Horizontal overview GREECE

1. Energy-related and socio-economic analysis: past, present and future

1.1. Factual information

1.1.1. Geography & population

Greece has a surface area of 131940 km², including an archipelago of more than two thousand islands. Greece is a peninsular country located at the southern part of South-East Europe. There are several mountains leaving arable land which corresponds to only 21.1% of total surface. Greece has a coastal line of 14,220 km. Greece's climate is temperate and mild, with wet winters and hot dry summers.

Greece counts 11 million inhabitants and approximately 4.7 million households.

1.1.2. Economy and Energy Demand

Greece is since 1981 a member of the European Union and since 2002 a member of the European Monetary Union. Greece has a market economy with the public sector accounting for 40% of GDP and with per capita GDP slightly above 70% of the leading euro-zone economies. Tourism provides 15% of GDP, agriculture 7% and industry 22%. In purchasing power parity, Greece's GDP per capita was 15 thousand Euros in 2004.

Over the last five years GDP growth was steadily higher than 3.5% per year, in real terms. Inflation is constantly around 3% on an annual basis. Unemployment is high, exceeding 10% of active population. Public debt, being higher than 110% of GDP, and public budget deficit which exceeds the EU stability pact criterion of 3% of GDP are the most important problems of the Greek economy. Public debt, inflation and unemployment are all above the euro-zone average.

The services sector accounts for 70% of total value added and manufacturing accounts only for 11.7%. There exist no more than 200 industrial plants that are heavy energy users, among which only 50 are directly connected to high voltage power. Iron and Steel, nickel and other metals, aluminium melting, cement and basic chemicals are the most important heavy energy-using industrial activities.

The use of primary energy per capita is 75% of the EU-15 average but energy intensity is higher by 25% of the EU-15 average. Electricity consumption per capita is in Greece at 80% of the EU-15 average. Energy intensity has improved by 8% over the last 15 years, but deteriorated in houses and in the tertiary sector by more than 15% over the same period. The use of electricity is expected to grow over the next ten years at rates slightly above GDP growth, as it was the case over the last fifteen years. There is a significant potential for more rational use of energy in buildings and in the transportation sector.

1.1.3. Energy Supply

Greece has large endowments of lignite of low calorific value, but has little hydrocarbon resources. These lignite endowments have a large influence on the energy balance and as a consequence on the environmental issues as well.

Estimations of Greece fossil reserves:

- Lignite: 3.5 Gt (exploitable through open air mines) which implies more than 50 years of reserve at current utilisation level; however opening of new lignite mines involves considerable environmental damages and is very unlikely given the current land use constraints; despite their low calorific value (0.125 toe per ton) the lignite resources extracted from the currently open mines are very competitive in economic terms;
- Hydrocarbons: The proven oil reserves are 1.2 Mt and those of gas 1 Gm3.

Greece has a considerable technical potential of renewable energy resources. The hydro potential is estimated at 84 TWh/year, but generation from lake reservoirs is very unlikely to exceed 4500 GWh annually. The deployment of small hydro generation is very limited due to environmental restrictions. The wind potential is important (theoretically up to 10,000 MW) but very little exploited mainly due to the fact that most of the windy areas are deprived from high voltage power grid. Solar radiation is also important in Greece.

Natural gas was introduced into the Greek energy balance since the late 90s after the construction of a gas pipeline of 8 bcm capacity which goes from the North to the South of Greece and a LNG gasification terminal in the Attiki region. Despite this infrastructure, gas is penetrating very slowly in final energy consumption. Currently 2.1 bcm of gas are imported from Russia and 0.5 bcm of LNG gas from Algeria. Most of this gas (77%) is used in power generation. Gas is the fastest expanding energy form. This is expected to continue in the next two decades. Energy imports of Greece are expected to increase significantly in the future, consisting mainly of gas to be used mainly in power generation and crude oil to be used mainly in transportation.

Import dependency of Greece, being 67% in 2000, may reach 75% over the next twenty years. Gas imports are considered an important policy issue, given the high dependence of incremental power generation on gas and the current dependence on a single supplier and a single pipeline. This explains the efforts to diversify gas imports by origin and to expand the LNG terminal, as well as the priority given to new projects of gas interconnection, linking Greece with Turkey and with Italy. The new gas linkage to Turkey is under construction (expected to finish by 2008).

The production of crude oil is negligible and covers less than 1 % of the oil needs. Crude oil imports come for 50% from Russia, 25% from Saudi Arabia and 13% from Iran. With 4 refineries with a quasi-stable capacity (0.40 Mbl/d since 1990), Greece is largely over-equipped compared to its needs. The modernization of its refineries allows the country to export light products (gasoline, jet fuel) but import diesel and heavy oil.

