is 12,4% of gross domestic electricity consumption. The installed electricity generation capacity from RES was 3.894 MW at the end of 2006 and as is shown in Table A1.9 (Annex 1), the result of financial support measures mainly from the operational programmes "Energy" and "Competitiveness" of the 2nd and 3rd Framework Programmes and the Development Law is the steadily increasing development of wind energy, small hydro and biogas.

Specifically, 27 MW was produced by wind farms in 1997 in contrast to 745 MW at the end of 2006. Small hydro reached 108 MW at the end of 2006, up from 43 MW (all by the PPC) in 1997. Electricity generating plants using landfill gas and cogeneration from biogas from sewage sludge (at Liosia and Psyttaleia) have an electrical capacity of 14 and 10 MW correspondingly. Electricity generation from RES reached approximately 8,3 TWh and 79% came from hydroelectric plants (6774 GWh), 20% from wind farms (1691 GWh), 1,1% (92 GWh) from biogas aand there was a small amount produced by photovoltaic plants (Table A1.10-Annex 1). The gross electricity consumption in the same year was 64,3 TWh. For 2006 the total primary heat generation was around 44.000 TJ, derived mainly from biomass and a smaller percentage from solar energy and biogas.

Statistics in recent years show fluctuations in the share of the participation of RES in electricity production of 10% to 12% (Table A1.10) which is mainly due to the variability in the operation of the large hydroelectric plants which depends on water reserves, while conventional RES show a steady increase in participation which reached 3,3% in 2006. It is noted that 12,4% in 2006 is not entirely representative because large hydroelectric plants, which in Greece are almost exclusively dams, are chiefly used for peak loads and their production depends on the availability of water behind the dams.

The production of thermal energy from RES is mainly from active solar, thermal uses of biomass and geothermal heat pumps (Table A1.11, Annex 1). The big expansion of the solar collector industry in recent decades has put Greece in second place for installed solar collector surface at the European level. However, heat generation from RES is mainly provided either from burning biomass, in the domestic sector, or from biomass residues in woodworking plants, food processing, cotton ginning, etc., where it is used to cover the plants' own needs. The Greek RES heat market is in the beginning stage. A profitable field for RES heat penetration seems to be the building sector, depending, however, on the revision of national legislation on "buildings with

increased energy efficiency". The use of biofuels in Greece is also in the beginning stages. At the present, attention is focused on biodiesel and it is expected that the prospects for bioethanol will soon be studied. For the time being, however, the supply and importation of bioethanol is not expected to start before 2010.

Looking at the corresponding markets, the future for renewable energy sources is different for electricity , heat and transportation. The current development of the markets for RES in Greece is shown in Tables A1.9 (RES Electricity Generation Capacity (MW), A1.10 (RES Electricity Generation (GWh)), A1.11 (RES Thermal Energy Generation (GWh)).

The energy system in Greece is wasteful, polluting and uneconomical. In order to achieve energy security for the country and meet the E.U. goals of 20% RES penetration in the total consumption of the member states, 20% reduction in CO_2 emissions and 20% conservation in total energy consumed, the reduction of the dependence on imported oil and polluting lignite is a necessary prerequisite. At the present time there is no coal burning unit in Greece. The promotion of RES is a top political priority.

In order to achieve the aforementioned goals, based on the analysis done in Chapter 2, the installation and operation of RES (mainly wind and hydroelectric plants, as well as photovoltaic) with a total capacity of 7,5 GW is required and is technically feasible, and it will produce about 15.000 GWh of energy. It is noted that the development of the installed capacity of RES increased steadily from 2000 to 2004, around 22% per year. The 483 MW of installed capacity at the end of 2004 became 1060 MW at the end of 2007, and in 2008, a further 140 MW was added. The above numbers show a yearly increase in capacity of about 38% over the years 2004-2008.

For the faster penetration of all forms of RES in the Greek market, Greek energy strategy looks to the creation of reliable and stable institutional, regulatory and inspection frameworks, as well as the enactment of effective rules for the smooth operation of energy markets and competition.

For the purpose of creating a reliable, integrated and harmonious framework for the development of private RES investments, there was substantial cooperation among all the bodies involved, the responsible Ministries, the market, and non governmental organizations.

In the meantime, legislation has already been promoted for further simplification of the licensing processes and the balanced financing and development of photovoltaic systems.

1.2.5 Electricity: Energy under Pressure

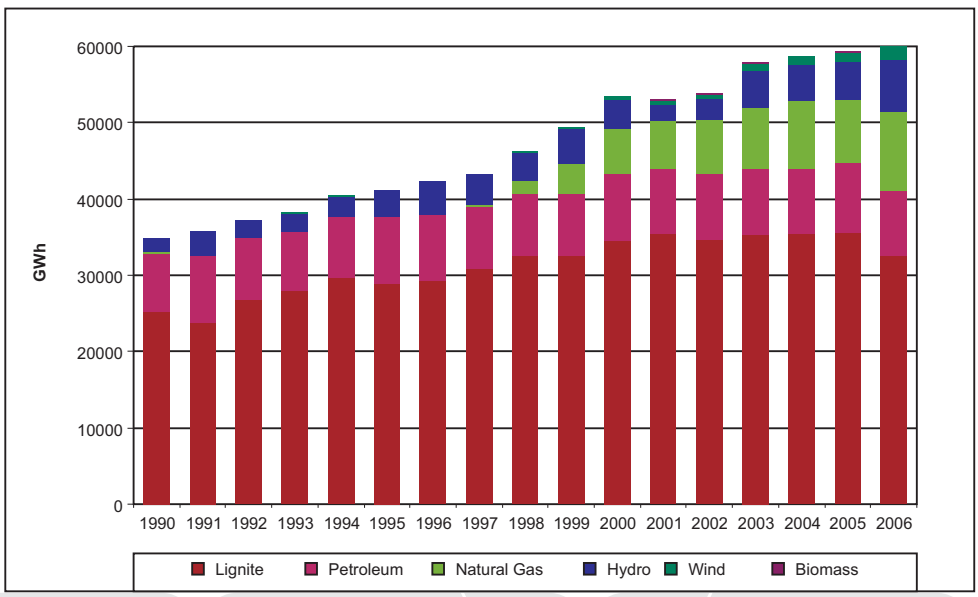
The Greek electricity system developed mainly after 1960, for the purpose of electrification of the country through exploitation of domestic energy sources. Thus, the demand in the grid connected system of mainland Greece was covered by lignite burning plants and hydroeledtric projects and in the islands by independent oil burning plants and recently by wind farms, due to the high cost of connection. As shown in Figure 1.9 the biggest part of electricity is produced from lignite , while natural gas was first used in electricity generation in 1997. The total assigned capacity of the electrical system was 13,6 GW in 2006 (Table 1.5), 36% of which corresponds to lignite plants (which cover mainly base loads) and as a result the biggest part of electricity is generated from them.

Table 1.5 Analysis of Electricity Generation Capacity in 2006 (MW)

Fuel	Total Installed Capacity	Total Net Capacity (net)	Grid Connected (net)	Crete (net)	Rhodes (net)	Non-connected Islands (net)
Wind	751,5	751,5	549,2	136	15,3	51
Biomass	30,7	30,7	30,3	0,4		
Hydroelectric	3135	3135	3134,4	0,6		
Natural Gas	2518	2454	2454	-	-	-
Oil	2317	2131,7	718	693,4	199	521,3
Lignite	5288	4808	4808	-	-	-
CHP	243	243	243	-	-	-
Total	**14.283,2**	**13.553,9**	**11.936,9**	**830,4**	**214,3**	**572,3**

The systematic exploitation of lignite deposits in Northern Greece and the Peloponnese was the main priority of energy policy after the oil crises. In Northern Greece there are 17 plants with an installed capacity of 4052 net MW and in the Peloponnese there are 4 units with an installed capacity of 756 net MW.

Figure 1.9 Electricity generation by fuel



The lignite generating stations account for 36% of the total installed capacity, petroleum plants 16,3%, natural gas plants 18,4%, hydroelectric plants 23,4% and wind farms 5,6%[6].

In the year 2006, the net electricity generation was 57 TWh, 52% of which came from lignite, 14,2% from petroleum products, 18% from natural gas, 11,5% from hydro, and 3% from wind. The net electricity generated has increased by 76% since 1990, when it was 32 TWh with an average yearly rate of about 3,5%. The highest increase was in the use of lignite from which 23 TWh was generated in 1990 and 29 TWh in 2006. The most important change was the penetration of natural gas which reached 10,1 TWh in 2006. The remaining electricity is generated by use of petroleum, hydro, the recent development of wind farms and also recently there has been an increased share of imports.

Table 1.6 Analysis of Net Electricity Generation in 2006 (GWh)

Fuel	Total Net Generation	Grid Connected System	Crete	Rhodes	Islands
Wind	1683,4	1199,4	348	24	112
Biomass	65,5	65	0,5	-	-
Hydro	6484	6484	0,2	-	-
Natural Gas	10169	10169	-	-	-
Oil	8045	3309	2472	674	1590
Lignite	29165	29165	-	-	-
CHP	983	983	-	-	-
Total	**56.595**	**51.374,4**	**2.820,7**	**698**	**1702**

The demand for electricity in Greece increased greatly after 1990 (Table 1.7). The largest increase was in the household and tertiary sectors. In particular, the tertiary sector in 2006 was the biggest consumer of electricity in Greece with 17,7 TWh yearly consumption. This is a percentage increase of around 216% compared to 1990 levels when consumption in the tertiary sector was 5,6 TWh.

Although industry was the biggest consumer in 1990, consuming 12,1 TWh, in 2006 it fell to 3rd place, consuming 14,1 TWh with a percentage increase of 14% in comparison to the 1990 levels. The household sector now consumes more than the industrial sector. It consumed 16,6 TWh in 2006 compared to 9,1 TWh in 1990, showing a 93% total increase.

[6] For comparison, we note that for the generation of 3.275.357 GWhe of electricity in the EU(27), nuclear energy corresponded to 30%, hydroelectric and wind to 11,5% and thermal to 58% for the year 2005. Specifically for thermal, 54% was produced by solid fuels, 7% by petroleum and 31% by natural gas.

A special feature of the Greek electricity system is the type of peak load in the grid connected system, which occurs in the middle of the day in the summer months, **especially** in the month of July.

The transfer of the peak load from the winter to the summer months began in 1992 and is due to the increased use of air conditioners, which is related to the increase in the average income of consumers and the change of the climatic conditions in urban areas.

The Greek electricity system is divided into the grid connected system of the mainland and the island non-connected systems of Crete, Rhodes and the Independent Generating Stations of the islands.

The grid connected system is developed and has interconnections with all the neighbouring countries (Table 1.8). Despite this, the grid connected system of electricity generation is not evenly distributed, with 68% of electricity generation near the lignite deposits of Northern Greece, while 33% of the consumption is in the area of Attica.

The island system covers a large number of islands, mainly in the Aegean Sea. It includes independent systems based on petroleum burning units using mainly HFO, LFO and Diesel fuels. The technologies used are mainly gas turbines, ICE, and steam turbines as well as several combined cycle units.

The yearly rate of increase in demand in Crete and Rhodes is greater than that of the grid connected system. Furthermore, the load factor is smaller for the systems in Crete and Rhodes than that of the grid connected system (see Annex A2.3). This means that these systems have a much worse peak load problem, which is mainly due to the greatly increased demand in the summer months because of tourism.

Table 1.7 Development of electricity consumption 1990-2006 (TWh)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total	28,5	29,3	30,7	31,2	32,7	34,1	35,6	37,2	39,3	40,6	43,2	44,5	46,6	48,6	49,7	50,8	52,4
Industry	12,1	11,9	11,7	11,4	11,7	12,1	12,1	12,4	12,9	12,9	13,5	13,8	14,1	14,2	14,0	14,4	14,1
Comm. & Public Buildings	5,6	6,0	6,6	7,2	7,9	8,4	8,8	9,8	10,8	11,5	12,3	13,2	14,0	15,0	15,9	16,5	17,7
Household	9,1	10,0	10,6	10,5	10,9	11,5	12,3	12,4	12,8	13,5	14,2	14,5	15,8	16,4	16,9	16,9	17,6
Agricultural	1,6	1,3	1,6	2,0	2,1	2,0	2,2	2,4	2,6	2,6	2,9	2,8	2,5	2,8	2,8	2,9	2,7
Transportation	0,1	0,1	0,1	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,1	0,2

The result of the above is that the electricity which is produced in the islands is much more expensive than that in the grid connected system. This cost difference, however, is not passed on to consumers due to unified pricing.

By RAE Decision No. 588/2008, the definition of the average variable cost of production for the PPC S.A. in the non-connected islands for the year 2008 amounts to 151,76€/MWh.

Table 1.8 Power Transmission Capacity of the International Interconnections of the Greek Transmission System (MW)

Interconnection	From Greece	To Greece
Greece – FYROM	500	1000
Greece – Albania	250	
Greece – Bulgaria	400	
Greece – Italy	500	500
Total	**1650**	**1500**

The large number of petroleum generation plants in Greece is due to the electricity needs at the non-connected islands.

An important fact about the electricity system in Greece is that it is on the brink of an investment deficit. RES are not especially developed, in spite of the great potential. Thermal systems have unique characteristics. In particular, endogenous energy sources and the concern for ensuring security of supply have led to the continuing use of a significant portion of lignite in electricity generation. The use of oil in electricity generation seems excessive at first compared to the European average but it is due to the island nature of the country. A strategy for the reduction of petroleum products in electricity generation has already been adopted in the framework of environmental policy.

The forced increase in lignite production is only a temporary solution due to the reduction in the available reserves and the continually increasing mining costs and CO_2 emission permits. Carbon Capture and Storage (CCS) technology is still in the experimental stage[7] and it will not be on an industrial scale for at least 15 years. The interest in such an investment is also difficult to forecast and it must also be evaluated in relation to forecasts of the price per ton of CO_2.

Combined Cycle Natural Gas plants will play a decisive role in the long term relieving deficit problems.

Hydroelectric projects are attractive but the latitude for developing them, either natural or geographic, is limited. Renewable energy sources (wind, photovoltaic, hydroelectric, biomass), instead of being stimulated by the ETS, remain at present more expensive than traditional energy sources.

[7] The Commission in order to support large scale demonstrations in the field of CCS, is programming to co-finance up to twelve CCS demonstration plants through the EU Recovery Plan. All the projects are at an advanced state of readiness so as to ensure the beneficial effects of the investment as soon as possible (MEMO/09/36, IP/09/142, COM(2008) 781 final).

In Greece public opinion on nuclear energy is split despite the especially low emissions. The European Union delegates the responsibility for such decisions to each member state. In regards with the situation in Greece, the use of nuclear energy as a source for electricity generation is not foreseen in the proposed scenarios until 2020[8].

1.2.6. Cogeneration of Heat and Power

Cogeneration of Heat and Power (CHP) is relatively underdeveloped in Greece where a large part of the installed capacity is located in refineries, in large generating stations and in the food industry.

The first cogeneration units were installed in large Greek industries at the beginning of the 1970s. At present, cogeneration units operate at sugar and pulp and paper industries, petroleum refineries, textile manufacturers, etc. Moreover, generating stations belonging to the PPC have been suitably modified in order to cover the heating needs of urban areas with district heating networks, such as the district heating networks in Kozani, Ptolemaida, Amyntaio and recently, Megalopolis. As a result of the financial support measures for CHP, such installations are becoming viable in large buildings of the tertiary sector. It is anticipated that Laws 3468/2006 and 3734/2009 will provide a significant stimulus for CHP installations in combination with capital subsidy measures.

The total installed electrical capacity in industrial cogeneration plants is currently approximately 255 MWe.

Table 1.9 shows the number of operating CHP installations in 2006 by sector of economic activity.

Category of Activity	Electrical Capacity (MWe)	Heat Capacity (MWth)
Provision of electricity, natural gas, steam and hot water		**316,0**
Collection, purification and distribution of water	7,10	9,60
Production of petroleum refinery products	133,00	159,22
Food and beverage industry	60,50	254,06
Manufacture of textile materials	3,90	5,00
Mining of metal ores	13,70	54,18
Manufacture of products from non metallic ores	1,10	3,68
Hospitals	0,80	0,89
Higher education (universities)	2,72	3,09
Vegetable cultivation and greenhouse vegetable gardens	9,80	11,00
Manufacture of basic chemical products	21,60	
TOTAL	**255**	**816**

[8] According to the Eurobarometer of February 2008, which shows public opinion on energy in research on "behaviour on matters related to European Energy Policy", 83% of Greeks asked were against the development of nuclear energy in Europe.

A national energy market is not a closed market but it is influenced, favourably or unfavourably, by developments on all fronts. These external factors and the limits created, influence the supply and demand for energy on a global and state level. Among the external factors which affect the energy sector, one must mention geopolitical changes, efforts at combating climate change and the globalization of the economy. The recent publication of the European Commission titled "Region 2020", which was presented by Commissioner Danuta Hubner on December 9th, 2008, estimates that most of the Euromediterranean countries (one of which is Greece) seem to be much more influenced by these three factors. Their vulnerability to globalization is due mainly to their relatively large number of activities with a low added value and the inability of their work force to specialize. The trends which are connected to the battle against climate change will become visible in many sectors of economic activity and particularly in tourism and energy production. Finally, the security of energy supply will become more fragile as energy dependence tends to increase. The total energy dependence of the European Union will exceed 67% in 2020 and for natural gas and petroleum it will be correspondingly 84% and 95%.

1.3.1 Global geopolitical conditions

Global geopolitical conditions by definition are continually unstable and sudden shifts can completely change the facts as was shown by September 11, 2001.

Recent years have been marked by tense geopolitical conditions and by the increased demands from developing countries, a fact which has led to a price increase for all raw materials in international markets. In July 2008 the price of crude reached 150$ a barrel[9] after it passed the symbolic barrier of 100$ on January 3rd 2008. Since then the price of a barrel of crude has been falling again and fell to under 50$ a barrel in mid November 2008.

Greece, like all countries which import energy, suffered from price increases for energy products and mainly for petroleum. The country's economic development was negatively affected in spite of having an economic performance better than the average of the member states of the European Union[10] and in spite of participation in the Eurozone[11]. Paradoxically, the low level of taxation on petroleum products compared to

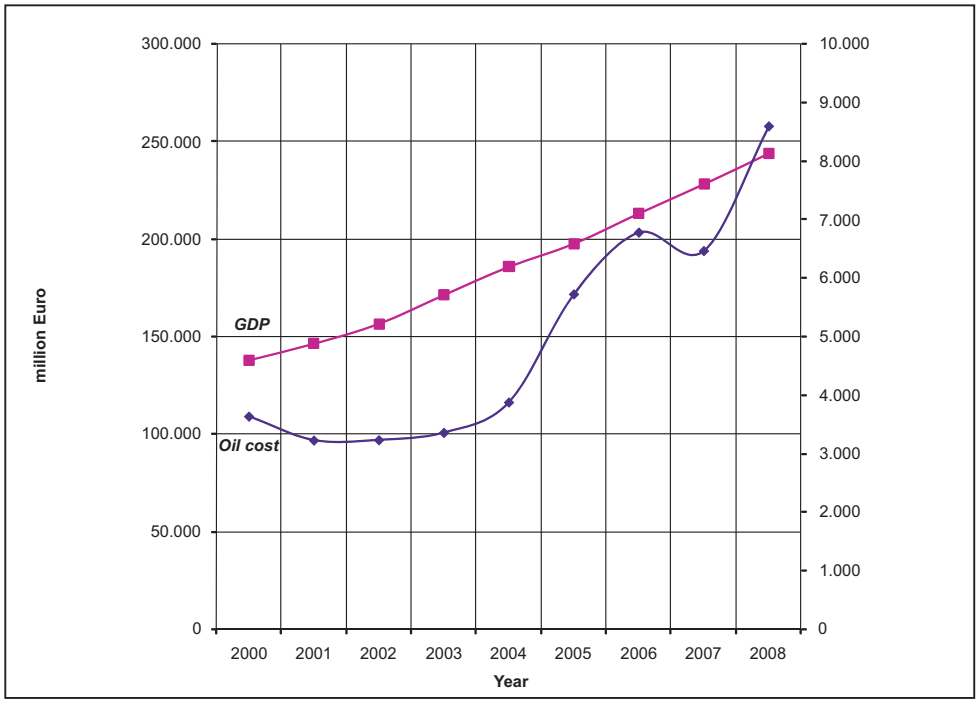
[9] On July 11th 2008 the price of a barrel of crude broke the record of 147,50 dollars in the New York Stock Exchange.

[10] In 2007 economic development in Greece was estimated at 4% in comparison to the past year while the Eurozone average was 2,9%.

[11] The stability of the Euro against the dollar played a non negligible role in maintaining prices.

the E.U. average, was a burden for the Greek economy which was marked by the return of the inflationary cycle (4,7% from September 2007 – September 2008)[12]. In reality, the influence of prices in the international market becomes more significant as the level of taxation becomes lower.

Figure 1.10 Value of Imported Petroleum Products 2000-2008



Correlated to the economic crisis which has slowed down world development since the summer of 2007, the expected cutback in demand is visible, contradicting the theory according to which the reaction of demand to supply was traditionally elastic[13].

In Greece, the elasticity of demand was not borne out as in other OECD countries (see Annex 4). In transportation, there has been an increase in the number of cars in circulation[14] and the corresponding amounts of gas sold with the exception of super (LRP), which only represents a small market share (4% of the road transportation market in 2007).

[12] Based on data from Eurostat (Report 141/2008 of October 15th 2008), the average yearly percentage of inflation in the Eurozone was around 3,6% for the period September 2007-September 2008 and around 4,7% for Greece. The Netherlands had a better performance with only 2,8% inflation over the same time period while Slovenia is at the tail end of the group, with inflation of 5,5%.

[13] Since the beginning of the year, the International Energy Agency and OPEC have been revising their forecasts (downward) each month for demand in 2008 and 2009.

[14] In 10 years (1998-2008) the number of cars in Attica has more than doubled from 1.026.000 to 2.400.000.

Table 1.10 National Consumption of Liquid Fuels

YEAR	UNLEADED GASOLINE 95RON	UNLEADED GASOLINE 98RON	NEW SUPER (LRP)	DIESEL FOR HEATING	DIESEL FOR TRANSP.
2004	2.842.031	294.664	676.158	4.044.205	2.561.190
2005	3.116.574	298.634	542.474	3.926.101	2.537.546
2006	3.323.249	273.835	428.847	3.856.858	2.714.656
2007	3.496.340	297.879	333.681	3.393.417	2.842.917
2008*	3.124.013	253.060	236.036	2.338.584	2.749.055

(*)Up until August 2008, the estimate for the year is made by analogy

In Europe, despite the new economic data and development indicators, many people contend that the new global energy situation must continue to serve as a reason for a voluntary energy policy in favour of continuing and sustainable development[15].

1.3.2 The battle against global warming

Fighting climate change is a global priority and the main theme and basic factor in all of the international and national decisions related to the use of energy sources.

a) Emissions of greenhouse gases due to human activity basically come from energy

As widely accepted, the expression "global warming" is applied to the climate change which was observed from the 2nd half of the 20th century. Most scientists attribute the cause of global warming to human activities[16] and especially due to mass energy production from fossil fuels[17] (development of transportation and industrialization of the planet). The European Union is in 3rd place for emissions of greenhouse gases after China and the USA in total emissions.

In accordance with European Union policy on climate change, it was agreed by the European Council of Ministers in 1998 that greenhouse gas emissions in Greece for the average of the years 2008-2012, are allowed to increase by 25% compared to base emissions levels (emissions in 1990 for the three gases and 1995 for fluorine compounds). The total goal for the European Union is a reduction by 8% for the corresponding period.

On a global scale, industry and transportation account for more than 80% of CO_2 emissions. The share of transportation in CO_2 emissions which are due to petroleum combustion is around 24%, according to data published by the International Forum on

[15] The Convention of October 2008, after analyzing the economic and public financial state of the E.U. confirmed its "determination to keep its ambitious commitments on climate and energy policy which was agreed upon in March 2007 and March 2008.

[16] The IPCC committed itself to drafting a scientific agreement on this matter. The fourth and final report, which more than 2500 scientists from 130 different countries worked on, confirms that the probability that global warming from 1950 onwards is due to human activity is over 90%.

[17] Solid fuels, petroleum and petroleum products, natural gas.

Transportation[18], where 18% is due to road transportation, 3% to aviation, 2% to shipping and 1% to all others. The share of industry in CO_2 emissions is about 63% (45% for energy industries, 18% for manufacturing and construction).

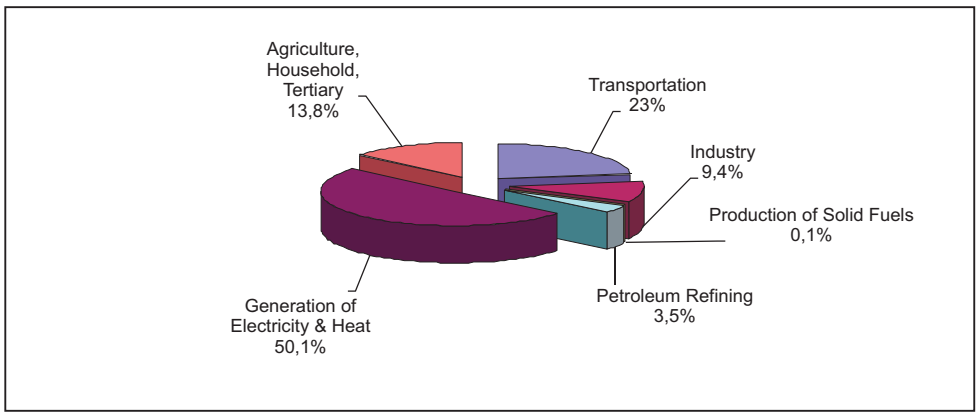
From this vantage point, the energy balance in Greece corresponds to the global average except for the fact that the generation of electricity and heat have a slightly increased environmental impact due to the use of lignite in electricity generation.

In the future, the service and household sectors must be closely observed due to the visible increase in emissions from these sectors in Greece.

Emissions per unit of gross domestic energy consumption in Greece is one of the highest in the E.U. The reason is the dominant role of lignite and petroleum in the country's energy mix. About half of the CO_2 emissions in Greece come from the heat and electricity generation sector where 83% is due to lignite combustion.

In 2006, carbon dioxide emissions in Greece accounted for 82,4% of total emissions, while methane accounts for 6,3% and nitrous oxide for 7,8%. The remaining gases (F-gases) contribute the remaining 3,5% (according to the latest official published data).

Figure 1.11 Contribution to CO_2 emissions by activities connected to the use (combustion) of fossil fuels for the year 2006



[18] The emissions in the transportation sector increased between 1990 and 2003 by 1412 million tons (31%) globally and by 820 million tons (26%) in OECD countries. The emissions produced by transportation in OECD countries correspond to 71% of those produced globally.

Figure 1.12 CO_2 emissions intensity by industrial sector

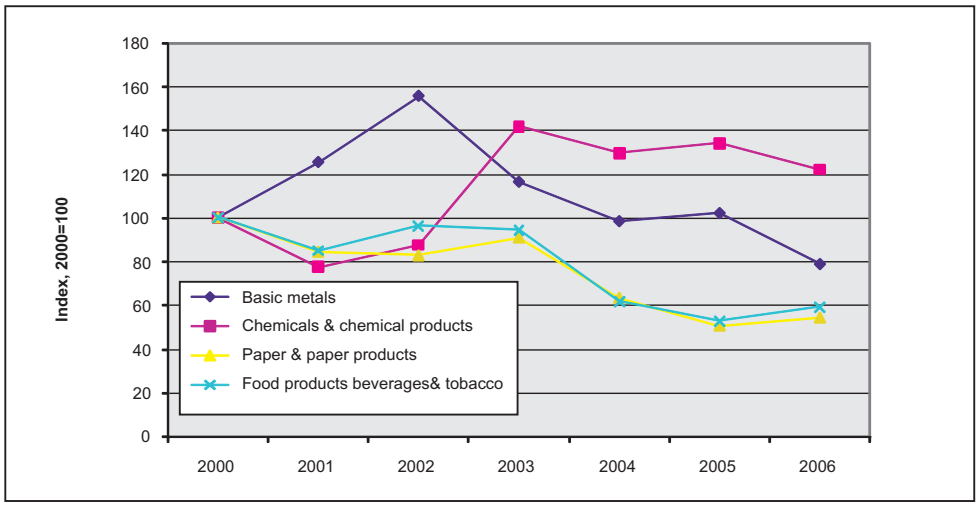


Figure 1.13 CO_2 Emissions Intensity in the Agricultural and Tertiary Sectors

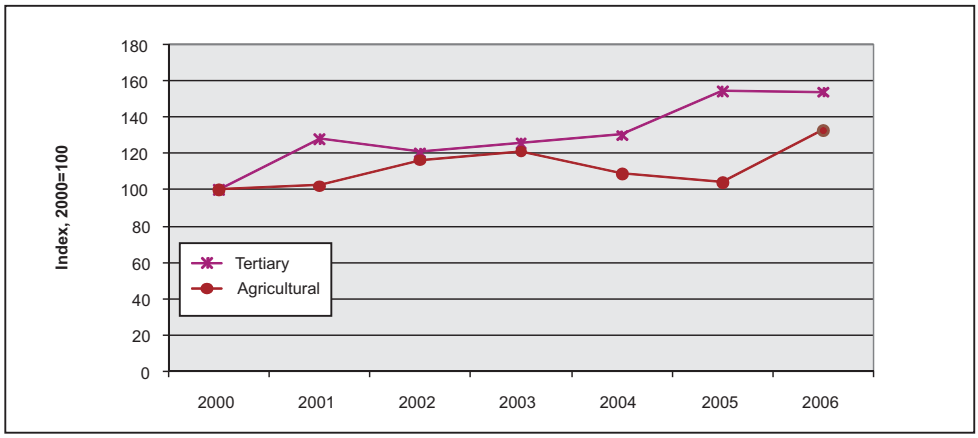


Figure 1.14 CO_2 Emissions in Transportation per Inhabitant

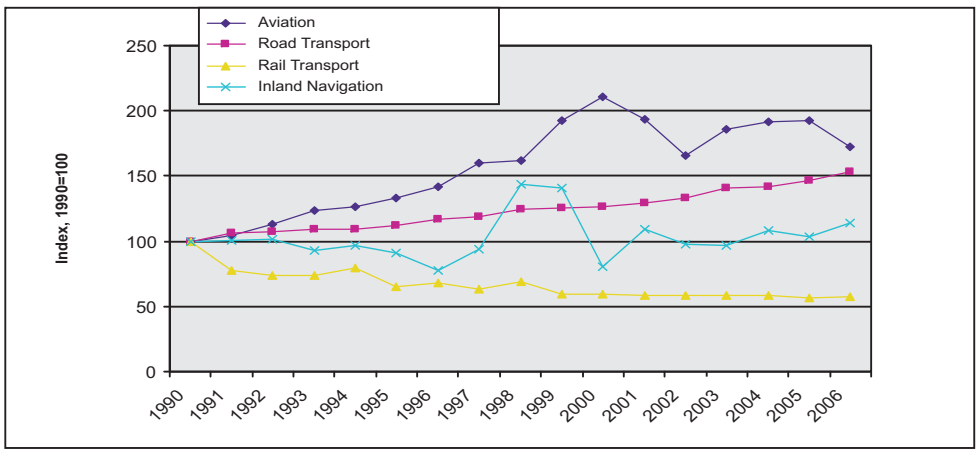
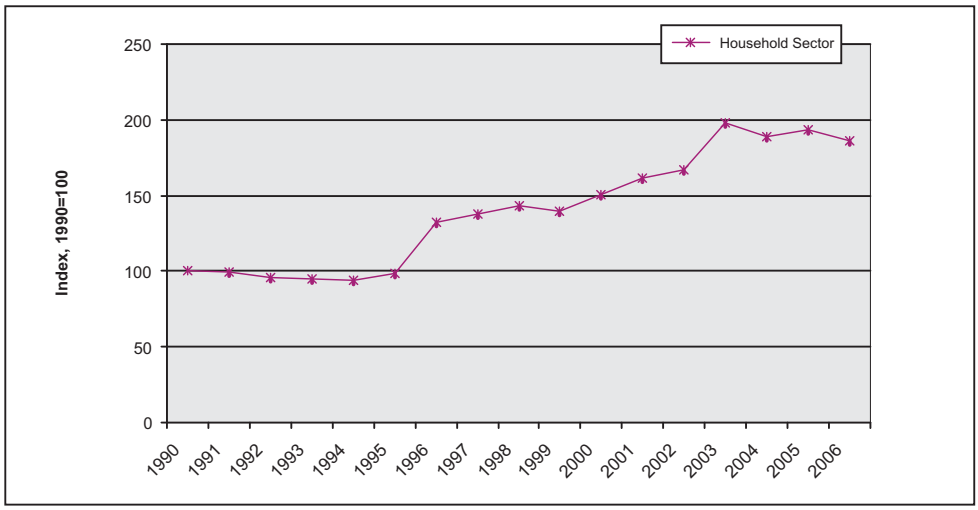


Figure 1.15 CO_2 Emissions Intensity in the Household Sector



Activities in the energy sector are the main source of greenhouse gases and account for 78,6% of the emissions in 2006. The greenhouse gases emission in the energy sector include 97,2% CO_2 from the combustion of fossil fuels and 1,7% CH_4 from the production, storage, distribution and combustion of fossil fuels. Finally, **nitrogen hypoxide** accounts for 1,1% of Greenhouse Gases emissions in the energy sector and 13,8% is due to lignite combustion for electricity generation and about 70% from the combustion of liquid fuels in the agricultural, household, tertiary and transportation sectors.

Industrial processes account for 9,8% of emissions, the agricultural sector 8,7%, waste 2,7% and the use of solvents, 0,1%.

In Figure 1.11 the contribution to CO_2 emissions is shown for various activities related to the combustion of fossil fuels. Thus 50,1% is accounted for by electricity generation, 23% by transportation, 9,4% by industry, 3,5% by petroleum refining and 13,8% by buildings and agriculture. Most of the emissions in electricity generation are due to lignite combustion. The transportation sector is also a big and continually increasing source of CO_2. The combustion of gasoline, petroleum and LPG in road transportation are the basic cause of CO_2 emissions and smaller quantities are due to the use of diesel and HFO in coastal shipping, the use of diesel in railroads and finally the use of kerosene for domestic airlines. The industrial emissions are due to the combustion of fossil fuels to cover demand for heat and steam. The emissions from industrial processes concern non energy industrial uses and especially in activities which include chemical processes. The CO_2 emissions from industrial processes are due mainly to the production of cement and lime.

The agricultural sector is the main source of N_2O emissions in Greece (79% of the total N_2O emissions in 2006). The N_2O is produced also by the reaction of nitrogen with oxygen during the combustion of fossil fuels.

In 2006, the emission levels of 6 gases were 24,4% greater than that of the base year (1990 for CO_2, CH_4, N_2O – 1995 for the remaining gases). In particular, the CO_2 emissions by the energy industry increased by 29% between 1990 and 2006 while emissions from transportation increased by 62%.

b) World and E.U. strategy for reducing polluting gas emissions

The forecasted increase of the average temperature in the next century from 1,5 degrees Celsius to 7 degrees Celsius would be smaller if strict environmental measures are taken or if a truly competitive energy source to fossil fuels is discovered. In order to limit the increase in global temperature to the level of 2.0-2.4 ^{0}C, the application of strict environmental measures as well as the use of non fossil energy sources is required. There are three complementary approaches to this problem: the effort to reduce greenhouse gases, carbon storage and adaptation.

Thus, the international community set a goal of stabilizing the concentration of gases causing the greenhouse phenomenon in the atmosphere at a "level which prevents any dangerous human disturbance to the climate" in the framework of the UN Convention on Climate Change (signed in 1992 during the Earth Convention in Rio de Janeiro and came into effect on March 21 1994) and by the Kyoto Protocol (which came into effect on February 16th 2005). The industrial nations (with the exception of the USA) committed to reduce greenhouse gas emissions (CO_2, CH_4, N_2O, SF_6, HFC, PFC) by 5,2% between 2008 and 2012 in relation to 1990 levels. USA is also included in this commitment, given that they signed the protocol but later did not ratify it. This goal corresponds in reality to a reduction of about 20% in relation to the expected emissions levels for 2010 which would occur if a controlling measure had not been adopted. The goals for reduction for each country start with a reduction of 8% for the European Union[19] and go up to a probable increase of 10% for Iceland. Greece, along with France, Sweden and the United Kingdom reached the Kyoto limits in 2006. (Report by the European Environment Office entitled "Notes from the European Environment Office 2009").

Negotiations for a new world treaty on climate to replace the Kyoto Treaty (which ends in 2012) are underway and it is anticipated that it will be signed in Copenhagen in December of 2009. The Treaty of Copenhagen aims to limit global warming by 2 degrees at most in relation to preindustrial era levels. In the opinion of the IPCC, this would require a reduction of world greenhouse gas emissions by 50-85% at least from the present up to 2050 compared to the levels of the year 2000. In order to achieve this,

[19] Greece will have to reduce the non-ETS emissions by 4% in the year 2020 in comparison to 2005

the developed countries will have to drastically reduce greenhouse gas emissions by 25% to 40% in relation to 1990 levels from now until 2020, with the main target being to achieve a reduction of 80% to 95% from now until 2050.

The European Union has already committed independently to reduce these emissions at least by 20% in relation to 1990 levels, by 2020. The E.U. is even prepared to reduce these emissions by 30% if an international treaty on reduction of greenhouse gas emissions is signed.

Many people are concerned that the battle against climate change would exert new pressure on prices and that economic development would cease. According to the Stern Report[20], however, the cost of inaction would put the world economy in even more certain danger. For the European Commission, these revolutionary changes will support the modernization of the European economy "preparing it for a future in which technology and society will adjust to new needs and innovations will provide new opportunities for development and employment to be created."[21]

1.3.3 The Globalization of the Economy

The globalization of the economy puts new pressure on the supply as well as on the demand for energy.

From the Second World War onwards, the globalization of economies has resulted in a faster increase in trade than in increased production. This phenomenon became more evident after the collapse of prices in the oil market in 1985. Seven million tons of goods were traded between America, Europe and Asia. The hub of the world economy gradually moved beyond the west, hastening the modernization of the Asian economy. Of the 10 most important ports in the world, 5 are located in China and form the starting point of a real sea lane between East and West.

At the moment, the percentage of the European Union market in world trade is around 19,5% having been reduced by 1,3% over the last 10 years. Still, the E.U. has a better performance than the U.S.A. (13% with a reduction of 4,4 percentage points) and Japan (9,5% with a reduction of 4,1%). The E.U. is still the first export power in the service sector (26,9%) and manufactured products, mainly due to the high quality products. Likewise,it is the biggest investor in the world and the biggest receiver of foreign investments. However, the report of the European Commission defends itself against loss of its market share to Asia on high technology products[22].

[20] The cost of inaction is estimated at between 5 and 20% of the world GNP.
[21] COM 2008 30 Final, January 23rd, 2008.
[22] Report of the European Commission, published on October 27, 2008 concerning the competitiveness of the European Union.

Among the consequences of globalization, it is worthwhile to mention the development of international transportation[23], the departure of industries which suffered from European labour law, and the rapid growth of the so called emerging countries which are the new competitors of the industrial nations.

Greece, which has one of the largest merchant fleets in the world, benefits to a great extent from globalization. (See Annex 5).

The Greek fleet owns 20% of the freighters in the world market. The flow of foreign exchange from shipping exceeded 4,8 billion Euro in the first quarter of 2008 compared to 3,7 billion in the previous year (+32%).

In terms of energy, these facts result in increased demand for petroleum products for transportation in the international market, in a redistribution of the commercial routes for fossil fuels both in supply[24] and demand and a reduction in imports of energy products by the European Union countries. This is also related to the decreased production of industries which have moved elsewhere and is a result of the competition from new consuming nations. The competition between consuming nations is acutely demonstrated by the strategies for preferential access to raw materials from certain emerging nations, mainly those of Africa.

Since then, the question of energy supply has taken on a new dimension and if we assume that the dialogue with the producing nations is an indisputable goal of European diplomacy, we should also refer here to the consumer nations.

Pressure from geopolitics, environmental matters and globalization no longer permit a national energy policy to be effective if it is not an integral part of the problem on a community and global scale.

The Kyoto Treaty and possibly the Copenhagen Treaty, if it succeeds, are consequently a new beginning in this sense, and the newly founded, by the European Commission, world fund for the promotion of energy efficiency and renewable energy sources, is a specific practical application[25].

---

[23] The volume of transportation has increased in the last 25 years. Despite the slowdown due to the second oil crisis and the consequences of September 11, 2001, sea and air tonnage increased at a rate of 3% per year from 1985 while the average distance covered remains stable.
The increase in the cost of transportation mainly due to the rising cost of energy could cast doubt on the increase in world trade, the source of economic globalization. Answers to this question are not at all simple. In the beginning world trade represented only a small part of total world transportation (about 20%). The cost of transportation represents only a small fraction of the sale price of "global" goods. Finally, there are still significant productivity and efficiency margins in transportation.

[24] Countries such as Russia and Venezuela have acquired the infrastructure of countries which export hydrocarbons, something they did not have during the oil crises of 1973 and 1979.

[25] NCY

2.

Greece will have to adopt the new European Policy on greenhouse gas emissions trading and the penetration of Renewable Energy Sources and Energy Conservation. For all the member states it is anticipated that by the year 2020, there will be:

1. 20% reduction of greenhouse gas emissions (GHG) compared to 1990 levels.
2. 20% penetration of Renewable Energy Sources (RES) in final energy consumption and
3. 20% conservation of primary energy.

In particular, for Greece, the goal for GHG emissions is a 4% reduction in sectors excluded from emissions trade (non-ETS) compared to levels in the year 2005 and 18% penetration of RES in final consumption.

Given the time frame covered by this study, and due to the significant uncertainties which come into play in an analysis in a complex sector of economic activity of a country, such as the one of energy, a method of analysis based on scenarios was adopted. These scenarios show different prospects for the development of the energy sector in Greece, which, in the framework of this study, could theoretically take place, under specific assumptions for the time frame of the study, which is the period up to the year 2020.

Thus, first of all, a reference scenario was analyzed, where it is assumed that the energy system develops according to policies already in place and then scenarios where successful realization of the goals of the new European Policy for Greece were analyzed. In these scenarios, the alternative energy policy measures were defined and evaluated by which national-European goals could be achieved.

In the final "Scenario in Which the New European Energy Policy is Applied" , the energy policy which has been chosen includes the development of the energy system without using coal and nuclear energy and the greatest possible energy generation from RES. In the results, the energy balances for Greece are given every five years (2010 2015, 2020) and analytical quantified goals are defined by energy producing technology, such as for example, the required capacity for wind farms, small hydro, generation units using biomass, as well as the anticipated levels of energy consumption in different sectors such as agriculture, industry, transportation, household and tertiary sector, etc. The electricity generation sector is analyzed in detail in order to improve the accuracy of the results.

The quantitative analysis was done with the aid of mathematical models such as MARKAL, WASP IV and COSTPLUS.

The energy model MARKAL (from the International Energy Agency) describes the whole energy sector of the country and, with given assumptions concerning the development of the country's macroeconomic data, international energy prices and the available energy technologies, defines the optimal combination of technologies and fuels which covers demand given the useful energy, with restrictions such as, for example, greenhouse gas emissions by the energy sector. Thus, it is possible simultaneously to evaluate the energy and environmental policies in the sectors of supply and demand for energy.

For a more detailed analysis of the electricity generation system, the WASP model from the IAEA (International Atomic Energy Agency) is used. The WASP model determines the least cost generating system which satisfies anticipated demand for electricity and power capacity and at the same time ensures the economic viability of the electricity generating stations in the liberalized market and in situations with a large number of wind farms and in general distributed generating stations.

Finally, the model COSTPLUS is used for the detailed (hourly) simulation of the operation of the electricity generation system. With this model, the timeline of the electricity generation units is defined so as to ensure the smooth cooperation of wind farms with thermal stations. Thus the reliability indicators of the electricity system and cost data for generation are accurately defined.

2.1 FORECASTS WE DO NOT WISH TO APPROACH – REFERENCE SCENARIO

2.

The **Reference Scenario** contains only national policies already in effect for the energy sector, assuming that in the future there will be no other policies. Thus the Reference Scenario is used as a measure of comparison for the evaluation of policies for meeting the targets.

The basic assumptions of the reference scenario are that:

- The rate of energy consumption in final use develops based on policies already in effect.
- Electricity demand in the grid connected system will develop at a high rate reaching 79 TWh in 2020. The forecast is shown in detail in Annex A2.
- The penetration of RES by 2020 will develop in accordance with policies in effect up to the present.

Figure 2.1 Development of the Basic Parameters of the Greek Energy Balance According to the Reference Scenario

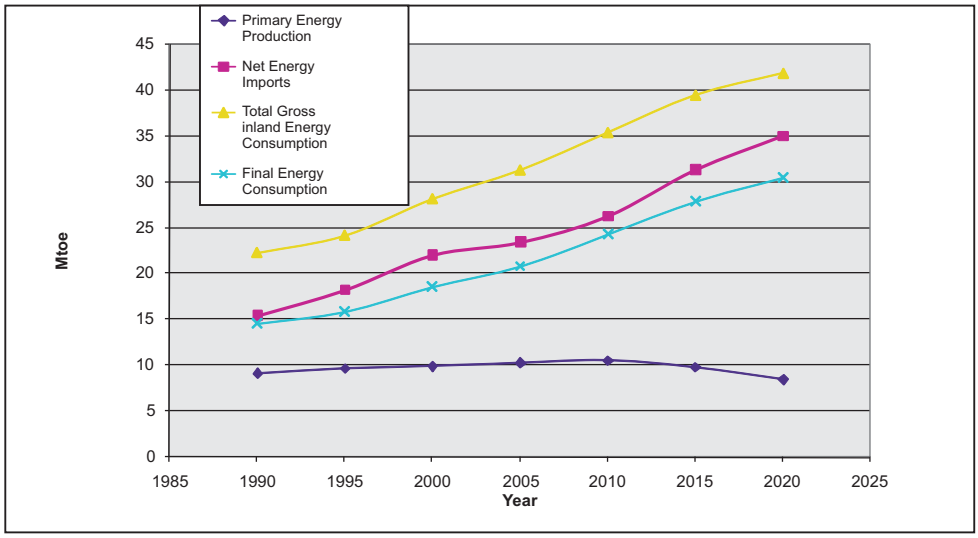
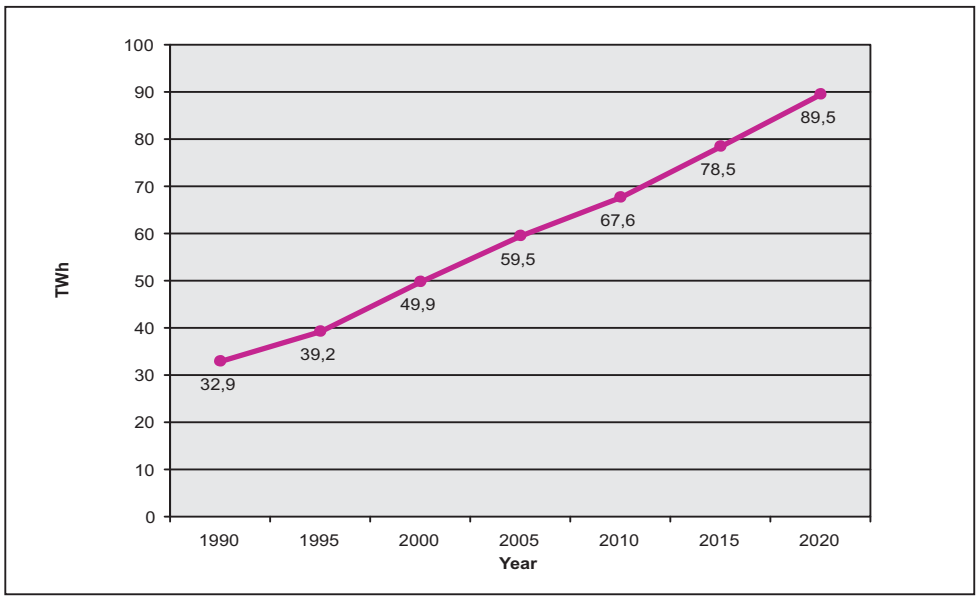


Figure 2.2 Development of Energy Demand According to the Reference Scenario

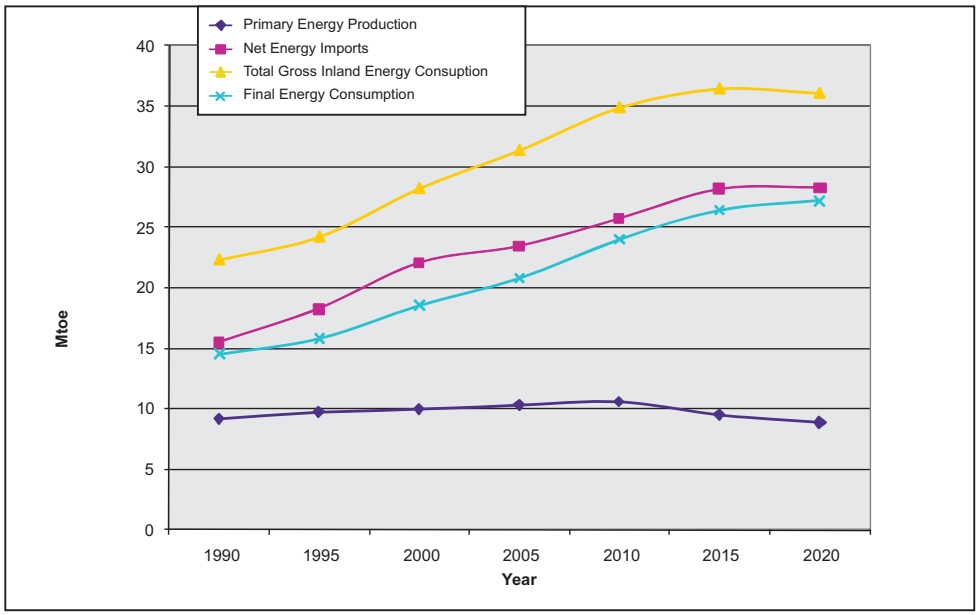


2.2 THE SCENARIO IN WHICH THE NEW EUROPEAN ENERGY POLICY IS APPLIED

2.

In the framework of the study, various scenarios were analyzed for the successful achievement of European policy goals. The scenarios that were analyzed are alternative solutions for achieving the National and European Goals for Energy and Environmental Policy using different aproaches. In particular, they were focused on alternative means for realizing energy policy goals where the basic parameters are the fuel mix for electricity generation and as a consequence, the security of supply. The latter is associated with electricity generation and the mix of RES technologies which could be used to achieve the target of the new Directive on RES.

Figure 2.3 Development of the basic parameters of the Greek Energy Balance according to the Scenario with the application of the New European Policy



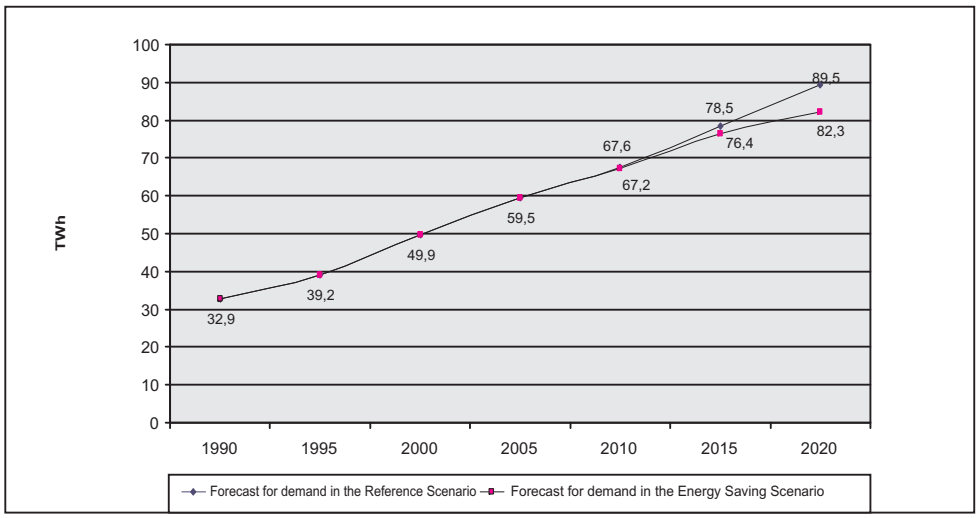
The **Scenario in Which the New European Policy is Applied** which was chosen has as its basic principles the exclusion of coal and nuclear energy from the energy system and the increased penetration of RES and energy conservation. Thus, the installation of lignite plants according to the plans of the PPC is considered and the inability to use coal as a supplementary fuel, results in the partial use of combined cycle plants with natural gas for base loads. This has a positive effect on the limiting of rejected energy from RES at times of low demand. Thus, up to the year 2020, 4 GW lignite plants, 5,4 GW combined cycle plants with natural gas and 3,7 GW large hydro plants is forecasted for the grid connected system. The goal for RES in electricity generation is achieved in combination with large hydro plants and a mix of technologies where wind farms in the grid connected system are 5500 MW and 800

MW in the island's system, small hydro are 200 MW, photovoltaic systems are 600 MW in the grid connected system and 200 MW in the island's system and also 200 MW of biogas and 200 MW from biomass cogeneration in industry. Considering that there is the possibility of connecting the island of Milos with the Cyclades, 120 MW of high enthalpy geothermal energy from Milos can be used.

In the energy consumption sector, the policy measures should ensure:

- The achievement of the RES goal where RES must make up 18% of final energy consumption. Besides the electricity generation mix from RES, the 18% target is achieved through the penetration of biofuels in transportation by 10% for 2020, which is obligatory, as well as by the increased use of solar thermal systems and the use of heat pumps.
- The achievement of the goal for energy conservation according to Directive 2006/32/EC which concerns sectors excluded from emissions trading. These sectors must reduce their emissions in total by 4% in comparison with 2005 levels.

Figure 2.4 Development of Demand for Elecricity according to the Energy Saving Scenario



2.

In this analysis, a scenario in which the new European Energy and Environmental Policy is applied by Greece is presented, which succeeds in achieving the national goals. The main parameters used in the analysis are the fuel mix for electricity generation, the RES technology mix and energy conservation planning.

Thus, the results which are presented in Annex A3, contain the following assumptions-limits:

- The cost of acquiring emission permits for electricity generation plants and in other emissions trading establishments will be 40 €/tn CO_2 after 2013.
- Greenhouse gases emissions from establishments not included in the emissions trading system will be reduced in 2020 by 4% compared to 2005 levels.
- Energy conservation will develop according to the National Action Plan for Energy Efficiency, which is based on the Directive 2006/32/EC. The National NEEAP anticipates 9% conservation by 2016 compared to the average of the years 2001-2005. In 2020 the goal will already have been met.
- Energy conservation on the primary energy level will develop according to the European goal of 20% compared to 2005 levels.
- In the grid connected system the Scenario for Electricity Conservation will be in effect (see Annex A2) with a forecasted a demand of 72 TWh for 2020.
- Concerning the interconnections of the Greek electricity generation system, the anticipated developments in neighbouring electricity generation systems will take place as announced by the bodies responsible in those countries.
- The penetration of RES in final consumption will be around 18%.
- The penetration of RES in electricity generation will be around 30%.
- The PPC will carry out a plan for decomissioning. Also, it is assumed that the lignite plants which the PPC is planning will be included, as well as PPC plants which are being planned for the island system.

In order for RES technologies to penetrate according to the results which have been presented, infrastructure projects will be required and refer to the following:

1. Construction of a large number of 150/20 kV substations in order to connect the wind farms.
2. Connection projects of the grid connected system with island systems such as the Cyclades and possibly the island of Milos at a later stage.
3. Construction of pumped storage hydroelectric projects, a possibility which even though it has various degrees of difficulties and inherent implications, must be studied in order to absorb rejected wind power.

These projects must be financed either by the E.U. structural funds, or by the Fund which will be created by the national emissions auction.

The fuel and technology mixes for electricity generation and the anticipated actions for the consumption sector are shown in Table 2.1.

It is worth noting that the Scenario in which the Policies are Applied which has been adopted has a rational structure where the individual choices have arisen mainly through studies which have been recently carried out. Thus, the rational use of lignite supplemented by natural gas for base load stations in the grid connected system is considered to be a good choice technically, while in case of uncertainty in the gas market, the exploitation of new lignite deposits should be studied and possibly, the use of IGCC technology in lignite stations. Also, the penetration of wind farms on the level of 5500 MW in the grid connected system seems not to face serious techno-economic problems, according to a recent study by the TSO and NTUA. The connection of Milos with the Cyclades seems possible also, according to a study by RAE. In addition, biogas is anticipated to be developed on a practical level and CHP from biomass is anticipated to be economically viable. The usage factor for wind farms is expected to be around 27-28% after the rejection of energy which, however, due to the increased use of natural gas, will be limited.

The results include the improvement measures for energy efficiency in the 1st National Allocation Plan for Energy Efficiency, and which, integrated into all sectors, will lead to energy conservation of at least 18,7 TWh in 2016, meeting the target of 9% and thus aiding Greece in reducing its dependence on energy imports. In addition, the adoption of technologies with better energy efficiency supports innovation and competitiveness, contributes to the improvement in the business climate, the direct and substantial development of the country and the creation of new jobs.

It is estimated that the transportation sector has the greatest margins for energy conservation, as it has been calculated to be around 36%. In order of importance, the tertiary and household sectors follow with a percentage of participation in energy conservation of 30% and 29% correspondingly.

The total of these measures creates an integrated national programme for the improvement of energy efficiency, the application of which will lead to achieving the energy goal by saving large amounts of fossil fuels and electricity and at the same time will support the further penetration of natural gas and renewable energy sources.

Table 2.2 shows the energy conservation goal, calculated according to the methodology in Directive 2006/32/EC, for 2016 as well as for the interim goal for 2010.

In the Annexes of the study the results from the MARKAL energy model are presented for the scenarios which were studied and are then followed by the calculations of the WASP model (grid connected system).

Table 2.1 Measures for Achieving the Goals of the New European Policy in the Electricity Generation Sector

Grid Connected System 2020

Technology	GW
Lignite Thermal Plants	4,0
Combined Cycle Natural Gas	5,4
Natural Gas Turbines	0,75
Large Hydro	3,7
	13,85
Wind Farms	5,5
Small Hydro	0,2
Photovoltaics	0,6
Biogas	0,2
Biomass	0,2
High Enthalpy Geothermal Energy	0,1
	6,8
Total	**20,65**

Island System 2020

Technology	GW
Petroleum	1,3
Natural Gas	0,8
	2,1
Wind Farms	0,8
Other RES	0,2
	1,0
Total	**3,1**

Table 2.2 Goals for Energy Conservation by Sector according to the Action Plan for Energy Efficiency

	Conservation for achieving the goal (GWh)	
	2010	**2016**
Household Sector	1679	5533
Tertiary Sector	1562	5751
Industry (except ETS)	127	680
Transportation	1787	6731
Total	**5.155**	**18.696**

3.

The difficulty in policy decision making in the energy sector is caused by the relationship and the influences which any policy and institutional decisions on energy matters have on the sum of economic and social activities. For this reason, energy policy, in order to maintain citizens' prosperity, must pursue simultaneously three main goals: support for economic competition, ensuring security of domestic and external energy supply and protection of the environment.

3.1 TOWARDS A NON CARBON BASED ECONOMY

Climate changes force society towards a real revolution both in the financial sector as well as in the way of thinking about human behaviour[26]. The basic modifications which were described in the preceding paragraphs on the energy balance must be applied from the present up to 2050 in order to limit the effects of climate change due to human activity. Even if the very long term ambition is to approach an ideal energy balance where no greenhouse gas emissions will be produced, Greece, like all the other European Union countries, is still far short, consuming fossil fuels in more than 80% of the total consumption.

However, even though strategic choices strengthen the competitiveness of the member states, the European Union has committed that in the year 2020, greenhouse gas emissions will be reduced by 20%, that energy efficiency will be improved by 20% and that the participation of renewable energy sources will be increased by 20% and that the share of biofuels in transportation will be 10%[27].

The anticipated results based on the meeting of the European Commission in January of 2008[28] are the reduction of European energy demand and the corresponding reduction by 50 billion Euro in 2020 (a scenario which is based on the price of a barrel of oil being 61 dollars) in the value of imports of hydrocarbons.

---

[26] In the "World Energy Outlook 2008" the IEA calls for a world energy revolution

[27] Spring European Council 2007 "32. The European Council emphasizes that the E.U. has committed to convert Europe to an economy with high energy efficiency and low greenhouse gas and decides that until there is a total world agreement for after 2012 and without affecting the position which will be adopted in international negotiations, the E.U. undertakes an independent commitment to achieve at least a 20% reduction in greenhouse gas emissions by 2020 in relation to 1990. In the footnotes it is mentioned that:

- note 6 – According to the aforementioned, the European Council underlines that it is important to increase energy efficiency in the E.U. in order to achieve the goal of 20% conservation in energy consumption in the E.U. in relation to the forecasts for the year 2020 as they are estimated in the European Commission Green Paper concerning Energy Efficiency and calls on the member states to make use of their national activities to benefit energy efficiency
- note 7 – A binding target of 20% consumption from renewable energy sources in the final energy consumption of the E.U. up to 2020.
- 10% binding minimum goal to be achieved by all the member states for the penetration of biofuels in the total consumption of petroleum and diesel in the transportation sector of the E.U. by 2020, which must be done at a logical cost.

[28] COM (2008) 30 Final of January 23, 2008

These goals have been converted to national goals. In Greece, they have been defined as follows:

- Reduction of greenhouse gas emissions in relation to 2005 for non ETS installations exempted from trading by 4%.
- Increase in the share of renewable energy sources in final consumption by 18%.
- Improvement of energy efficiency in final use by 9% by 2016.

The European energy and climate change package of January 23rd, 2008, the action plan for energy efficiency which was presented by the Commission at the end of 2006, Directive 2001/77/EC for the "promotion of electricity produced from renewable sources in the internal energy market", Directive 2002/91/EC for "energy performance of buildings", Directive 2002/31/EC for the energy consumption labeling of household air conditioners, Directive 2003/66/EC on the energy consumption labeling of household electric refrigerators and freezers, Directive 2004/8/EC for the promotion of "cogeneration of heat and power", Directive 2005/32/EC for the "ecological design of equipment" and finally the recent Directive 2006/32/EC for the improvement of "Energy Efficiency in final use and Energy Services" convert measurable policy targets into legal obligations. The new Directive 2009/28/EC on the promotion of the use of energy from renewable sources amends and subsequently repeals Directives 2001/77/EC and 2003/30/EC and is setting targets for RES penetration in the member states by the year 2020.

3.1.1 A new market tool: The European Emissions Trading Scheme

The traditional policy tools for managing demand (grants for investments for energy efficiency, energy conservation or renewable energy sources, suitably modified taxation, etc.) have reached their limits. These tools, although they are effective when prices are high, do not function well when prices fall and burden the national budget. In addition, they cannot include the internalization of the external cost of damage done to the environment.

The emissions trading scheme allows this need to be met and operates according to market principles. It was introduced to the European Union in 2005. The purchase price of CO_2 certificates is continually changing on the market[29]. The basic idea is that the relative value of the energy products must be converted in favour of forms of energy which do not emit greenhouse gases, replacing the thinking which prevails today.

[29] On November 28th 2008 the prices of the EUA and CER were correspondingly 16€ and 14€. The PPC buys CER for 6€, given that it bought them in 2005.
Prices of 26-28 € are forecast for the period 2010-2011, which will probably reach 35-40€ by 2014.

Directive 2003/87/EC of the European Parliament and the Council of October 13th, 2003 (L275/25.10.03) for the creation of a greenhouse gas emissions trading scheme in the European Union and the modification of Directive 96/61/EC of the Council, adopts an E.U. greenhouse gas emissions trading scheme, for the purpose of the more effective fulfillment of the European Union's and member states' commitments for reducing greenhouse gas emissions. According to the E.U. system, emission rights are distributed by each Member State to its plants which are covered by the system. These rights can be transferred and businesses can use them for fulfillment of part of their obligation to reduce greenhouse gas emissions. Each member state is obliged to submit to the European Commission a National Plan for distribution with the total number of rights which it will distribute in a given time period, and the distribution of these rights to the responsible user in each plant.

The National Emissions Allowance Allocation Plan (NAP) for the period 2005-2007 was approved by the Joint Ministers' Decision 36028/1604/2006 (Government Gazette 1216 B'). The National Allocation Plan for the period 2008-2012 was submitted to the European Comimission on September 1st, 2006. The European Commission issued a decision on November 29th, 2006.

The responsible authority will review the National Allocation Plan taking into consideration the decision of the European Commission and the results of the inspection which it carries out.

Emissions rights trading, which was gradually introduced to the Greek market should motivate accordingly both industrialists as well as consumers to definitely orient themselves towards a low carbon use economy. Greece should prepare itself for the new directives which will come into effect from 2013.

The fact is that the Greek electricity generating system was based on and continues to be based on a domestic fuel source, lignite. Even though the percentage of the share of lignite in the electricity generation mix is continually being reduced, in 2006, the share of lignite in net production was 52%. This fact and that petroleum continues to play a significant role in electricity generation, mainly in the non connected islands, lead to increased greenhouse gas emissions. In order to achieve the common European goal for reducing emissions by 20% by the year 2020, inspection and the imposition of financial counterincentives for the emission of these gases is necessary.

The ETS is the first form of control which has been already applied and will continue to be applied and which is a demanding but necessary process for emissions reduction. Through the National Allocation Plan the amounts of greenhouse gases which each sector of activity (electricity generation, industry, refineries, combustion, etc.) have a right to emit are precisely defined. Beyond these allowances, if one of the installations in the system has to exceed the distribution given, then by the principle "the polluter

pays" it has to buy additional rights, thus making conformity to E.U. environmental directives an absolute necessity.

According to a United Nations report, Greece remains within the set limits for both the first period of application of the NAP (2005-2007) as well as within the planned application of the second NAP (2008-2012), thus making the achievement of the goal for the total reduction of 4% of greenhouse gas emissions for the liable plants absolutely possible. Taking into consideration interventions already underway, upgrading, extensions and improvements in which almost all of the plants which receive emissions trading rights from the ETS are taking part, it can be realistically stated that Greece will be fully compliant with the binding targets which were set by the corresponding E.U. and Greek legislation.

3.1.2 Influencing the factors which affect demand

After the first petroleum crises, the consuming nations tried to apply innovative tools to reduce energy consumption, keeping their economies competitive through technology or by suitable actions to motivate consumers to change their behaviour.

a) Favourable development of energy intensity

In Figures 3.1, 3.2 and 3.3 the basic indicators of energy intensity in Greece are presented. In 2006 the intensity of primary energy and final energy showed a reduction of 17% and 12% correspondingly in relation to 1995 levels[30]. The energy intensity in the whole of industry is shown to be falling. A small but steadily increasing trend appears in the energy intensity in the tertiary sector due to the large development in the sector and the change in its structure from smaller to large businesses.

b) Technology in the service of energy conservation

The E.U. Energy Efficiency Action Plan which was adopted at the end of 2006 aims to improve energy efficiency in the European Union from now to 2020 by 20%, which means energy saving of 250 Mtoe and reduction of CO_2 emissions by 780 million tons a year[31] at the E.U. level. The report of the French Presidency emphasizes the need for taking action first in the construction sector and then in the transportation sector.

[30] Two basic indicators are used to describe the total energy consumption of a country, the primary energy intensity and the final energy intensity. The primary energy intensity shows the energy efficiency of the entire economy while the final energy intensity shows the energy efficiency of final consumers.

[31] Report by the French Presidency to the European Council of October 16th, 2008 on energy security.

Energy conservation is covered by a number of directives of the European Commission, such as Directive 2002/91/EC for the "energy performance of buildings", Directive 2002/31/EC for energy consumption labeling of household air conditioners, Directive 2003/66/EC on energy consumption labeling for household electric refrigerators and freezers, Directive 2004/8/EC for the promotion of "cogeneration of heat and power", Directive 2005/32/EC for the "ecological design of equipment" and the recent Directive 2006/32/EC for the improvement of Energy Efficiency in final use and Energy Services".

Figure 3.1 Development of the energy intensity of primary and final energy

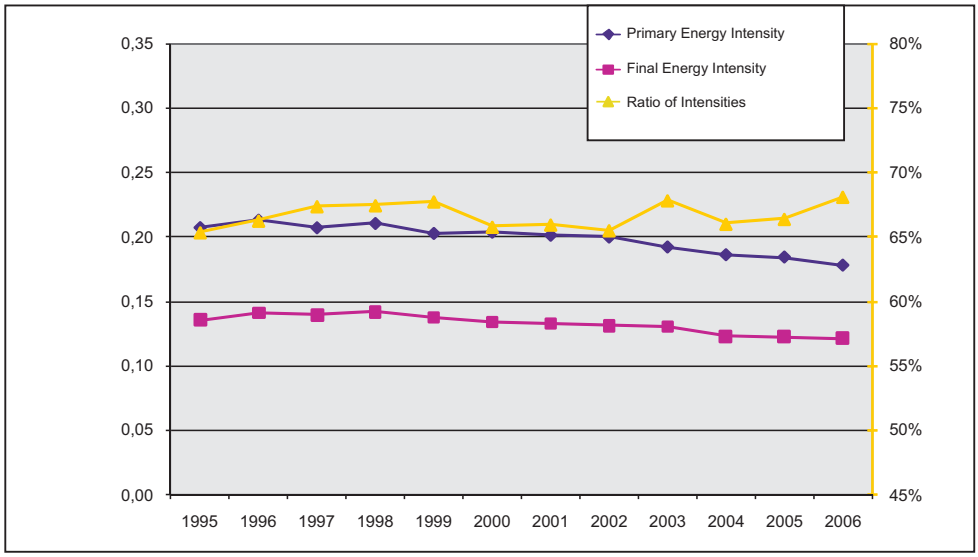


Figure 3.2 Energy Intensity by Consumption Sector

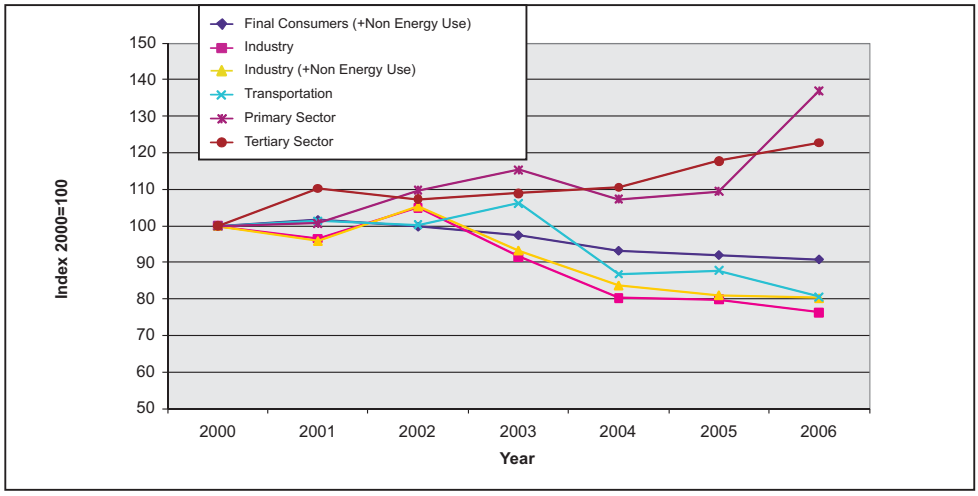
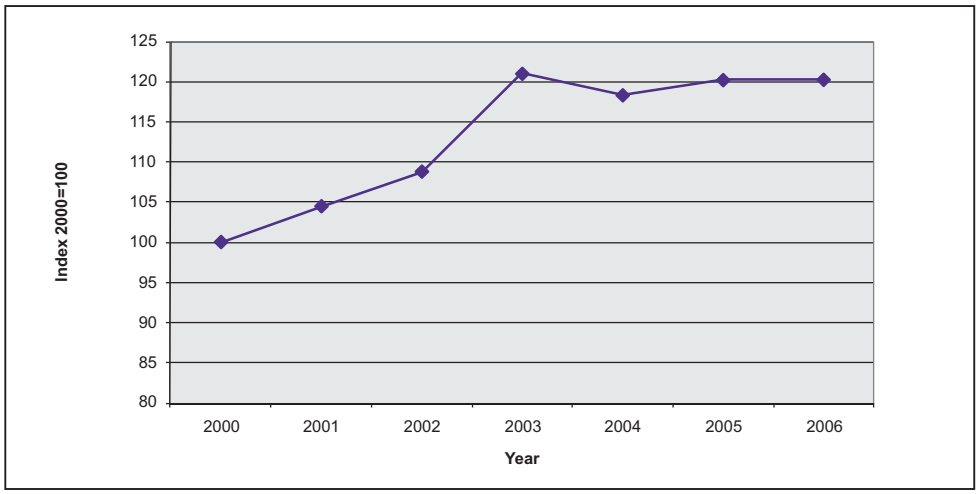


Figure 3.3 Per capita energy consumption in the household sector



In particular, Directive 2006/32/EC on Energy Efficiency in final consumption and Energy Services, sets a typical target of 9% for energy conservation in the Member States for the next nine years and also obliges the Member States to draw up National Energy Efficiency Action Plans (NEEAPs) starting on June 30th, 2007.

In Table 3.1 all the proposed measures for achieving the goal of the Greek NEEAP, are presented together, and the anticipated annual energy conservation for 2010 and 2016 as they were submitted to the European Commission in 2008. In particular, in the sectors which are referred to in the above table, in order to achieve the corresponding potential for energy conservation, the following interventions and follow up actions must be planned for:

Household sector

The uses which have the greatest potential for conservation in the household sector are space heating which covers 57% of possible conservation, domestic hot water (22%) and lighting (9%).

For space heating, conservation is achieved in combination with insulation of the building shell, the use of double glazing in the windows, the penetration of natural gas boilers, as well as the penetration of district heating. The total energy conservation will reach about 3,2 TWh in 2016, from which approximately 60% will be due to actions for improving the building shell (insulation, double glazing).

For domestic hot water, energy conservation of around 1,2 TWh is mainly due to the penetration of solar collectors using electrical impedance or natural gas as an alternative source with the displacement of electric water heaters (99% energy conservation). At the same time the penetration of district heating and the use of natural gas for water heating in combination with space heating contributes to the remaining percentage of energy conservation. In lighting, the energy conservation is mainly due to the replacement of incandescent light bulbs with fluorescent bulbs and will reach 0,5 TWh in 2016.

Transportation

In the transportation sector, the greatest potential for energy conservation appears to be in the use of privately owned automobiles (73% energy conservation) and in commercial truck transportation (21% of the total energy conservation in the sector).

In passenger transportation using automobiles, energy conservation is achieved with the penetration of cars with more efficient gas engines which consume 20% of the energy in 2016, hybrids which consume 5% of the energy in 2016, new diesel engine cars and natural gas cars. At the same time non technological measures lead to a reduction in demand in privately owned automobile passenger kilometres, with the corresponding increase in demand for passenger bus kilometres by 2% above the reference scenario each year. Also for passenger transportation, the target is considered in relation to the further penetration of buses using natural gas (20% of the consumption in 2016) and new petroleum-fuelled buses with improved engines, while for movement of goods by large trucks (over 3,5 tn) it is considered that existing technologies will be replaced at a rate of 2% per year from 2010 onwards, with the penetration of new, more efficient trucks which will consume almost 30% of the energy in 2016.

Tertiary Sector

The commercial buildings sector shows in total the greatest potential for energy conservation in the tertiary sector (44% of total energy conservation in the tertiary sector) and the hotel sector (24% of the total energy conservation in the tertiary sector).

The types of consumption with the greatest potential for energy conservation are space heating (70%), lighting (15%) and space cooling (13%).

In space heating, there is a potential for energy saving of around 0,6 TWh in total in the tertiary sector, due to technologies for improvement in the building shell (insulation, double glazing), while the penetration of natural gas technologies and improved natural gas technologies mainly in the public sector also contribute to the achievement of the goal. A significant penetration of heat pump technologies which produce simultaneously space cooling and hot water, as well as the penetration of district heating is anticipated. In addition, the penetration of cogeneration using natural gas and LPG to cover thermal-electrical loads in hospitals, hotels, commercial buildings and in the rest of the tertiary sector is also assumed.

Municipal lighting provides a potential for energy conservation of 0,2 TWh in 2016. Fifty four percent of the energy conservation in lighting is achieved by the replacement of almost all incandescent bulbs and old light fixtures and fluorescent lights in buildings in the public sector. Sixteen percent of the potential for energy saving in lighting relates to hotels and 14% in commercial sector buildings. For space cooling, the potential for energy conservation is derived from the penetration of new electrical technologies for greater efficiency, as well as heat pumps which simultaneously produce space heating-cooling and hot water.

Industry

In the industrial sector, energy conservation is derived from the reduction of consumption in electrical and heat uses and from the cogeneration of heat and power.

Thus, for electrical appliances, action on energy saving is considered to be the use of more efficient electrical appliances and light fixtures. In electrical machinery, the gradual replacement of existing electrical machines with more efficient ones which results in the reduction of electricity consumption in this use by around 5% compared to the reference scenario for 2016 is assumed. In thermal processes, an increase in cogeneration mainly with the use of natural gas, and an increase in the use of biomass-biogas in industries where they exist as process residues (Food Industry, Woodworking Industry) is taken into consideration.

Forty percent of the energy conservation in industry is due to cogeneration. Of the installed cogeneration capacity, 56% is located in the chemical industry, 26% in the food and beverage industry and the remainder in the woodworking, clothing, leather and remaining industries.

Table 3.1 Measures in Energy Consumption Sectors to carry out the National Energy Efficiency Action Plan

	Yearly Energy Conservation2010 (GWh)	Yearly Energy Conservation 2016 (GWh)
Horizontal Measures		
Creation of a unit for collecting energy data & forecasting	Included in the other measures	Included in the other measures
Targeted campaigns for education, information and rewards for "good practice"	Included in the other measures	Included in the other measures
Financial support programmes for energy saving technology investments and research	300	1000
Intersectoral Measures		
Energy efficiency in buildings	Household 210 Tertiary 375 Public 27	Household 850 Tertiary 1125 Public 81
Further promotion of the use of natural gas & liquid gas (LPG)	230	360
Energy labeling of appliances and requirements for minimum energy efficiency	995	2426
Application of an Energy Management Systems (EMS) in the tertiary and public sector	150	1000
Energy upgrading of existing buildings through Third Party Financing (TPF), Energy Efficiency Contracts (EEC) and Public and Private Joint Ventures (PPJV)	In relation to the size-cost of the energy intervention	In relation to the size-cost of the energy intervention
Installation of electronic and smart meters in consumers of electricity and natural gas	80	800
Promotion of Cogeneration of Heat and Power (CHP) systems and district heating	180	823
Household Sector		
Energy upgrading of the building shell in housing	200	2000
Financial support for upgrading boiler/burner systems for heating in existing buildings	300	900
Obligatory installation of central solar thermal systems in new housing and financial incentives for further penetration of small scale solar thermal systems in housing	180	540
Energy upgrading of social housing	An integrated study is required	An integrated study is required
Tertiary Sector		
Private Sector		
Obligatory installation of central solar thermal systems in the tertiary sector which are over 1000m^2	10	250
Promotion of voluntary agreements for energy upgrading actions in tertiary sector buildings	Depending on the number of voluntary agreements	Depending on the number of voluntary agreements
Public Sector		
Obligatory installation of central solar thermal systems for domestic hot water requirements	2	50
Obligatory supply procedures (for energy efficient technologies and RES technologies – green procurement) in public buildings	Requires study	Requires study
Integrated energy planning in municipalities	Requires study	Requires study
Obligatory replacement of all low energy efficiency light fixtures in the public and broader public sectors	98	298
Industry		
Incentives for the obligatory application of an Energy Management System (EMS) in industry	30	200
Creation of Centres for Energy and Environmental Management in Industrial Estates	20	100
Programme for voluntary agreements in industry	20	100
Energy Services for Energy Conservation	50	400

Transportation		
Innovation in the mass transport system	The application of a documented data collection and processing system is required	The application of a documented data collection and processing system is required
Infrastructure works in the transportation sector	The application of a documented data collection and processing system is required	The application of a documented data collection and processing system is required
Development of urban mobility plans	A study is required for the organization, development and application of the measure	A study is required for the organization, development and application of the measure
Promotion of Economic, Ecological and Safe Driving	820	2014
Incentives for the replacement of old medium weight and heavy vehicles (over 3.5 tn and over 10 years old)	624	1738
Incentives for replacing private vehicles and promotion of energy efficient vehicles (Natural gas, biofuels, hybrids)	768	1330
Ecological Labeling – Energy Label on Passenger Vehicles	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles
Obligatory percentage of energy efficient vehicles in the civil service or public bodies	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles
The connection of vehicle taxation to energy efficiency and CO_2 emissions	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles	Its contribution has been calculated in the energy conservation from the measures for the replacement of vehicles

Promotion of High Efficiency Cogeneration

The short term outlook for CHP depends on the economic potential of CHP for the investor and is shown in Table 3.2.

In brief, the short term outlook for the penetration of CHP must be concentrated on the following lines:

- Further development of district heating applications, especially in combination either with existing generating stations or where there is natural gas.
- Further penetration of CHP in industry in combination with development of natural gas networks
- Development of trigeneration in the tertiary sector and in particular,
  - Management of heating-cooling potential with CHP in the hotel sector
  - Penetration of CHP in large hospitals
  - Management of the heating-cooling potential with CHP in large office buildings

It is anticipated that the availability of natural gas for consumers in industry and the tertiary sector will be a significant incentive for the installation of new CHP units.

Table 3.2 Economic Potential of CHP Investments at present on the investor's side

TYPE	Economic Potential of CHP (MWe)	Economic Potential of CHP (MWth)	PES (GWh/year) Total by Type
INDUSTRY	***998,5***	***1993,2***	***6552,8***
Food, Beverages, Tobacco	320	622	2599
Pulp and Paper	80	183	614
Wood	13,5	135	100
Clothing and Leather	109	237	760
Chemicals and Petrochemicals	104	163	631
Iron, Steel , Non Steel	275	484	963
Non Metallic Ores	97	169	887
TERTIARY SECTOR	***531***	***840***	***1023***
Grid Connected Hotels	58	78	286
Non Connected Hotels	10	13	39
Hospitals	70	106	187
Office Buildings*	393	643	511
HOUSEHOLD SECTOR	***224***	***332***	***774***
District Heating IPs.*	224	332	774
BIOMASS	***423,5***	***874,4***	***4369,3***
Biomass in Industry	291	625	3107
District Heating with Biomass	83	181	812
Biogas	40	56	447,9
Glass Greenhouses	9,5	12,4	2,4

*these data contain a high degree of uncertainty

c) Motivation for investments and energy conservation behaviour

The promotion of measures and programmes for Energy Conservation (EC) and the Rational Use of Energy (RUE) is a matter of high priority for Greek energy and environmental policy. In this framework Greece supports the new world coalition for cooperation in matters of energy efficiency (IPEEC) which began in June of 2008 in the G8 framework.

With the adoption of the European directives, a legal basis was established for issuing ministerial decisions on energy labeling in Greece, as well as for the anticipated certification of the energy efficiency of buildings under the recent Law 3661/2008 and the new law 3734/2009 on High Efficiency Cogeneration. Also a new law is in the final stages of completion for energy efficiency and energy services in the framework of harmonization with Directive 2006/32/EC. In addition, a number of measures have been adopted for transportation, with the integration of Law 3423/05 on biofuels, the replacement of old passenger cars and the improvement in the specifications of road networks and public mass transportation.

The main financial support tools for energy investments were the Operational Programme for Energy (OPE), the Development Law 2601/1998, the Operational Programme for Competitiveness (OPC) and the new Development Law 3299/2004. These programmes financed investments in energy conservation, high efficiency CHP, RES and substitution with natural gas.

Besides capital subsidies through the Operational Programmes of the Ministry of Development and the Development Law, Law 3468/2006 on RES and high efficiency CHP guaranteed market prices for electricity which is produced by these technologies. Higher market prices are offered for the island system and the technologies with high investment cost (for example, photovoltaic systems).

3.1.3 Increase in the supply of energy and diversifying it in the direction of reducing greenhouse gas emissions

The electricity generation and transportation sectors must receive support for the diversification of energy sources in order to facilitate the predetermined reduction of greenhouse gases.

a) The **electricity sector** is the one thatover the next few years will require the largest investments without which Greece risks a deficiency in security of supply and as a result increased imports (most probably of nuclear origin) mainly due to the required decommissioning of many old units after 2010 and up to 2015.

Even if it is not possible to abolish the use of fossil fuels for electricity generation, the cost data for greenhouse gas emissions which are related to energy technologies must be taken into consideration. The increase in natural gas is in a transition phase, replacing solid fuels or petroleum.

In the framework of the prospects which are opening up for the Greek Electricity Generating System, the PPC, in its business plan of November 19th, 2008 which aims to reduce greenhouse gas emissions and increase installed capacity by 4000MW, includes a variety of investments as follows:

- 4 hydroelectric projects with total capacity of 630 MW
- 3 new natural gas stations (1387 MW), importation of liquid natural gas to Crete and investments in certain islands to allow the share of solid fuels and petroleum to be reduced in electricity generation in Greece
- 2 thermal lignite stations (900= 2x450 MW).

In parallel, older technology thermal lignite, petroleum and natural gas stations with a total capacity of 2400 MW will cease operation.

Concerning the development of renewable energy sources, the situation is as follows: The legal solution which will be submitted to Parliament for photovoltaics is the result of long negotiations with representatives of the sector and RAE and the careful study of the institutional framework of other countries. The goal is the

enactment of a rational system which on the one hand, will ensure the successful application of complete and reliable business plans and on the other hand, will not disproportionately burden the consumer with the effect that the RES charge will have on electicity bills.

The **legislation provides for,** in a predefined brief time period, the examination of all the applications which have been submitted and the granting of an exemption from the production license or a production license for those applications which are positively evaluate, without assigned capacity, so as to not change business plans.

Taking into consideration estimates on cost developments in the market and the installation of the relevant equipment, the gradual de-escalation of the feed in tariff was planned on a six month basis in combination with maintenance of guaranteed price stability for a period of 20 years, from the date of signature of the PP Contract with the TSO (with the prerequisite that a trial operation or connection of the photovoltaic plant is started, within 18 months for plants with a capacity of up to 10 MW).

The date for the beginning of the de-escalation (August 2010) is tied to the time required for evaluation of the applications (up to 31.12.2008, all those submitted up to 31.5.2007, up to 30.4.2009 for those submitted up to 30.6.2007 and by 31.12.2009 for those submitted by 29.2.2008) and will be 11% on a yearly basis.

At the same time, an explicit prohibition of transfers of exemption for generation licenses or generation licenses before the beginning of the operation of the plants **was enacted.**

In the same legislation, the development of RES is promoted, for the citizen as well, with the provision for the creation of a programme which will allow the fast, easy and efficient operation of small photovoltaic plants on the roofs of homes and businesses, in cooperation with the PPC grid or independent of it.

In this way, the solar potential of Greece is used , which is one of the highest in Europe and coverage of peak demand in the summer months due to the increased use of air conditioning is improved .

In 2006, the planning of the new Operational Programme for Competitiveness – Entrepreneurship (OPCE) was completed. In the energy sector, actions are provided for, which will contribute to the gradual limitation of Greece's dependence on petroleum either with the promotion of natural gas and electrical energy networks and the further penetration of renewable energy sources in the energy balance, as well as the strengthening of the strategic role of Greece in the energy map of the broader area, through the country's participation in large international networks.

These actions mainly concern:

- Renewable Energy Sources (RES) – Energy Conservation (EC)
  - Support for investments in energy production from RES and High Efficiency Cogeneration of Heat and Power

- Conservation and improvement of energy efficiency in the secondary and primary sectors.
- Support for investments for covering energy needs in the islands.

- Natural Gas
  - Penetration of natural gas in new areas with the extension of the distribution networks in the regions of Mainland Greece, Eastern Macedonia and Thrace and Central Macedonia with significant participation by private capital,
  - Extension of the Natural Gas Transmission System, as well as increasing its capacity and stability,
  - Interconnection of the National Natural Gas Transmission System with Italy, in order to strengthen Greece's role in the energy map of Europe
- Electricity
  - Connection of the islands with the National Grid Connected System, in order to cover the electricity requirements of these areas,
  - Construction of Ultra High Voltage Substations to provide an uninterrupted supply of electricity to the Southern System and to increase its stability.

b) In the **transportation** sector:

By itself, the transportation sector accounts for 1/5th of the greenhouse gases emissions. At the same time, transportation is the sector where greenhouse gases emissions show the greatest rate of increase. Over the period 1995-2005, emissions from transportation increased by 26% in the European Union and by 46% in Greece. It is noteworthy that the Ministry of Development considers that, in order to have results in the battle against climate change, it is not enough to invest in renewable energy sources, it is not enough to reduce energy consumption, it is absolutely necessary to focus on the transportation sector as well.

Urban transportation requires special attention in the battle against climate change. Thus an interministerial committee was created (Ministries of the Environment, Transportation and the Economy) to plan and apply suitable measures which are as follows:

- Measures for information campaigns on energy conservation in transportation with emphasis on promoting ecological driving, where its advantages are explained through a campaign for public awareness in the mass media.
- Measures for the modernization of public and private means of transportation by providing incentives for the replacement of old cars and renewal of the bus fleet (520 new buses , 200 of which use compressed natural gas)
- Measures for the use of alternative fuels such as natural gas and biofuels[32].

[32] The European Commission has suggested that the share of biofuels make up 10% of liquid fuels by 2020. In 2007, biofuels were 2,6% of fuels for road transport. The Commission is cautious on the development of biofuels because a large scale transfer to biofuels has significant dangers for changes in the availability of land.

A National Committee was created with the task of drafting proposals for the promotion of biogas in Greece, in which all of the responsible public bodies and industry representatives participate.

In the framework of promoting the RES market, legislation for the dynamic participation of biofuels in continuation of the policy which was applied in 2008, for product quality assurance and competitive pricing. Already 10 biodiesel production units operate in Greece, while another 2 are expected to begin operation in 2009. With the legislation for the promotion of bioethanol which was passed in March 2008, as well as the legislation which is being drafted which provides for further penetration of biodiesel in transportation, further development in the sector is anticipated in the next year.

- Provision of incentives for the use of mass public transportation with support for urban transportation (operation until 2 in the morning on weekends and expansion of the metro, tram and electric railway networks).
- The rationalization of the routes and the creation of bicycle paths, complete the measures to promote ecological transportation.

c) **Obstacles to investments**

The obstacles to investments cannot be ignored. The International Energy Agency notes that Greece suffers from the strong reaction of local authorities and administrative obstacles for every investment in energy infrastructure, a fact which makes any increase in the supply of energy difficult.

In addition, the current economic crisis can, should its effects continue, influence the ability of businesses and banks and limit investment possibilities due to the lack of available capital.

The Greek government is taking care to avoid any delay in the planned investments.

The first significant stimulus for investments in the sector was given by the OPE of the Ministry of Development (1994-1999), while the Development Law 2601/98, which connects economic support for investments to the geographical area where they will be constructed, in order to promote greater development in the area.

Beyond the capital subsidy, Law 3468/2006 for RES and High Efficiency CHP provides guaranteed purchase prices for electricity which is produced by these technologies. Higher purchase prices are offered for the island system and for technologies with a high cost of investment (for example, photovoltaic systems).

3.2 TOWARDS A LIBERALIZED AND REGULATED MARKET

3.

The liberalization of internal energy markets (electricity and natural gas) is one of the foundations of the energy policy which has been adopted by the European Union[33]. The introduction of regulations for competition in the energy sector was gradual and done in many stages over the last fifteen years.

The large scale market on the European Union level should at the same time allow the rationalization of the functioning of the market and a reduction in prices.

The recent field research done by the European Commission (DG TREN and MARKt) showed the deficiencies in market competition caused mainly by the extreme fragmentation or the degree of horizontal concentration of the market.

These findings are derived from the third set of proposals of the European Commission for the internal energy market (September 2007), which is now under discussion.

Like other Member States, Greece has incorporated the European Directives, which were adopted by the Council of the European Union into its legislation. In the natural gas sector, as in the electricity sector, this meant the adjustment of the structure of the Greek market and a tactic of successive approaches to liberalization.

3.2.1 Changes in the Greek market

1) Structure of the market

1a) The electricity market

According to Law 2773/1999, the **Electrical Energy System of Greece is exclusively owned by the PPC** which is obliged to maintain the grid and ensure its operational and technical sufficiency. The purpose of the company is the operation, exploitation, ensuring the maintenance of and the responsibility for the development of the Electricity Transmission System according to Arcticle 2 of Law 2773/1999, as well as connections with the grids of neighbouring countries in order to ensure the country's supply of electricity in a sufficient, secure and economically acceptable way. Also included in the company's responsibilities is the functioning of the liberalized electricity market.

[33] The energy policy of the E.U. is based on three pillars: security of supply, fighting climate change and the competitiveness of the European Union.

As of 1.1.2001, **the PPC became a corporation** (Presidential Decree 333) for the main purpose of carrying out commercial and industrial activities in the energy sector in Greece and abroad. On 12.12.2001, it was inducted into the Stock Exchanges of Athens and London. It controls about 89% of the installed electrical capacity in Greece which is derived from lignite, petroleum and hydrolectric plants, natural gas units as well as from wind and solar farms. At the same time it owns the two large lignite mines in Ptolemaida and Megalopolis (it controls its own production of the basic fuel – lignite – with sufficient reserves). All the lignite stations in the country produce 56% of the electricity produced by the PPC (2nd largest electricity producer from lignite in the E.U.).

A company independent of the PPC, **DESMIE S.A.** (Transmission System Operator of the Greek Electricity Transmission System)**,** was created by Law 2773/1999 which transfered the responsibility for **the operation of the transmission system** for electricity from the producers to the Grid. DESMIE ensures that electricity is supplied with security and reliability, incorporating producers into the system (PPC and independent producers) in the most cost efficient way. It is also responsible for managing the accounting of the market, in order to calculate at any given moment with clarity and accuracy what is owed and to whom.

The PPC's General Directorate of Transmission is the proprietor of the Interconnected Transmission System with which the TSO (DESMIE) transports electricity through high voltage lines from the generating stations (which belong to the PPC S.A. or other producers) and from the interconnection points with neighbouring countries, to the distribution grid or to high voltage customers.

The **System is owned by the PPC S.A.** according to Article 12 of Law 2773/1999. The PPC, as owner of the system is obliged to develop it according to the programme proposed by the TSO (DESMIE) and approved by a Ministerial Decision in the form of a Study for the Development of the Transmission System (SDTS). Two **STDS** have already been issued **for 2005-2009 and 2006-2010.**

The operation, maintenance and development of the grid connected transmission system, as well as third party access to it are the responsibility of DESMIE, in accordance with the System Operation Code. DESMIE delegates the construction of new projects and the upgrading and expansion of the grid connected system to the General Directorate for Transmission of the PPC.

The wholesale electricity market in Greece is dominated by the PPC S.A., which covers 95% of the market, and the retail market remains a 99,9% monopoly with pricing set by the Minister of Development. In parallel, in March 2008, the E.U. requested that Greece ensure equal access to lignite reserves which are used as a basic fuel in base load electricity generating plants.

1b) The natural gas market

The liberalization of the natural gas market is in the beginning stages. The basic organizing principles for the natural gas sector were defined by **Law 3428/2005,** already by the end of 2005. However, the real operation of the market under the new regime requires the enactment of all the detailed rules of engagement for all the players in it.

In **December 2005,** when Law 3428/2005 was passed, the necessary changes for the adaptation of the Greek legal system to the rules in Directive 2003/55/EC were enacted, which aimed at hastening the creation of an internal (European) natural gas market, according to liberalization principles.

For the sale of natural gas to contestable or non contestable Customers, a natural gas supply license must be issued, while every other market action, the purchase, sale, and import and export of natural gas is exercised freely in accordance with Law 3428/2005. However, until a set of rules for licenses is issued, the supply of gas to contestable customers is permitted before the issue of the licence (Law 3428/2005).

The foundation stone for the new system is the **division of the market into two parts:**

- The part of the market which is involved in the operation of natural gas infrastructure (transmission systems, terminals, Liquid Natural Gas (LNG) and storage facilities). The operation of infrastructure is a monopoly activity, which is exercised by a specific person in a strictly regulated way.
- The part of the market which concerns the supply of natural gas to consumers. This activity is open to free competition, and as a result it can be excerised by anyone who has the required license and who complies with terms set in it. The "free choice of supplier" includes the case where a customer undertakes on his own the supply of natural gas for his own account (self supplying customer).

The **detailed rules for the organization of the market** according to the above choices which are set by the law are defined with secondary legislation, with Codes and Regulations, in a way similar to that which was followed for the electricity market.

The **Necessary Codes and Regulations** for the function of the market are the following:

- Code for the Administration of the National Natural Gas System, which regulates all matters concerning the monopolized sections of the market and specifically the operation, maintenance and further development of the infrastructure, but most important the terms and conditions for third party access to them (except pricing).
- Pricing Regulations, which define the methodology by which prices are set for third party access to natural gas systems.

- Licensing Regulations, which define all procedural matters for licensing for natural gas market activity but most importantly, the terms and conditions of activity and the means by which RAE supervises the licensees. Of special significance are supply licenses and licenses for the construction of Independent Natural Gas Systems (INGS), that is systems which are developed outside the National System by private interests.

According to the **provisions of Law 3428/2005** (which incorporates Directive 2003/55) in February 2007 the **"**Operator of the National Natural Gas System**"** (DESFA) was created. The new company is a 100% subsidiary of the Public Gas Corporation DEPA S.A. (legal separation) and is the proprietary manager of the National Natural Gas System.

Although 70% of the natural gas market is open to competition, **DEPA S.A.** remains for the time being, the sole importer and supplier of natural gas in Greece. However an application has been submitted to RAE for the granting of a supply license to an interested company. For the time being, DEPA S.A. **has not issued separate account**s, given that its subsidiary was recently created. Gas distribution companies (EPA) are being prepared for the separation and the submission of separate accounts is anticipated.

The **distribution of natural gas in Greece has already been organized** through the Natural Gas Distribution Licenses which have been issued to the EPA and regulate their activities.

1c) The Regulatory Authority for Energy (RAE)

RAE was created by Law 2773/22-12-99, is an independent administrative authority and mainly has a consulting role in the energy sector. It was created in the framework of harmonization with **Directive 96/92/EC.** Law 2773/1999 was modified by Law 3175/2003 and Law 3426/2005,which incorporated Directive 2003/54/EC. Also the laws 2941/2001 (Government Gazette A' 201), 3468/2006 for the Generation of Electricity from Renewable Energy Sources, Law 3054/2002 for the petroleum products market, as well as the law for the liberalization of the natural gas market (Law 3428/2005) give specific responsibilities to RAE.

The purpose of RAE on the one hand is to **facilitate free and healthy competition** in the energy market, so that through the development of competition, the services offered to customers will be improved, and on the other, to apply a suitable regulatory policy which will allow healthy and maintainable economic viability in the regulated businesses and will provide assurance for potential investors who want to enter the energy market, that they will have equal access to transmission and distribution grids, for the promotion of the products offered.

2) Process for liberalizing the market

a) Electricity sector

The process of liberalizing the electricity market in Greece began with the enactment of Law 2773/99 (Government Gazette 286 A') in the framework of the harmonization of Greek law with the provisions of Directive 96/92/EC. Law 2773/99 defines the general operational framework and the new market institutions and specifically:

- The Regulatory Authority for Energy (RAE) whose purpose is to supervise the market, especially for the maintenance of competition and consumer protection.
- The Transmission System Operator (DESMIE) which is responsible for the operation of the transmission system.
- Selecting customers who have the right to freely make supply contracts with the electricity suppliers of their choice.
- Electricity producers, independent companies which are licensed to construct and operate electricity generating plants
- Electricity suppliers, the agents for domestically produced energy

Law 2773/99 was supplemented with a series of legislation related to the functioning of the market and the procedure for licensing institutional bodies. The Administrative and Transaction Codes which supplement and clarify the Law in matters of the functioning of the market include rules of operation for the System and access to the grids and interconnections in Greece, rules for load distribution in Production Units, rules of operation for the system of electricity offers in the market, metering, liquidation, etc. **Law 3175/2003,** which includes adjustments to the electricity market in Greece, by modifying several provisions of Law 2773/1999, adjusts some matters which pertain to the field of application of the above mentioned Directive, such as, for example, the definition of customers outside of communities as being contestable customers as of 1.7.2004, and other matters pertaining to security of the energy supply.

The goal of the new provision was to ensure in practice the possibility of creating new production potential through the organization of a day market for electricity and the application of a stable and permanent mechanism for ensuring sufficient capacity. **The provisions of Law 3175/03** include many bases for the enactment of further detailed and technical rules which should be incorporated into the System Operation and Transaction Codes for Electricity Generation. The first such plan was drawn up by RAE and was published in November 2003. After a long dialogue, the text was published in 2004.

In December 2005, **Law 3426/2005 "Hastening the Process of Electricity Market Liberalization"** was passed, with which national legislation was harmonized with the provisions of Directive 2003/54. The Directive includes, among other things,

regulations for the organization of access to the grids, regulations on the management of the distribution and transmission grids and the effective separation of the Transmission System Operation and the Distribution Grid from electricity production and supply activities.

In the framework of the application of the above laws **a series of Codes, Regulations and Permits in the form of Ministerial Decisions have been issued,** following consultation with RAE.

The most important are:

- Code for System Administration and Electricity Transactions. In 2001, the Code for System Administration and the Code for Electricity Transactions were issued, and the unified revised Code for System Administration and Electricity Transactions was issued in 2005, was modified in 2006 and then after a transition period for application of some of its provisions is anticipated to be put into full effect accompanied by a series of Manuals which provide the details for application on technical and other matters.
- Electricity Supply Code for Customers
- Regulations for Permits for Management and Use of the System
- Regulations for Permits for the Exclusive Proprietorship of the Electricity Transmission System
- Regulations for Production and Electrical Energy Supply Permits

The latest developments on the process of liberalization of the electricity market in Greece are as follows:

❖ **Production:**

Through the provisions of Law 2773/1999, a licensing system was chosen for all the units on the Grid Connected System, both RES units and small CHP in non-connected islands.

In the provisions of Law 3426/2005 **a system for issuing generating permits is laid out** after an application is made for thermal electricity generating stations in non-connected islands. This process is based on objective criteria, decisions are made and this is especially provided for in the Regulations for Issuing Generating and Electricity Supply Permits. In compliance with Directive 2003/54/EC, a tender process is provided only for ensuring supply in the non connected islands.

In 2005-2008, two new units with a maximum capacity of 250 MW started operation. In addition, private investors have, up to the present, proceeded with investments for starting construction on new electricity generating stations using natural gas and it is anticipated that at least 1200 new MW will enter the system in 2010-2011. In addition, private groups have already constructed power plants of 870 MW.

Beyond 2010, interest has been expressed by private investors in broadening the technology mix in electricity generation in which they intend to invest, and the PPC on its part is active in replacing and modernizing its generating capacity. The electricity generation capacity supply sector is expected to complete the transition from the present deficit to sufficiency in 2010.

❖ **Transmission:**

In the case of the System Operator, the unbundling has been realized with the provisions of Law 2773/1999, through which the company "Operator of the Greek Electricity Transmission System S.A." was created. Through the provisions of Law 3426/2005 the duties and responsibilities of the Operator of the Transmission System (DESMIE SA) are enhanced in relation to the development and maintenance of the system, given that in Directive 2003/54, the TSO is exclusively responsible for the operation, maintenance and development of the System.

In parallel, through the provisions of the new law **DESMIE's independence is enhanced** with respect to the PPC S.A., in view of the prohibited conflict of interest of the members of the Board of Directors with companies involved in generation or supply of electricity, further requirements for functional separation for persons responsible for the operation of the system, the procedure for the transfer of personnel from the PPC to DESMIE as well as the requirement of creating and enforcing a Code of Ethics.

In **February 2005** the fifth edition of the Draft System Operation Code and Electricity Transactions Code(SOC & ETC) was presented by RAE for public consultation following many months of work with the Transmission System Operator. During this work, it was found necessary to set a defined transition phase for the application of the new SOC & ETC, so that there will be sufficient time for a) preparing the technical infrastructure which will allow the function of the electricity market according to the provisions of the SOC & ETC, and b) achieving the gradual adjustment and preparation of those participating in the new regulations in the electricity market.

The final draft of the new SOC & ETC included modifications with respect to previous drafts which aimed to remove the technical limitations dictated by the technical specifications of the existing generating units as well as the idiosyncrasies of the Greek Transmission System and especially the distance between generating stations and centres of consumption.

❖ **Distribution:**

Law 3426/2005 provides for a distinction between distribution grid operation as opposed to ownership of the grid. In this framework, it is provided that the ownership of the distribution grid in the entire country remain with the PPC while the operation of the distribution grid is delegated to the "operator of the grid". The proprietor of the

grid undertakes, through the provisions of the law, important responsibilities for connection of new users, day to day operation and maintenance of the Grid as well as its development.

According to the new law, and for the purposes of complete legal separation, DESMIE S.A. is to undertake the responsibilities of the operator of the grid as well and change its name to "Operator of the Greek Electrical System and Network S.A." with the Greek abbreviation "DESDIE A.E.". Until the creation of the combined Operator of the System and Grid, the responsibilities of the Operator of the grid are exercised by the PPC S.A. and for this purpose it has received a temporary permit for operation of the grid, the terms and conditions of which are defined by a decision of the Minister of Development and will be published after consultation with RAE.

As for the operation of the distribution grid in the non connected Islands, the PPC S.A. has been appointed as Operator of the non connected Islands. For this purpose, a permit for exclusive management of the non connected Islands was issued which defines the specific obligations of the company especially with regard to effective operational separation of the operation of the grid as opposed to production and supply of electricity. Further, the respective obligations and rights of the PPC as Operator of the Grid in the non connected Islands are defined.

❖ **Supply:**

The right to choice of supplier for all consumers except households. For the latter, this right was approved in 1.7.2007[34].

It is noted that the requirement for provision of long term guarantees to ensure generating potential installed in a member state, which was introduced with Law 3175/2003, is abolished as a prerequisite for the issuing of a supply permit. In particular, the obligation of suppliers to submit satisfactory long term guarantees to ensure the availability of sufficient electricity generating capacity for the system is set out in the provisions of the System Operation Code and the Electricity Transactions Code.

The issue of an exclusive supply permit to the PPC refers only to the isolated microgrids in Paragraph 3 of Article 11, for those cases where an exemption has been granted according to the provisions of Article 26 of Directive 2003/54/EC.

❖ **Non Connected Islands:**

A permit for production has been issued only to the PPC S.A. for the non connected islands, which fall within the definition of isolated microgrids and for which an exemption was granted according to the provisions of article 26 of Directive 2003/54/EC, except for generation from renewable energy sources and hybrid plants as well as for autoproducers. Also, it is provided that the PPC S.A. will be obliged to

[34] An exemption is provided for consumers who are located on isolated microgrids for whom an exemption has been granted according to the provisions of Article 26 of Directive 203/54/EC.

provide an uninterrupted supply to the isolated microgrids for which a specific permit has been issued as well as for ensuring the long term economical operation of the electricity systems of these islands.

❖ **Public Benefit Services:**

In **June** 2006 a Ministerial Decision was published which defined Public Benefit Services, and soon a related Ministerial Decision will be published which will approve the methodology for calculating the exchange for the provision of these services by permit holders. In **November 2007** The Minister of Development approved the methodology for calculating the yearly cost for providing public benefit services and in particular the uniform application of pricing for the end consumer. The process for the complete calculation of pricing data for the end consumer was completed in **July 2008.**

❖ **Pricing and billing:**

As of 1/7/2008, high voltage pricing was liberalized and the process of readjusting invoices (separate mention of individual charges) for end users, so that charges for the monopoly part and the competitive part of the charges are separated in the total charge to consumers, has already begun and is proceeding rapidly,

❖ **Still outstanding:**

- **The publishing of the "Code for the Management of the Distribution Network"** which was given for public consultation in July of 2008. After the public consultation procedure, RAE incorporated the conclusions and its decisions in its opinion of the enactment of the Code for Operation of the Distribution Network.
- **The definition of the operator of the distribution network** in the grid connected network. According to the new Law 3425/2006, and for the purpose of complete unbundling, it is provided that DESMIE S.A. will undertake the responsibilities of the Operator of the Network and will be renamed "Operator of the Greek Electricity System and Network S.A.", abbreviated to "DESDIE S.A."

b) Natural gas sector

Up to the present there have been the following developments:

- In March 2006, the pricing for third party access to the National Transmission System and the LNG terminal at Revithousa. This pricing is in effect. Also, special pricing was set for peak load electricity generating units with the goal of further leveling the field for competition between electricity generation units using natural gas.

- As the Operation Code for NNGS has not yet been finalized, the procedure for third party access to the National Transmission System was transitionally defined. Specifically, the process for drawing up a Transmission Contract between a party interested in acquiring access to the System and the Operator was defined as well as the contents and the terms of these contracts. Terms sufficient to temporarily replace the Operation Code in matters concerning the Transmission System were included in these contracts.
- At the same time the Operator drafted a catalogue of development projects scheduled to be constructed for the National Natural Gas System which includes the land portion and the Greek-Italian pipeline.
- In February 2007, the Operator of the National Natural Gas System S.A. (DESFA S.A.) was created, a 100% owned subsidiary of DEPA S.A. to which the ownership of the National Natural Gas System (NNGS) was transferred and it was given responsibility for the operation, use and development of that System, while DEPA S.A. continues to exercise trading activity only in the natural gas market.

In parallel, with the completion of the regulatory framework for the liberalization of the natural gas market, there have been significant steps taken in the sectors of **production and supply**. In October 2007 DESFA completed work on upgrading the Liquid Natural Gas (LNG) Terminal at Revithousa, and the addition of a third LNG storage tank is being studied to further enhance energy sufficiency and the country's security of supply.

3.2.2 The citizen-consumer: a factor in market supervision

a) A new responsibility

As the beneficiary of a public service which is supplied by a public corporation which very often has a state monopoly, the consumer in the past had a passive role with respect to the function of the national electricity market. On the other hand, the energy policies of the member states were exclusively concentrated on satisfying demand. The decisions on investments depended on public authority and citizens had no possibility of influencing it. The only exception were the referendums on nuclear energy.

From the time that climate change became a cause for concern, the liberalization of the energy sector and the rapid rise in energy product prices, the consumer (private citizen or business) has been playing a more active role in the market. A new responsibility arises for the consumer in the form of three basic challenges. In a surely rather theoretical way, the consumer is now responsible for climate warming, the efficiency of the energy system and the cost of his imported energy consumption to the national economy.

Public authorities call on consumers to be aware of their new responsibility and the significance they have as participants in the economy. According to the European

Commission "the 493 million European consumers are the linchpin of the European economy. **Loyal**, informed and empowered consumers are the key to economic development. We have not yet fully made use of the power that our consumers represent"[35].

A specific number of directives call on the consumer's conscience. For example, the directive on energy labeling[36] was adopted mainly to make consumers aware of the practical consequences of their investments in the household electrical appliance sector in matters of energy consumption and to direct them to more energy efficient appliances taking into account the available technologies. In the same way, in the framework of the complete liberalization of the internal energy market from July 1st 2007, consumers have a free choice of supplier. The market will be in a position to function properly only if consumers have a real choice and choose to exercise it in a rational way. According to the Eurobarometer, three quarters (73%) of those surveyed in Greece believe that there should be freedom of choice of gas and electricity supplier , but on the European level the poll shows that the Greeks place great importance on the role of public services in energy matters.

The European Commission plans to enhance energy consumers' rights within the European Union. A European Charter on the rights of energy consumers should be on the horizon in the near future. It should aim to set out the fundamental rights for consumers concerning electricity and natural gas supply, contracts, information, prices and solving disputes and protection from unethical business practices.

b) Measures to benefit the poor

Still, not all consumers are in a position to benefit from the workings of the market. Global access to basic services at a low cost are necessary not only for a modern and flexible economy but also for social inclusion.

Energy poverty has not been defined in E.U. legislation up to the present time. This concept has been developed only in Great Britain. However, a policy response to energy poverty requires coordinated action on the government level as part of its economic policy and at the same time as part of E.U. policy.

The directives in force on the internal natural gas and electricity market require the member states to ensure that electricity and gas are provided at a reasonable price and order that the member states take suitable measures to protect end consumers and especially to guarantee suitable protection for vulnerable consumers. European

[35] E.U. strategy on consumer policy matters for 2007-2013.
"Making the consumer responsible, improving his prosperity and protecting him effectively" COM (2007) 99 Final

[36] Directive 92/75/CEE of September 22, 1992.

legislation responds to the needs of the member states to develop targeted support systems which will help vulnerable consumers without altering competition. With the goal of promoting consumer protection, the European Commission has instituted an energy forum for citizens which met for the first time on October 27th and 28th 2008.

In Greece a National Fund for Social Solidarity was created. Its purpose is to combat poverty and inequality. It will allow the financing of integrated policies through targeted measures and providing practical economic support to poor households. The budget for 2008 provides 100 M € to finance the fund but other supplementary funds have been approved from other sources. In April 2008 a study was done to propose an action plan to combat poverty due to energy prices. The minimum social norms for household energy requirements are being determined in order for appropriate measures to be enacted and applied.

Among the measures which have already been applied, the setting of an upper limit on petroleum products by the Ministry of Development on islands for a short length of time (14-30 August 2008) and the heating subsidy which was given to low income families for the winter of 2008-2009 should be mentioned.

3.

The security of external supply is one of the central prerequisites of Greek energy policy, taking into consideration the high energy dependence on hydrocarbons and to a lesser extent on electricity. In order to solve this problem, Greece has acknowledged the need for significant investments in transmission grids and natural gas , petroleum and electricity supply. Greece supports the goals of European energy policy and cultivates close relations with energy producing countries.

Today Greece has good grid inter connections to neighbouring countries such as Italy, Bulgaria and Turkey. Projects for enhancing these connections are already underway. The projects will equally benefit the security of supply for Greece and energy cooperation with European Union member states.

3.3.1. Gas networks and LNG

Natural gas is transported to Greece through the pipeline which connects Greece to Russia and passes through the Ukraine and Bulgaria and also in the form of liquid natural gas from Algeria. Two twenty year contracts ensure supplies for Greek consumers. The terminal at Revithousa is at present the only terminal which can accept LNG tankers. During the Russo-Ukrainian crisis of January 2009, the terminal allowed an increase in natural gas imports and thus for Greece to avoid catastrophic economic consequences.

Many projects for enhancing the natural gas grid connections are underway or are in the planning stage.

A second liquid natural gas terminal should be built in Greece. The island of Crete could be a suitable location for this purpose.

Concerning natural gas pipelines, the construction of two pipelines is underway, one of which is the ITGI with Italy and the South Stream from Russia.

- **South Stream Pipeline**

The South stream natural gas pipeline, which in the beginning was a Russian-Italian plan, will pass under the Black Sea, connecting Russia with Bulgaria, where it will be divided into two branches, the northern one towards Austria and the southern one towards Greece and Italy capable of transporting 30 billion cubic metres of gas per year. Last spring (April 29th 2008), Greece was included in the plan. The section of the pipeline will be capable of transporting an estimated 10 billion cubic metres a year.

On 28/07/08, the Minister of Development agreed with his Russian counterpart on the creation of a Joint Working Group for closer supervision of the project. Greece will undertake the initiative to organize a meeting with all the European Union countries

which have signed an agreement with Russia on the South Stream for better cooperation among them and uninterrupted coordination of the project.

- **ITGI**

The second important development concerns the operation of the **Greek-Turkish natural gas pipeline** and its extension towards Italy. The fact that the project has been included in the Intereuropean Networks, is indicative of its importance for the European Union both for security of supply as well as for the diversification of supply sources and passage routes.

For this purpose, DEPA S.A. and the Italian company EDISON signed on July 11th 2008 the foundation agreement for the company "IGI POSEIDON", based in Athens which will plan, construct and develop the undersea natural gas pipeline between Greece and Italy. The undersea pipeline will begin on the coast of Epirus and end on the coast of Apulia at Otranto in Italy. As provided for in the agreement, 50% of the new company will belong to DEPA and the other 50% to EDISON. **The construction and operation of the ITGI is anticipated to be completed at the end of 2012.**

3.3.2. Oil pipelines

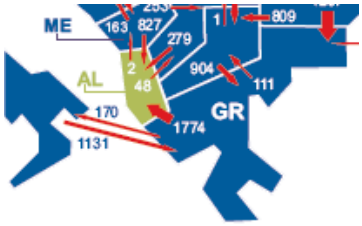
Oil is imported to Greece by sea. The possibility of oil imports through the pipeline "Burgas-Alexandroupoli" will strengthen the Greek security of supply.

On January 18th 2008, the Treaty for Participation in the Burgas-Alexandroupoli Pipeline was signed in Sofia. This was followed by the creation of an international company, "Trans-Balkan Pipeline B.V.",in February 2008 for the construction of the project. The transit charges will be set based on the Transit Agreement which will be signed by the countries involved and the international company in charge of the project, and which will be used for development programmes and environmental improvement in the greater area of Evros.

3.3.3. Electricity exchanges

Electricity exchanges between neighbouring countries permit the rationalization of national electricity systems. At present Greece is connected at its northern borders with adjoining countries (Albania, FYROM and Bulgaria) as well as with Italy through an underwater cable. For the near future the upgrading of the connections with Turkey and Bulgaria is being studied.

Physical flow of electricity for Greece (Source: UCTE)



GWh	
Imports	9047
Exports	2055
Net Imports	4366

- In November 2008, Greece and Bulgaria signed an agreement for the construction of the 2nd electricity transmission interconnection line which will contribute to the balance and security of the country's electricity system. In parallel with the new study for the Development of the Transmission System 2008-2013 which was signed by the Minister of Development, nationally important projects for the Greek electricity grid are being planned, such as the new branch for Ultra High Voltage in the Peloponnese and the Connection of the Cyclades.
- Also in June 2008, a Protocol for Cooperation was signed between Greece and Turkey for the exchange of electricity with a capacity of up to 200 MW to cover peak loads in the two countries. It should be emphasized that this exchange will be possible after the completion of the electrical connection of Greece and Turkey from the superhigh voltage transformation centre at Nea Santa in Thrace to the substation in Babaeski in Turkey.

EPILOGUE

The two gravest challenges humanity is faced with, are climate change and energy security. Regarding the climate change, its successful handling necessitates policies that encourage sustainable development and guarantee a viable tomorrow for future generations. It is obvious that any benefits that come from wasting natural resources can only be temporary in the end. Today, we realize that whoever pollutes the environment damages the economy, society as a whole and life itself.

Regarding energy security, its attainment necessitates the exploitation of each country's geo-strategic position and its incorporation into the large transnational grids of oil, natural gas and electricity through the promotion and implementation of international and transnational agreements. The geopolitics of energy define the spheres of influence, spaces of vital interests and it could evolve either into a parameter of conflict or peace. Thus, oil and natural gas rich countries possess a multifaceted element of power. At the same time, countries traversed by the pipelines acquire an important role in the flow of energy. Thus, energy balance constitutes the basic parameter of peace, security and stability.

The challenges of energy security and environmental protection are inevitably two intersecting circles. Energy policy without an environmental dimension may end up gravely damaging for society. On the other hand, environmental policy that neglects the energy foundations of economic development is incomplete, weak and eventually doomed to fail in practice.

Considering these challenges, Greece, as an EU member and at the crossroads between East and West, already has put into place a robust energy policy based on the prosperity of its citizens. Greece has already designed its energy future through a development policy that exploits its geo-strategic position and by incorporating the environmental dimension.

Indeed, our country has already implemented serious steps in both directions. Thanks to a number of transnational agreements with respect to the supply and flow of natural gas, Greece secures a long-term and continuous flow of this crucial, popular and abundant conventional fuel.

Through the implementation of transnational agreements, Greece ensures the construction of new electricity transfer networks with neighboring countries. With a rich legal framework, Greece promotes RES and energy saving in all private and public activities, developing at the same time public awareness campaigns on environmental protection. As the current study has shown, all the aforementioned steps taken by Greece are in total compliance with the new and specific energy targets of the EU up to the year 2020.

A1

Table A1.1 Total Energy Supply between 1990 and 2006 (Ktoe)

	Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Mining - Generation	Solid Fuels	7.077	6.859	6.995	6.963	7.361	7.911	8.202	8.073	8.353	8.003	8.222	8.392	8.914	8.176	8.547	8.538	8.137
	Nat. Gas	138	136	126	93	48	44	46	45	40	3	42	40	42	31	29	18	26
	RES	1.105	1.230	1.162	1.178	1.204	1.289	1.374	1.340	1.329	1.420	1.403	1.318	1.393	1.543	1.554	1.634	1.793
	Petroleum Prod.	835	839	692	566	535	460	516	468	317	16	281	192	190	138	134	101	95
	Total	**9.155**	**9.064**	**8.975**	**8.800**	**9.148**	**9.704**	**10.138**	**9.926**	**10.039**	**9.442**	**9.948**	**9.942**	**10.539**	**9.888**	**10.264**	**10.291**	**10.051**
Net Imports	Solid Fuels	988	932	1.398	883	982	925	1.137	763	849	732	768	856	626	421	464	371	223
	Petroleum Prod.	14.424	14.729	16.392	16.395	14.839	17.275	17.608	18.174	19.502	17.848	19.610	19.669	20.679	19.989	21.828	20.419	21.544
	Nat. Gas	0	0	0	0	0	0	8	129	690	1.216	1.689	1.670	1.755	2.002	2.174	2.332	2.721
	Electricity	61	55	52	70	33	69	116	197	138	14	-1	215	249	180	242	325	361
	RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	Total	**15.473**	**15.716**	**17.842**	**17.348**	**15.854**	**18.269**	**18.869**	**19.263**	**21.179**	**19.810**	**22.066**	**22.410**	**23.309**	**22.592**	**24.708**	**23.447**	**24.853**
Bunkers		2.529	2.323	2.670	3.110	3.295	3.544	3.117	3.124	3.470	3.093	3.570	3.464	3.115	3.183	3.215	2.842	3.068
Total Primary Energy Supply	Solid Fuels	8.091	7.717	8.175	7.965	8.477	8.783	8.923	8.816	9.154	8.524	9.040	9.308	9.319	8.906	9.101	8.952	8.392
	Petroleum Prod.	12.942	13.373	13.615	13.411	13.897	14.006	14.974	15.122	15.592	15.627	16.007	16.499	17.057	17.619	17.612	18.063	18.207
	Nat. Gas	138	136	126	93	48	44	49	171	725	1.218	1.705	1.683	1.801	2.026	2.229	2.354	2.747
	Electricity	61	55	52	70	33	69	116	197	138	14	-1	215	249	180	242	325	361
	RES	1.105	1.230	1.162	1.178	1.204	1.289	1.374	1.340	1.329	1.420	1.403	1.318	1.393	1.543	1.554	1.634	1.796
	Total	**22.338**	**22.512**	**23.174**	**22.746**	**23.709**	**24.228**	**25.476**	**25.688**	**26.987**	**26.867**	**28.217**	**29.061**	**29.856**	**30.307**	**30.773**	**31.352**	**31.509**

Table A1.2 Final Energy Consumption between 1990 and 2006 (Ktoe)

	Fuels	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agriculture	Solid Fuels	3	4	4	11	8	11	12	8	8	13	14	13	0	0	0	5	7
	Petroleum Products	887	977	909	883	889	825	841	840	840	840	840	852	935	1.000	854	874	919
	Electricity	134	113	140	175	179	171	189	205	223	220	250	239	213	239	240	252	234
	RES	3	3	3	3	4	3	3	2	3	3	3	3	2	7	9	13	14
	Total	**1.027**	**1.097**	**1.056**	**1.072**	**1.080**	**1.010**	**1.045**	**1.055**	**1.074**	**1.076**	**1.107**	**1.107**	**1.150**	**1.246**	**1.103**	**1.144**	**1.174**
Industry	Solid Fuels	1.022	1.051	995	1.045	1.035	1.026	1.015	909	917	734	852	870	721	597	553	435	394
	Petroleum Products	1.683	1.490	1.624	1.503	1.517	1.849	2.042	2.099	2.069	1.924	1.943	1.922	1.976	1.970	1.718	1.798	1.938
	Nat. Gas	0	0	0	0	0	0	3	33	129	190	244	294	309	328	373	426	445
	Electricity	1.041	1.023	1.010	976	1.002	1.037	1.043	1.070	1.110	1.109	1.165	1.183	1.215	1.217	1.203	1.240	1.217
	RES	191	195	196	197	191	195	206	209	205	208	241	236	246	202	207	244	219
	Total	**3.937**	**3.759**	**3.825**	**3.721**	**3.745**	**4.107**	**4.309**	**4.320**	**4.430**	**4.165**	**4.445**	**4.505**	**4.467**	**4.314**	**4.054**	**4.143**	**4.213**
Transportation	Solid Fuels	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0
	Petroleum Products	5.809	5.980	6.151	6.455	6.445	6.432	6.561	6.725	7.293	7.452	7.193	7.355	7.447	7.787	7.946	8.056	8.425
	Nat. Gas	0	0	0	0	0	0	0	0	0	0	0	6	10	11	11	12	13
	Electricity	11	11	11	11	12	13	14	14	15	17	20	18	19	20	20	17	19
	RES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
	Total	**5.821**	**5.992**	**6.163**	**6.466**	**6.457**	**6.446**	**6.576**	**6.740**	**7.308**	**7.469**	**7.213**	**7.379**	**7.476**	**7.818**	**7.977**	**8.085**	**8.503**
Household	Solid Fuels	27	31	30	41	38	37	41	41	35	20	22	20	23	4	3	4	1
	Petroleum Products	1.484	1.476	1.448	1.437	1.445	1.519	2.062	2.156	2.264	2.226	2.409	2.596	2.698	3.203	3.050	3.108	2.958
	Nat. Gas	0	0	0	0	0	0	0	0	0	4	5	5	9	19	35	73	139
	Electricity	780	861	913	901	940	990	1.053	1.068	1.099	1.159	1.222	1.251	1.356	1.414	1.449	1.451	1.520
	RES	758	765	772	777	781	784	788	791	796	799	801	801	800	799	801	803	817
	Heat	0	0	0	0	0	0	0	0	0	26	28	28	28	46	43	49	56
	Total	**3.049**	**3.133**	**3.163**	**3.156**	**3.204**	**3.330**	**3.944**	**4.056**	**4.194**	**4.234**	**4.487**	**4.701**	**4.914**	**5.485**	**5.381**	**5.488**	**5.491**
Tertiary	Solid Fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Petroleum Products	160	209	197	188	194	211	255	246	249	240	245	317	318	343	365	442	451
	Nat. Gas	0	0	0	0	0	0	0	0	13	7	9	12	18	28	44	74	90
	Electricity	482	514	567	617	679	720	759	842	932	987	1.054	1.138	1.200	1.288	1.365	1.417	1.527
	RES	0	0	0	0	0	0	0	0	0	0	1	2	2	6	6	6	7
	Total	**642**	**723**	**764**	**805**	**873**	**931**	**1.014**	**1.088**	**1.194**	**1.234**	**1.309**	**1.469**	**1.538**	**1.665**	**1.780**	**1.939**	**2.075**
Other Sectors	Solid Fuels	0	-1	0	0	0	0	0	0	0	0	0	0	1	2	3	2	0
	Petroleum Prod.	50	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nat. Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electricity	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0
	Total	**50**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**23**	**0**	**0**	**1**	**2**	**3**	**2**	**0**
Non Energy Use	Petroleum Prod.	487	433	446	429	427	452	463	477	419	428	598	640	677	694	748	633	777
	Nat. Gas	97	92	88	57	6	4	4	40	201	149	121	59	72	124	131	128	130
	Solid Fuels	89	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**672**	**583**	**534**	**486**	**433**	**456**	**466**	**517**	**620**	**577**	**719**	**699**	**749**	**818**	**879**	**761**	**907**
	SolidFuels	1.053	1.086	1.030	1.096	1.081	1.074	1.069	959	960	766	888	903	746	603	559	446	402
	Petroleum Prod.	10.073	10.135	10.328	10.466	10.490	10.837	11.761	12.066	12.715	12.683	12.631	13.042	13.374	14.303	13.933	14.278	14.691
	Nat. Gas	0	0	0	0	0	0	3	33	142	201	257	317	345	385	461	585	686
	Electricity	2.448	2.522	2.640	2.681	2.812	2.931	3.058	3.200	3.380	3.515	3.710	3.829	4.004	4.179	4.277	4.377	4.516
	RES	952	963	970	977	976	982	997	1.003	1.003	1.010	1.046	1.042	1.050	1.014	1.023	1.066	1.103
	Heat	0	0	0	0	0	0	0	0	0	26	28	28	28	46	43	49	56
Total	**Total**	**14.526**	**14.706**	**14.968**	**15.220**	**15.359**	**15.824**	**16.888**	**17.261**	**18.200**	**18.201**	**18.560**	**19.161**	**19.547**	**20.530**	**20.296**	**20.801**	**21.454**

Table A1.3 Gross Electricity Generation between1990 and 2006 (GWh)

	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gross Electricity Generation (GWh)	Solid Fuels	25.170	23.702	26.612	27.795	29.578	28.697	29.297	30.629	32.442	32.381	34.313	35.431	34.566	35.170	35.380	35.543	32.264
	Petroleum Prod.	7.740	8.847	8.186	7.837	8.011	8.860	8.534	8.299	8.078	8.157	8.885	8.477	8.633	8.707	8.385	9.207	9.601
	Nat. Gas	90	93	79	84	80	75	78	332	1.713	3.907	5.920	6.133	7.061	7.995	8.991	8.171	10.610
	Biomass/Biogas	0	0	1	1	1	1	0	0	0	1	0	79	126	105	123	122	114
	Hydro	2.000	3.171	2.389	2.541	2.842	3.782	4.504	4.096	3.866	5.058	4.111	2.725	3.463	5.332	5.205	5.610	6.475
	Wind	2	2	8	47	37	34	36	37	73	162	451	756	651	1.021	1.121	1.266	1.699
	Other Gen. Stations	0	0	135	90	74	102	106	114	160	194	163	103	108	141	140	100	25
	Total	**35.002**	**35.815**	**37.410**	**38.395**	**40.623**	**41.551**	**42.555**	**43.507**	**46.332**	**49.860**	**53.843**	**53.704**	**54.608**	**58.471**	**59.346**	**60.020**	**60.789**

Table A1.4 Electricity Balance between 1990 and 2006 (GWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gross Electricity Generation	**35002**	**35815**	**37410**	**38395**	**40623**	**41551**	**42555**	**43507**	**46332**	**49860**	**53843**	**53704**	**54608**	**58471**	**59346**	**60020**	**60789**
Autoproducer Plants	2857	2957	3051	3204	3247	3172	3270	3349	3575	3839	3980	3974	4000	4134	4458	4281	4243
Net Electricity Production	**32145**	**32858**	**34359**	**35191**	**37376**	**38379**	**39285**	**40158**	**42757**	**46021**	**49863**	**49730**	**50608**	**54337**	**54888**	**55739**	**56546**
Electricity Imports	1330	1498	967	1093	816	1390	2664	3003	2500	1811	1729	3562	4602	4169	4854	5616	6140
Electricity Exports	619	854	362	284	434	593	1314	709	890	1647	1740	1062	1706	2076	2034	1836	1938
Consumption by Pumped Storage Hydro	325	102	265	370	347	362	223	305	212	338	597	897	946	807	758	841	610
Electricity Available for End Use Consumption	32531	33400	34699	35630	37411	38814	40412	42147	44155	45847	49255	51333	52558	55623	56950	58678	60138
Network Losses	2866	2885	2675	3017	3173	3173	3247	3271	3173	3334	4273	4951	4014	4953	5199	5598	5100
Total Energy Consumption (Calculated)	29665	30515	32024	32613	34238	35641	37165	38876	40982	42513	44982	46382	48544	50670	51751	53080	55038
Statistical Differences	0	1	-2	0	-1	-2	0	1	3	240	0	0	0	0	-1	-1	181
Final Energy Consumption	**29665**	**30514**	**32026**	**32613**	**34239**	**35643**	**37165**	**38875**	**40979**	**42273**	**44982**	**46382**	**48544**	**50670**	**51752**	**53081**	**54857**
Energy Consumption Sector	**1195**	**1182**	**1323**	**1434**	**1536**	**1556**	**1603**	**1662**	**1667**	**1657**	**1831**	**1847**	**1980**	**2072**	**2014**	**2177**	**2334**
Industry	**12109**	**11896**	**11746**	**11353**	**11652**	**12066**	**12127**	**11447**	**12908**	**12900**	**13547**	**13762**	**14130**	**14156**	**13987**	**14419**	**14156**
Iron & Steel	1002	932	821	824	785	856	742	833	868	821	975	1101	1416	1550	1506	1683	1776
Chemical and Petrochemical	1381	1214	1050	968	956	1058	1150	1162	1246	1221	1212	1094	1154	627	524	569	529
Non Ferrous Metals	3315	3262	3424	3087	3240	3215	3203	3300	3446	3520	3861	3898	3929	3752	4237	4615	4111
Non Metallic Ores	1783	1807	1802	1801	1818	1906	1936	1947	2016	1979	2068	2063	2049	2072	2240	2407	2311
Transportation Equipment	572	575	534	572	585	627	645	663	713	754	790	785	808	1052	720	691	721
Mines & Quarries	282	214	231	253	269	273	281	285	277	281	276	270	276	89	294	264	319
Food & Tobacco	710	740	797	820	894	942	984	1017	1041	1107	1210	1231	1285	1875	1899	1896	2006
Pulp, Paper & Printing	505	471	469	461	494	534	512	458	444	475	512	491	473	576	584	543	583
Textiles & Leather	1072	998	952	978	965	974	987	982	980	951	996	996	965	1013	941	759	739
Unspecified Industry	1487	1683	1666	1589	1646	1681	1687	1800	1877	1791	1647	1833	1775	1550	1042	992	1061
Transportation	**124**	**123**	**130**	**125**	**138**	**149**	**159**	**167**	**180**	**197**	**227**	**214**	**222**	**237**	**238**	**199**	**217**
Tertiary	**5605**	**5979**	**6590**	**7180**	**7896**	**8373**	**8826**	**9793**	**10840**	**11482**	**12260**	**13233**	**13954**	**14978**	**15872**	**16479**	**17757**
Household	**9074**	**10014**	**10614**	**10481**	**10932**	**11508**	**12251**	**12423**	**12786**	**13484**	**14207**	**14546**	**15775**	**16444**	**16852**	**16875**	**17676**
Agricultural	**1558**	**1320**	**1623**	**2040**	**2085**	**1991**	**2199**	**2383**	**2598**	**2553**	**2910**	**2780**	**2483**	**2783**	**2789**	**2932**	**2717**

Table A1.5 Petroleum Balance between 1990 and 2006 (ktoe)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gross Inland Consumption	**12942**	**13373**	**13615**	**13411**	**13897**	**14006**	**14974**	**15122**	**15592**	**15627**	**16007**	**16499**	**17057**	**17619**	**17612**	**18063**	**18207**
Total Transformation Sector	**18398**	**17271**	**18150**	**16315**	**18545**	**20003**	**22548**	**22845**	**23198**	**21070**	**24588**	**23696**	**23595**	**24435**	**23133**	**23566**	**24684**
Independent Electricity Producers	1677	1810	1783	1823	1786	1932	1907	1846	1794	1856	1950	1853	1921	1953	1796	1960	1997
Electricity Autoproducers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Independent CHP Producers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	5
CHP Autoproducers	34	167	184	176	201	144	116	120	112	102	165	103	111	111	118	91	82
Independent Thermal Plant Generators	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thermal Plant Autoproducers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refineries	16670	15279	16163	14295	16532	17901	20505	20858	21278	19112	22473	21740	21563	22371	21215	21510	22600
Gas Plants	17	15	20	21	26	26	20	21	14	0	0	0	0	0	0	0	0
Final Consumption	**10073**	**10135**	**10328**	**10466**	**10490**	**10837**	**11761**	**12066**	**12715**	**12683**	**12631**	**13042**	**13374**	**14303**	**13933**	**14278**	**14691**
Transportation	5809	5980	6151	6455	6445	6432	6561	6725	7293	7452	7193	7355	7447	7787	7946	8056	8425
Industry	1683	1490	1624	1503	1517	1849	2042	2099	2069	1924	1943	1922	1976	1970	1718	1798	1938
Tertiary	160	209	197	188	194	211	255	246	249	240	245	317	318	343	365	442	451
Household	1484	1476	1448	1437	1445	1519	2062	2156	2264	2226	2409	2596	2698	3203	3050	3108	2958
Agricultural	887	977	909	883	889	825	841	840	840	840	840	852	935	1000	854	874	919
Not Specified	50	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Energy Use XB	**487**	**433**	**446**	**429**	**427**	**452**	**463**	**477**	**419**	**428**	**598**	**640**	**677**	**694**	**748**	**633**	**777**

Table A1.6 Final Petroleum Products Consumption between 1990 and 2006 (GWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Final Consumption	**117048**	**117781**	**120024**	**121615**	**121895**	**125916**	**136663**	**140208**	**147750**	**147377**	**146762**	**151548**	**155406**	**166211**	**161912**	**165910**	**170710**
Total Transportation	**67501**	**69488**	**71475**	**75007**	**74892**	**74741**	**76240**	**78145**	**84746**	**86604**	**83583**	**85464**	**86534**	**90495**	**92344**	**93610**	**97898**
Air Transport	14688	13514	14107	17012	15850	14479	14293	13793	13956	14920	15397	13839	13409	13502	14037	13723	15048
Road Transport	45469	48665	49861	51058	51744	53406	55985	57287	60157	61226	61981	63352	65607	69557	70022	71916	74147
Railway Transport	744	523	558	569	616	511	535	500	500	476	476	476	476	476	476	476	488
National Shipping	6600	6786	6949	6368	6682	6345	5427	6565	10133	9982	5729	7797	7042	6960	7809	7495	8215
Total Industry	**19556**	**17314**	**18871**	**17465**	**17628**	**21485**	**23728**	**24390**	**24042**	**22357**	**22578**	**22334**	**22961**	**22891**	**19963**	**20893**	**22520**
Iron & Steel	1604	244	1313	1267	1197	732	407	465	546	593	604	616	627	651	302	58	70
Chemicals and Petrochemicals	1708	1174	1290	1127	1208	1162	1964	2324	2847	1766	1836	1720	1627	1569	1964	1929	2092
Non Ferrous Metals	2057	1975	2068	2034	1917	2440	2777	2487	2719	3556	3091	3091	3137	3172	3044	2394	2615
Non Metallic Ores	3254	2940	3498	3846	3881	4462	4543	5334	4206	4021	4532	4880	5427	5415	6554	6763	6751
Transportation Equipment	0	23	23	23	23	139	337	279	372	383	407	395	395	349	302	314	349
Mines & Quarries	755	302	627	616	639	1336	1406	1301	1197	1243	1255	1232	1290	906	779	767	767
Food & Tobacco	3068	2963	3219	3312	3161	3312	3498	3184	3521	3021	3312	3114	3091	3323	2463	1789	1987
Pulp, Paper & Printing	1069	918	1011	953	895	755	1057	1243	1069	1127	1301	1127	1116	1127	674	627	720
Textiles & Leather	1429	1092	1371	1243	1174	1185	1685	1569	1197	988	1150	964	953	860	720	662	558
Unspecified (Industry)	4602	5659	4450	3033	3416	5961	6054	6217	6379	5659	5090	5183	5299	5520	3172	5589	6600
Commercial and Public Services	**1859**	**2429**	**2289**	**2185**	**2254**	**2452**	**2963**	**2859**	**2893**	**2789**	**2847**	**3684**	**3695**	**3986**	**4241**	**5136**	**5241**
Household Sector	**17244**	**17151**	**16826**	**16698**	**16791**	**17651**	**23960**	**25053**	**26308**	**25866**	**27993**	**30166**	**31351**	**37219**	**35441**	**36115**	**34372**
Agricultural/Forestry Sector	**10307**	**11353**	**10563**	**10260**	**10330**	**9587**	**9772**	**9761**	**9761**	**9761**	**9761**	**9900**	**10865**	**11620**	**9923**	**10156**	**10679**
Other Sectors	**581**	**46**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table A1.7 Natural Gas Balance between 1990 and 2006 [NCV (TJ)]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gross Inland Consumption	**5783**	**5713**	**5279**	**3893**	**1992**	**1837**	**2064**	**7160**	**30372**	**50994**	**71366**	**70466**	**75408**	**54835**	**93314**	**98538**	**115022**
Total Transformation Sector	**756**	**743**	**653**	**636**	**622**	**584**	**689**	**2939**	**14758**	**36280**	**53598**	**52963**	**56429**	**62115**	**66951**	**67211**	**79089**
Independent Electricity Producers	0	0	0	0	0	0	0	1913	14267	35735	52324	51865	55058	61214	66404	66259	78354
Electricity Autoproducers	756	743	653	636	622	584	689	1027	491	545	1274	1098	1372	902	547	952	735
Energy Sector Consumption	981	1103	950	887	1134	1094	1080	1065	1195	53	1397	1315	1462	1331	1535	1293	1351
Grid Losses	0	0	0	0	0	0	0	85	36	32	511	419	24	58	212	298	354
Available for Final Consumption	4046	3866	3677	2370	236	158	295	3071	14383	14629	15860	15768	17493	21331	24616	29736	34228
Final Energy Consumption	**0**	**0**	**0**	**0**	**0**	**0**	**145**	**1390**	**5953**	**8431**	**10770**	**13289**	**14461**	**16140**	**19319**	**24474**	**28728**
Non Energy Use Chemical Industry	**4046**	**3866**	**3677**	**2370**	**236**	**158**	**150**	**1681**	**8430**	**6256**	**5072**	**2479**	**3032**	**5175**	**5495**	**5363**	**5427**
Statistical Differences	-	-	-	-	-	-	-	-	-	-59	17	0	0	16	-198	-101	73

Table A1.8 Final Natural Gas Consumption between 1990 and 2006 (GWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Final Consumption	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**383**	**1650**	**2335**	**2998**	**3683**	**4021**	**4485**	**5380**	**6797**	**7983**
Total Transportation	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**70**	**116**	**128**	**128**	**139**	**151**
Road Transportation	0	0	0	0	0	0	0	0	0	0	0	70	116	128	128	139	151
Total Industry	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**383**	**1499**	**2208**	**2835**	**3416**	**3591**	**3811**	**4334**	**4950**	**5171**
Iron & Steel	0	0	0	0	0	0	0	23	337	569	639	744	767	686	767	813	790
Chemicals and Petrochemicals	0	0	0	0	0	0	0	0	35	93	81	105	198	256	337	616	500
Non Ferrous Metals	0	0	0	0	0	0	0	0	70	302	453	407	465	604	627	732	593
Non Metallic Ores	0	0	0	0	0	0	0	23	302	325	453	744	790	697	767	802	1081
Machine Equipment	0	0	0	0	0	0	0	0	0	0	0	23	25	0	8	21	
Mines & Quarries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food & Tobacco	0	0	0	0	0	0	0	291	453	616	732	604	627	802	953	1267	1464
Pulp, Paper & Printing	0	0	0	0	0	0	0	12	105	70	139	221	291	325	360	314	383
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles & Leather	0	0	0	0	0	0	0	23	186	198	244	349	314	349	349	221	209
Other Industries	0	0	0	0	0	0	0	0			58	198	139	105	151	163	128
Commercial and Public Services	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**151**	**81**	**105**	**139**	**209**	**325**	**511**	**860**	**1046**
Household Sector	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**46**	**58**	**58**	**105**	**221**	**407**	**848**	**1615**

Table A1.9 Capacity of Electricity Generated from RES (MW)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total	**2411**	**2515**	**2541**	**2552**	**2552**	**2552**	**2551**	**2757**	**2896**	**3068**	**3299**	**3369**	**3388**	**3473**	**3597**	**3622**	**3918**
Hydro	2408	2512	2523	2523	2523	2523	2522	2728	2856	2959	3072	3076	3078	3079	3099	3106	3135
of which pumped storage	315	315	315	315	315	315	315	520	615	615	699	699	699	699	699	699	699
Hydro -1 MW	2	2	2	2	3	3	3	4	5	8	14	15	17	19	23	26	44
Hydro 1-10 MW	28	28	39	39	39	39	39	39	40	42	42	45	45	50	56	63	73,7
Hydro 10+MW	2063	2167	2167	2167	2166	2166	2165	2165	2197	2294	2317	2317	2317	2311	2317	2318	2318
Geothermal	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0
Photovoltaic	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1,3
Wind	1	1	16	27	27	27	27	27	38	109	226	270	287	371	472	491	751,5
Biogas	0	0	0	0	0	0	0	0	0	0	1	22	22	22	25	24	30,7

Table A1.10 Electricity Generation from RES (GWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total	**1999,1**	**3173,1**	**2397,1**	**2588,2**	**2880,2**	**3817,2**	**4542,2**	**4132,1**	**3937,1**	**4992,2**	**4562,2**	**3553,2**	**4205,5**	**6431,6**	**6420,2**	**6971,3**	**8235**
Hydro	1997,0	3171,0	2389,0	2541,0	2843,0	3783,0	4504,0	4096,0	3867,0	4829,0	4111,0	2725,0	3463,0	5332,0	5205,0	5610,2	6484
of which pumped storage	228,0	72,0	186,0	259,0	243,0	253,0	156,0	214,0	149,0	237,0	418,0	628,0	663,0	566,0	533,0	593,0	610,0
Hydro -1 MW	6,0	5,0	5,0	5,0	8,0	7,0	7,0	11,0	8,0	9,0	26,0	40,0	58,0	76,0	91,0	105,8	220,4
Hydro 1-10 MW	54,0	71,0	43,0	77,0	97,0	89,0	119,0	138,0	138,0	160,0	140,0	95,0	92,0	169,0	212,0	218,4	170
Hydro 10+MW	1709,0	3023,0	2155,0	2200,0	2495,0	3434,0	4222,0	3733,0	3572,0	4423,0	3527,0	1962,0	2650,0	4521,0	4369,0	4693,0	6094,4
Wind	2,0	2,0	8,0	47,0	37,0	34,0	38,0	36,0	70,0	162,0	451,0	756,0	651,0	1021,0	1121,0	1266,4	1683,4
Biogas	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	72,0	91,0	78,0	93,4	93,8	65,5
Photovoltaic	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,1	0,1	0,2	0,2	0,2	0,5	0,6	0,8	0,9	1,4

Table A.11 Thermal Energy Production from RES (GWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
RES Heat Total (ktoe)	952	963	971	977	977	983	998	1003	1004	1011	1047	1073	1096	1046	1057	1093	1084
Biomass Total	893	897	897	898	893	897	908	911	907	911	945	938	948	910	917	957	931
Biomass Industry	191	195	195	196	191	195	206	209	205	209	243	236	246	208	215	255	229
Biomass Household	702	702	702	702	702	702	702	702	702	702	702	702	702	702	702	702	702
Biogas	-	-	1	1	1	1	1	1	1	1	1	33	48	36	38	33	33
Solar Energy	56	63	70	75	79	82	86	89	93	97	99	100	99	99	101	102	109
Geothermal	3	3	3	3	4	3	3	2	3	2	2	2	1	1	1	1	11

A2

A2.1 DEVELOPMENT OF INTERNATIONAL FUEL PRICES

The forecasts of the International Energy Agency that were published in November 2007 are used for crude oil, natural gas and coal prices. For means of comparison, the cost per unit of energy content is shown.

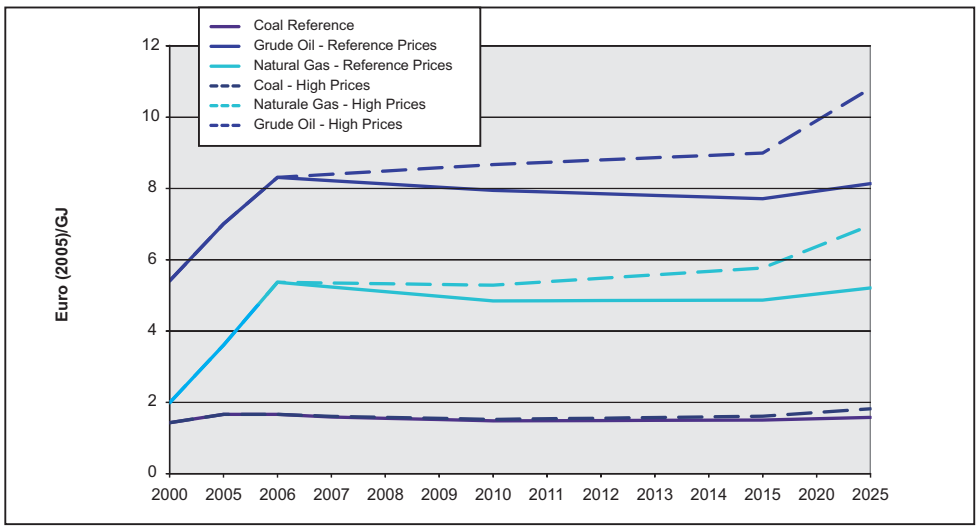
Reference Scenario (€$_{2005}$/GJ)

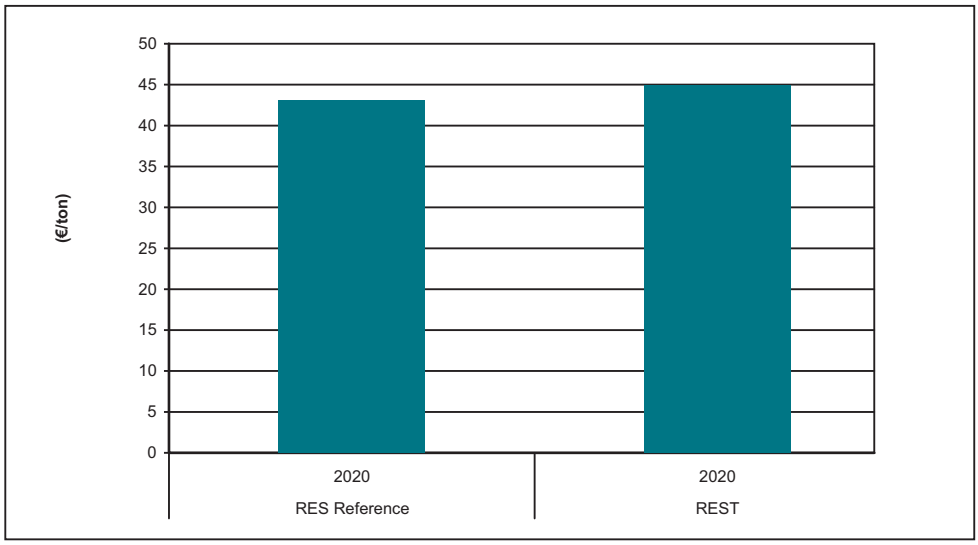
	2005	2010	2015	2020
Crude Oil	7,71	7,95	7,71	7,93
Nat. Gas	3,61	4,84	4,86	5,04
Coal	1,64	1,47	1,48	1,52

High Price Scenario (€$_{2005}$/GJ)

	2005	2010	2015	2020
Crude Oil	7,71	8,63	8,99	11,13
Nat. Gas	3,61	5,28	5,64	7,08
Coal	1,64	1,51	1,58	1,81

Development of international fuel prices according to the IEA (November 2007)





Marginal cost for avoiding emissions based on the scenarios of a paneuropean model, TIMES-MARKAL which was run for the Intelligent Energy for Europe RES2020 programme (Contractor: CRES)

A2.2 FORECAST FOR THE DEVELOPMENT OF THE NATIONAL ECONOMY

A2

A2.2.1. National Demographic Developments

The development of the Greek population is based on forecasts by the Greek National Statistical Service. According to the results of the census carried out by the National Statistical Service in 2001, the population of Greece increased at an average annual rate of 0,66% over the years 1991-2001, and the average annual rate of increase in population for the time period 2000-2020 is estimated to gradually decline according to the following table.

Average annual rates of change in the Greek population per five year period

2000	2005	2010	2015	2020
0,576%	0,326%	0,334%	0,214%	0,065%

Average annual rates of change in the number of persons per household in Greece

2000-2005	2005-2010	2010-2015
-0,43%	-0,29%	-0,37%

For the years 2000-2015, the average household size (expressed as the number of persons per household) is estimated to decline by the average annual yearly rates in the following table, reflecting both the aging of the population and new life styles.

A2.2.2. Macroeconomic Developments

The average rates of change in the basic macroeconomic data for Greece are taken in accordance with the forecasts of the model GEM-E3 for Greece.

The GEM-E3 model (General Equilibrium Model for Energy-Economy-Environment)[37] is a general equilibrium model which is applied in the European Union and was developed by an international team coordinated by the National Technical University of Athens. The model calculates the equilibrium prices for goods, services, labour and capital which lead all the markets in the European Union countries to general equilibrium (Computable General Equilibrium Model). The results of the model ensure global consistency in macroeconomic development of the data for all the countries and economic sectors. Of the many results of the model, those which are of interest for forecasting the development of useful energy are the average yearly rate of increase in the GNP, disposable household income, industrial production, activity in the tertiary and agricultural sectors and transportation.

[37] «The GEM-E3 model reference Manual», NTUA, Laboratory for Modeling the Economy-Energy-Environment, http://www.e3mlab.ntua.gr/

A2.3.1 Grid Connected System

Two Scenarios for Demand for Electricity and Power in the Grid Connected System were created. The Reference Scenario and the Energy Conservation Scenario: These scenarios were based on the respective forecasts of the National Committee for Energy Strategy and the Ministry of Development's National Energy Efficiency Action Plan:

In the **Reference Scenario** the annual rate of increase in demand for electricity is reduced by 3,5% to 2,45% between 2008 and 2020. Also, a gradual increase in the load factor from 0,59 in 2007 to 0,64 in 2020 is foreseen.

Year	Forecast for Increase in Demand (%)	Forecast of Demand (GWh)	Load Factor	Forecast of Peak Load (MW)
2009	3,4	59.128	0,60	11.243
2010	3,3	61.079	0,61	11.424
2011	3,15	63.003	0,62	11.594
2012	3	64.893	0,62	11.941
2013	2,85	66.743	0,62	12.282
2014	2,7	68.545	0,62	12.613
2015	2,55	70.293	0,62	12.935
2016	2,45	72.015	0,63	13.042
2017	2,45	73.779	0,63	13.361
2018	2,45	75.587	0,63	13.688
2019	2,45	77.439	0,64	13.805
2020	2,45	79.336	0,64	14.143

In the **Energy Conservation Scenario** it is assumed that the demand for electricity will be steadily reduced each year based on the National Energy Efficiency Action Plan. Thus the Energy Conservation Scenario is derived from the reference scenario by removing the gradually increasing conserved electricity which results from the NEEAP.

Year	Forecast of Energy Demand for Electricity (GWh)	Load Factor	Forecast of Power Demand (MW)
2009	58.832	0,60	11.187
2010	60.652	0,61	11.344
2011	62.279	0,62	11.460
2012	63.855	0,62	11.750
2013	65.375	0,62	12.030
2014	66.831	0,62	12.298
2015	68.184	0,62	12.547
2016	68.990	0,63	12.494
2017	69.795	0,63	12.640
2018	70.598	0,63	12.785
2019	71.399	0,64	12.728
2020	72.116	0,64	12.856

A2.3.2 Island System

The forecast of the energy and power demand for electricity for the island system comes from the PPC.

Year	Crete			Rhodes			Remaing Islands	
	GWh	PA	MW	GWh	PA	MW	GWh	PA
2009	3.360	5,3%	715	846	5,4%	227	2.030	5,0%
2010	3.508	4,4%	745	885	4,6%	237	2.132	5,0%
2011	3.679	4,9%	780	929	5,0%	248	2.233	4,7%
2012	3.875	5,3%	820	972	4,6%	259	2.338	4,7%
2013	4.048	4,5%	855	1.020	4,9%	271	2.448	4,7%
2014	4.222	4,3%	890	1.067	4,6%	283	2.558	4,5%
2015	4.419	4,7%	930	1.115	4,5%	295	2.673	4,5%
2016	4.618	4,5%	970	1.167	4,7%	308	2.781	4,0%
2017	4.841	4,8%	1.015	1.219	4,5%	321	2.899	4,2%
2018	5.041	4,1%	1.055	1.271	4,3%	334	3.020	4,2%
2019	5.266	4,5%	1.100	1.328	4,5%	348	3.144	4,1%
2020	5.491	4,3%	1.145	1.384	4,2%	362	3.272	4,1%

A2.3.3 The PPC Programme for Commissioning-Decommissioning

The PPC Commissioning-Decommissioning Programme, as it was presented by the President of the PPC to the Greek Parliament on February 2nd 2008 in combination with data from the Directorate of Strategy and Planning of the PPC and the business plan which was announced by the PPC in November 2008, is shown below.

Decommissioning of old PPC Units

Unit	Fuel	Net Capacity(MW)	Year of Decommissioning
TES - LIPTOL	Lignite	38	12/2010
Ptolemaida 1	Lignite	64	
Ptolemaida 2	Lignite	116	
Megalopolis 1	Lignite	113	
Megalopolis 2	Lignite	113	
Ptolemaida 4	Lignite	274	12/2011
Ptolemaida 3	Lignite	116	12/2012
Lavrio 1	HFO	143 [2]	1/2015
Lavrio 2	HFO	287 [2]	
Aliveri 3	HFO	144 [3]	
Aliveri 4	HFO	144 [3]	
Aghios Georgios 8	Nat. Gas	151 [1]	
Aghios Georgios 9	Nat. Gas	188 [2]	
Lavrio 3	Nat. Gas	173 [1]	
Megalopolis 3	Lignite	270	12/2017
Kardia 1	Lignite	275	12/2017
Kardia 2	Lignite	275	12/2017
Linoperamata IC 1,2,3,4	HFO	42	1/2012
Gas Turbines in Hania 1,4,5	Diesel	62	
Linoperamata 1-6	HFO	104	1/2014
Linoperamata Gas Turbines	Diesel	31	
Cyclades	Diesel & HFO	200	1/2012

[1] Cold reserve from 1/2011
[2] Cold reserve from 1/2012
[3] Cold reserve from 1/2013

Commissioning of new PPC thermal units

Unit	Fuel	Net Capacity(MW)	Decommissioning
Aliveri 5	Nat. Gas	380	6/2010
Megalopolis 5	Nat. Gas	800	11/2012
Meliti 2	Lignite	405	4/2013
Kozani-Ptolemaida	Lignite	435	10/2013
Atherinolakos - Crete	HFO-Nat. Gas [1]	100	1/2011
Korakia - Crete	Nat. Gas	250	6/2013
		250	1/2014
Hania CCGT	Nat. Gas	186 [2]	2012
TES Rhodes	HFO	120	1/2012

[1] Natural gas will be used at the Atherinolakos unit from 2016.
[2] This is derived from the conversion of the existing gas turbines 11 and 13 in the same plant with a total net capacity of 116 MW by adding a steam turbine with a net capacity of 70 MW.

Commissioning of new PPC hydroelectric plants

Unit	Net Capacity(MW)
Mesochora I,II	160
Ilarionas I,II	157
Metsovitiko II	29
Sykia I,II	125
Pefkophyto I,II	160

A2

The natural gas system in Greece has already three entry points and a fourth entry point is expected to be constructed by the year 2015. The first entry point is on the Greek-Bulgarian border (Promachonas) with gas imported from Russia where the supply capacity is 3,5-4 bcm/year. The second entry point is the area of Megara where the National Natural Gas Transmission Grid receives Algerian natural gas through the liquid natural gas terminal on the island of Revithousa. The gas supply capacity from Revithousa is expected to be 3,2 bcm/yer by 2018. The third entry point is in Kipi in Evros is being natural gas from Asian countries (for example, Azerbaijan). The supply of this is anticipated to be around 11bcm/year by 2012, of which 3 bcm/year is destined for the Greek market.

In total the gas which will be available on the Greek market by 2018 is anticipated to be around 9,5 bcm/year. Of this, 6,5 bcm/year can be used for electricity generation where this supply corresponds approximately to natural gas generating stations with a total capacity of about 5,8 GW.

A3

A3.1 RESULTS FROM THE MARKAL ENERGY MODEL

Reference Scenario

Mtoe	2010	2015	2020
Mining - Generation	10,55	9,78	8,55
Net Imports	26,27	31,31	35,05
Seagoing Vessels	2,42	2,80	3,14
Total Energy Supply in Greece	**35,40**	**39,45**	**41,93**
Consumption for Electricity and Heat	13,21	13,98	14,09
of which Cogeneration	0,17	0,39	0,37
Net Electricity Production TWh	65,0	76,6	87,9
of which Cogeneration TWh	1,9	4,5	5,1
Installed Electricity Generation Capacity GW	16,9	19,9	23,3
of which Cogeneration GW	0,5	0,7	1,4
Final Energy Consumption	**24,3**	**27,9**	**30,5**

20-20-20 Achievement Scenario

Mtoe	2010	2015	2020
Mining - Generation			
Lignite	8,90	7,49	6,17
Natural Gas	0,02	0,04	0,05
Biomass/Biogas	1,24	1,35	1,73
Biofuels	0,42	0,61	0,92
Total	**10,57**	**9,48**	**8,86**
Net Imports			
Solid Fuels	0,36	0,37	0,39
Petroleum and Petroleum Products	20,46	21,30	20,76
Natural Gas	4,73	6,38	7,12
Electricity	0,13	0,06	0,01
Biomass	0,05	0,07	0,01
Total	**25,74**	**28,18**	**28,28**
Seagoing Vessels	**2,42**	**2,80**	**3,14**
Total Energy Supply in Greece			
Solid Fuels	9,26	7,86	6,55
Petroleum and Petroleum Products	18,04	18,50	17,61
Natural Gas	4,75	6,42	7,17
Electricity	0,13	0,06	0,01
Biomass/Biofuels	1,65	1,96	2,64
Hydro	0,43	0,46	0,49
Wind	0,29	0,69	1,08
Solar	0,32	0,43	0,58
Total	**34,89**	**36,37**	**36,14**
Consumption for Electricity and Heat			
Total	**13,12**	**12,29**	**11,37**
of which Cogeneration			
Total	**0,33**	**0,60**	**0,62**

TWh	2010	2015	2020
Net Electricity Generation from			
Thermal Stations - Grid Connected	49,8	52,0	50,6
RES Stations - Grid Connected	9,4	15,1	21,7
Thermal Stations - Non Connected	5,8	6,9	7,8
RES Stations - Non Connected	0,8	1,4	2,5
Total	65,7	75,3	82,5
of which Cogeneration			
Total	**3,6**	**7,2**	**7,7**

GW	2010	2015	2020
Installed Electricity Generating Capacity			
Lignite	4,9	4,9	4,0
Coal	0,0	0,0	0,0
Petroleum and Petroleum Prod. - Grid Connected	0,9	1,1	0,4
Petroleum and Petroleum Prod. - Non Connected	1,4	1,3	1,3
Natural Gas - Grid Connected	4,3	5,9	6,2
Natural Gas - Non Connected	0,0	0,3	0,8
Biomass/Biogas	0,2	0,3	0,4
Hydro	3,7	3,8	3,9
Wind - Grid Connected	1,3	3,4	5,5
Wind - Non Connected	0,3	0,4	0,8
Other RES - Grid Connected	0,2	0,4	0,8
Other RES - Non Connected	0,1	0,1	0,2
Total	**17,1**	**21,9**	**24,3**
of which Cogeneration			
Petroleum Products	0,2	0,4	0,4
Natural Gas	0,4	0,8	0,9
Biomass/Biogas	0,2	0,2	0,2
Total	**0,7**	**1,3**	**1,5**

Mtoe	2010	2015	2020
Non Energy Use	0,6	0,6	0,6
Final Energy Consumption/Sector			
Agriculture	1,2	1,2	1,2
Industry	4,7	5,3	5,8
Transportation	9,6	10,5	10,7
Household	6,1	6,4	6,5
Tertiary	2,4	3,1	3,0
Final Energy Consumption/Fuel			
Solid Fuels	0,3	0,3	0,3
Petroleum Products	15,2	15,4	14,8
Natural Gas	1,6	2,5	2,7
Electricity	5,0	5,7	6,2
Biomass-Biofuels	1,6	1,9	2,4
Heat	0,1	0,2	0,2
Solar	0,3	0,4	0,6
Total	**24,0**	**26,4**	**27,2**

Policy Goals

	2010	2015	2020
Energy Conservation in comparison to the Reference Scenario (2006/32/EK) (Mtoe)	0,26	1,48	3,26
Emissions CO_2 (Mtons) Total Energy Sector+Processes	119	117	107
Penetration of RES(Mtoe)	2,76	3,71	5,05
Final Consumption according to the NEEAP (Mtoe)	25,03	27,56	28,46
% RES in Final Consumption	11%	13%	18%

CO_2 Emissions from the use of energy in sectors outside the ETS (in Million Tons)

Mtons	2010	2015	2020
Agriculture	2,7	2,8	2,7
CDM-Markets	0,0	-2,4	-3,0
Industry	3,5	3,9	3,9
Land Transportation	20,4	21,4	20,0
Household-Tertiary	12,3	12,4	11,0
Sea Transportation	2,5	2,8	3,1
Total	**41,4**	**40,9**	**37,7**

A3.2 RESULTS FROM THE WASP IV ELECTRICITY GENERATION SYSTEM PROGRAMMING MODEL

A3

NET CAPACITY OF THE ELECTRICITY GENERATION SYSTEM 2008-2020

YEAR	PEAK LOAD (MW)	NET CAPACITY PREVIOUS YEAR EXCLUDING RES (MW)	CAPACITY OF RES UNITS (MW)		CAPACITY* OF OLD UNITS TO BE DECOMISSIO-NED (MW)	NEW UNITS FROM THE OPTIMAL SOLUTION (MW)					INCREMENTAL CAPACITY MW/ YEAR EXCLUDING RES	TOTAL NET CAPACITY EXCLUDING RES (MW)	RESERVE MARGIN	
			NEW	CUMULATIVE		LIGNITE	COMB. CYCLE NAT. GAS	GAS TURBINES NAT.GAS	COAL	HYDRO			(MW)	%
2008	10841	11460	-	883	-	-	-	-	-	-	-	11460	619	5,7%
2009	11187	11460	568,5	1452	-	-	-	150	-	172	322	11782	595	5,3%
2010	11344	11782	718,5	2170	-	-	800	-	-	186	986	12768	1424	12,6%
2011	11460	12768	396	2566	-441	-	400	150	-	-	550	12877	1417	12,4%
2012	11750	12877	396	2962	-276	-	400	150	-	-	550	13151	1401	11,9%
2013	12030	13151	396	3358	-117	405	-	-	-	285	690	13724	1694	14,1%
2014	12298	13724	396	3754	-	435	-	-	-	-	435	14159	1861	15,1%
2015	12547	14159	496	4250	-1230	-	2x400	150	-	-	950	13879	1332	10,6%
2016	12494	13879	376	4626	-	-	-	-	-	16,5	16,5	13896	1402	11,2%
2017	12640	13896	376	5002	-	-	-	-	-	-	0	13896	1256	9,9%
2018	12785	13896	542,7	5545	-822	-	2x400	-	-	-	800	13874	1089	8,5%
2019	12728	13874	542,7	6087	-	-	-	-	-	-	0	13874	1146	9,0%
2020	12856	13874	762,7	6850	-	-	-	-	-	-	0	13874	1018	7,9%
TOTAL					**-2886**	**840**	**3200**	**600**	**-**	**660**	**5300**			

*According to Law 3175/2003 (as it was modified by Law 3426/2005), the PPC was granted a generation permit for the renewal and replacement of old units with a total capacity of up to 1600 MW. These old units, after being replaced, remain as "emergency reserves" and they are managed according to the System Management Code and are taken over by DESMIE, according to contracts with the PPC exclusively for DESMIE to provide auxiliary services and reserves. According to Law 3578/2007, Article 19, a generation permit for capacity up to 800 MW was issued in addition to that mentioned above for the replacement of old units with modern ones by the year 2017. When these units become operational, the old PPC units will be decommissioned.

TOTAL NET CAPACITY PER FUEL TYPE

YEAR	TOTAL NET CAPACITY EXCLUDING RES (MW)	RES UNITS CAPACITY (MW)	TOTAL NET CAPACITY INCLUDING RES (MW)	TOTAL NET CAPACITY PER FUEL TYPE													
				LIGNITE		NATURAL GAS				OIL		COAL		HYDRO		RES	
						CC	GT	TOTAL									
				MW	%	MW		MW	%	MW	%	MW	%	MW	%	MW	%
2008	11460	883	12343	4826	39,1	2711	150	2861	23,2	719	5,8%	0	0,0%	3054	24,7	883	7,2%
2009	11782	1452	13234	4826	36,5	2711	300	3011	22,8	719	5,4%	0	0,0%	3226	24,4	1452	11,0%
2010	12768	2170	14938	4826	32,3	3511	300	3811	25,5	719	4,8%	0	0,0%	3412	22,8	2170	14,5%
2011	12877	2566	15443	4385	28,4	3911	450	4361	28,2	719	4,7%	0	0,0%	3412	22,1	2566	16,6%
2012	13151	2962	16113	4109	25,5	4311	600	4911	30,5	719	4,5%	0	0,0%	3412	21,2	2962	18,4%
2013	13724	3358	17082	4397	25,7	4311	600	4911	28,7	719	4,2%	0	0,0%	3697	21,6	3358	19,7%
2014	14159	3754	17913	4832	27,0	4311	600	4911	27,4	719	4,0%	0	0,0%	3697	20,6	3754	21,0%
2015	13879	4250	18129	4832	26,7	4600	750	5350	29,5	0	0,0%	0	0,0%	3697	20,4	4250	23,4%
2016	13896	4626	18522	4832	26,1	4600	750	5350	28,9	0	0,0%	0	0,0%	3714	20,0	4626	25,0%
2017	13896	5002	18898	4832	25,6	4600	750	5350	28,3	0	0,0%	0	0,0%	3714	19,7	5002	26,5%
2018	13874	5545	19418	4010	20,7	5400	750	6150	31,7	0	0,0%	0	0,0%	3714	19,1	5545	28,6%
2019	13874	6087	19961	4010	20,1	5400	750	6150	30,8	0	0,0%	0	0,0%	3714	18,6	6087	30,5%
2020	13874	6850	20724	4010	19,3	5400	750	6150	29,7	0	0,0%	0	0,0%	3714	17,9	6850	33,1%

ELECTRICITY PRODUCTION PER FUEL

YEAR	ELECTRICITY DEMAND (GWh)	PUMPED STORAGE CONSUMPTION (GWh)	ENERGY GENERATED (GWh)	NET IMPORTS (GWh)	ELECTRICITY PRODUCTION PER FUEL TYPE																
					LIGNITE			NATURAL GAS			OIL			COAL			HYDRO			RES		
					GWh	%	HOURS	GWh	%	HOURS CC	GWh	%	HOURS	GWh	%	HOURS	GWh	%	HOURS	GWh	%	HOURS
2008	57012	1092	54896	3198	31282	57,0%	6482	13961	25,4%	5150	3195	5,8%	4444	0	0,0%	-	4146	7,6%	1357	2314	4,2%	2620
2009	58832	1092	56725	3199	31271	55,1%	6480	14017	24,7%	5170	3239	5,7%	4505	0	0,0%	-	4410	7,8%	1367	3788	6,7%	2610
2010	60652	1092	59765	1978	30581	51,2%	6337	16630	27,8%	4737	2366	4,0%	3291	0	0,0%	-	4750	7,9%	1392	5439	9,1%	2507
2011	62279	1092	61352	2018	28285	46,1%	6450	19570	31,9%	5004	2368	3,9%	3293	0	0,0%	-	4750	7,7%	1392	6378	10,4%	2486
2012	63855	1092	62984	1963	26821	42,6%	6527	21723	34,5%	5039	2366	3,8%	3291	0	0,0%	-	4750	7,5%	1392	7321	11,6%	2472
2013	65375	1092	64806	1660	28513	44,0%	6485	20517	31,7%	4759	2350	3,6%	3268	0	0,0%	-	5162	8,0%	1396	8265	12,8%	2461
2014	66831	1092	66878	1045	30906	46,2%	6396	19267	28,8%	4469	2334	3,5%	3246	0	0,0%	-	5162	7,7%	1396	9208	13,8%	2453
2015	68184	1092	68604	672	31127	45,4%	6442	21936	32,0%	4769	0	0,0%	-	0	0,0%	-	5162	7,5%	1396	10379	15,1%	2442
2016	68990	1092	69482	600	31116	44,8%	6440	21951	31,6%	4772	0	0,0%	-	0	0,0%	-	5212	7,5%	1403	11206	16,1%	2422
2017	69795	1092	70268	619	31118	44,3%	6440	21965	31,3%	4775	0	0,0%	-	0	0,0%	-	5212	7,4%	1403	11977	17,0%	2394
2018	70598	1092	71013	677	26264	37,0%	6550	26440	37,2%	4896	0	0,0%	-	0	0,0%	-	5212	7,3%	1403	13098	18,4%	2362
2019	71399	1092	72203	287	26285	36,4%	6555	26489	36,7%	4905	0	0,0%	-	0	0,0%	-	5212	7,2%	1403	14219	19,7%	2336
2020	72116	1092	73098	110	25906	35,4%	6460	25649	35,1%	4750	0	0,0%	-	0	0,0%	-	5212	7,1%	1403	16333	22,3%	2384

ANNEX 4

CORRELATION OF BRENT PRICES WITH PETROLEUM PRODUCT CONSUMPTION

A4

a) Correlation between the prices for Brent crude and average monthly prices for various petroleum products at gas stations (samples taken every Monday only)

Correlation of Petroleum Product Prices with the Brent Price					
Month, Retrogression	UNLEADED GAS.95RON	UNLEADED GAS.98RON	NEW SUPER (LRP)	DIESEL FOR HEATING	DIESEL FOR TRANSPORTATION
0	0,92	0,87	0,89	0,92	0,89
-1	0,81	0,76	0,77	0,81	0,73
-2	0,68	0,67	0,65	0,70	0,54
-3	0,58	0,60	0,57	0,58	0,43
-4	0,49	0,54	0,49	0,47	0,32
-5	0,41	0,50	0,42	0,39	0,22
-6	0,41	0,51	0,43	0,38	0,22

The correlation with the time lag shows that the effect of Brent prices on petroleum products is immediate (less than a month's difference).

b) Correlation of the Brent price with quantities consumed based on consumption data for various petroleum products.

Correlation of Petroleum Product Consumption with Brent prices [corr(Brent (t+l),Pro(t))]					
Lag l=	UNLEADED GAS.95RON	UNLEADED GAS.98RON	NEW SUPER (LRP)	DIESEL FOR HEATING	DIESEL FOR TRANSPORTATION
6	0,19	-0,07	-0,69	0,26	0,10
5	0,15	-0,07	-0,70	0,27	0,10
4	0,14	-0,04	-0,71	0,16	0,16
2	0,19	-0,04	-0,76	-0,01	0,32
3	0,28	0,03	-0,77	-0,15	0,51
1	0,36	0,06	-0,74	-0,24	0,62
0	0,47	0,11	-0,72	-0,30	0,68
-1	0,47	0,05	-0,71	-0,26	0,68
-2	0,38	-0,07	-0,73	-0,19	0,64
-3	0,35	-0,09	-0,72	-0,06	0,62
-4	0,31	-0,08	-0,72	0,03	0,52
-5	0,16	-0,15	-0,75	0,11	0,42
-6	-0,00	-0,25	-0,78	0,12	0,34

The above table was compiled to analyze the elasticity of demand in relation to the price of a barrel of Brent.

Only Super, which is consumed in very small quantities, shows strong elasticity while SP95 and diesel for transportation which have the greatest consumption show

strong positive correlation mainly in retrogression, which means that this demand shows a price increase and the consumption of these two products is not sensitive to Brent price changes if petroleum product prices are very strongly related to Brent prices.

Greek consumers of petroleum products for vehicles do not show sensitivity to price increases, but continue to consume more.

A5

Greek Tonnage Table (IMO)

Country	By flag (1000dwt)	By Ownership (1000dwt)
Panama	232.148	-
Liberia	105.227	-
Bahamas	55.238	-
Greece	55.145	170.181
Marshall Islands	54.644	-
Hong Kong	54.341	45.053
Singapore	51.043	25.723
Malta	40.201	-
China	34.924	70.390
Cyprus	29.627	-

Greek owned vessels under different flags including the Greek (ships over 1.000 gt)

Date	Vessels (number)	DW (Dry Weight)	GT (Gross Tons)
March 1988	2.487	85.047.436	47.269.018
March 1989	2.487	81.928.296	45.554.419
February 1990	2.426	84.439.159	46.580.539
March1991	2.454	87.102.785	47.906.852
March 1992	2.688	98.218.176	53.891.528
March 1993	2.749	103.958.104	56.918.268
March1994	3.019	120.650.373	66.342.046
March 1995	3.142	126.128.352	71.666.943
March 1996	3.246	129.737.336	75.156.763
March 1997	3.204	127.782.567	74.982.110
February 1998	3.358	133.646.831	78.900.843
March 1999	3.424	139.255.184	83.454.890
March 2000	3.584	150.966.324	90.227.491
March 2001	3.618	168.434.370	100.220.348
March 2002	3.480	164.613.935	98.195.100
May 2003	3.355	171.593.487	103.807.860
March 2004	3.379	180.140.898	108.929.135
March 2005	3.338	182.540.868	109.377.819
March 006	3.397	190.058.534	113.603.803
February 2007	3.699	218.229.552	129.765.470
February 2008	4.173	260.929.221	154.599.221

Source: Greek Shipping Co-operation Committee based on data provided by the Lloyd's Register - Fairplay.

WORKING GROUP

The present publication was elaborated in the context of the project **"An Integrated Information System for Supporting Energy Policy and Planning" of the Operational Programme "Information Society"**

CRES was responsible for implementing the above mentioned project on behalf of the **Ministry of Development**

The working group for this publication was formulated by the Ministry of Development with staff from CRES, RAE, DESMIE and DESFA as well as independent experts who worked with CRES.

COORDINATION OF THE PROJECT

Ministry of Development

STUDY GROUP

CRES

DESMIE S.A.

DESFA S.A.

IGMS

EKPAA

INDIVIDUAL NATIONAL EXPERTS

We also wish to thank

RAE for its contribution with data and suggestions in its area of their responsibility

PPC S.A. who contributed to this effort with data and recommendations for electricity economics models

6937322636

This brochure was printed on recycled paper

HELLENIC REPUBLIC
MINISTRY OF DEVELOPMENT

119 Mesogeion Avenue, 101 92 Athens Greece

t: +30 210 6969000, www.ypan.gr

The project is jointly funded by 75% from the European Union - the European Regional Development Fund and by 25% from the Greek Government