The main energy balances and indicators are summarised in the table below.

[Mtoe]	2000	2005	[Mtoe]	2000	2005
Gross Inland Consumption (=TPES)	**28.08**	**32.39**	**Final Energy Demand (TFC) by Sector**	**18.48**	**21.77**
Solids	9.04	9.95	Industry	4.40	5.49
Oil	15.93	19.97	Residential	4.48	5.03
Natural gas	1.71	2.34	Tertiary	2.40	2.89
Nuclear	0	0	Transport	7.20	8.35
Electricity	-0.01	0.5	**Final Energy Demand (TFC) by Fuel**	**18.48**	**21.77**
Renewable energy forms	1.41	1.97	Solids	0.89	0.82
Net Imports	**21.98**	**25.71**	Oil	12.46	12.95
Import Dependency [%]	**70%**	**70%**	Gas	0.24	1.64
Energy Intensity Indicators (1990 = 100)			Electricity	3.71	4.63
Industry (Energy on Value Added)	94.52	92.63	Heat	0.19	0.32
Residential (Energy on Private Income)	110.35	104.74	Other	0.99	1.40
Tertiary (Energy on Value Added)	126.46	120.87			
Transport (Energy on GDP)	98.38	91.97			

1.1.4. Electricity

In 2004, 57 TWh of electricity were produced in Greece of which 52 TWh in the mainland (Greece's interconnected system) and 5 TWh in non-interconnected islands. In the same year, net imports were 3 TWh and transit flows to Italy were 1.5 TWh. Net generation electricity was 49 TWh in the mainland and 4.5 TWh in the non-interconnected islands. Electricity was mainly generated from lignite (32.5 TWh), followed by gas (8 TWh), hydro-reservoir (4.9 TWh) and oil products (2.7 TWh). In the non-interconnected islands almost all electricity was generated by using oil. Renewables (except hydro-reservoirs) contributed by 0.9 TWh only.

Peak electricity demand takes place in July and is increasing faster than total electricity demand because of the fast penetrating air conditioning systems. On July 12, 2004, Greece experienced a severe black out which was due to insufficient generation capacity, mainly in the South of the country near Athens, where most of the load is located. At the moment of power supply disruption the peak load attained 9370 MW, which is the maximum load ever seen. Estimations say that peak demand could have been 9600 MW if the disruption was not taken place.

The disruption revealed two fundamental problems of the Greek power supply system. First, the geographical imbalance between generation plants mainly located in the North (where lignite and hydro is located) and demand load mainly concentrated in the South. Grid reinforcements and measures aiming at managing reactive power proved not sufficient to prevent the disruption. The second problem is lack of investment in new generation plants, a failure which is attributed to the incomplete and distorted electricity market liberalisation.

All power plants currently in operation in Greece date from the times of centralised planning of investment, as implemented by the state-owned monopoly company (PPC SA) until 2000. Except

small scale renewables, not a single new plant was constructed on a private basis since 2000. The electricity market is fully controlled by the dominant vertically integrated company, namely PPC SA, who owns almost 100% of current generation capacity, holds 97% of electricity customers and owns the entire transportation and distribution grid. Although, since 2004 all customers, except the residential users and those located in non-interconnected islands, are eligible, few customers changed supplier. Currently, the few competitors of PPC are electricity traders who import up to 200 MW in total from Bulgaria. They are supplying peak needs of few industrial customers.

The installed power generation capacity of about 13.7 GW (gross) is mainly based on lignite firing plants (5.2 GW), followed by hydro-reservoir plants (3 GW), oil plants (2.7 GW of which 1.6 GW located on non-interconnected islands) and gas plants (1.9 GW of which 1 GW corresponds to modern combined cycle gas plants). Small-scale renewables have a total capacity of 710 MW of which 590 MW are wind parks. Cogeneration is poorly developed in Greece: 110 MW of CHP plants in industrial users, 90 MW in refineries and a small scale CHP district heating from lignite power plants in the North of Greece.

All analytical studies have identified lack of generation capacity especially in the South of Greece. Expansion of the generation park is expected to take place over the next 10 years mainly through combined cycle gas plants. Currently two new combined cycle plants of a total capacity of 800 MW are under construction by PPC SA and the state-controlled dominant refinery company. These plants are expected to be commissioned in 2006. It has been identified that an additional capacity of 1200 to 1500 MW of combined cycle gas plants are necessary in the coming 3-7 years. According to the amended electricity law (in 2003), financial incentives will be set in place to attract private generation companies for the delivery of this additional capacity. This policy package has not been yet implemented, so there is still uncertainty about the deployment of this private investment. The same law allowed PPC to replace old power plants by new ones up to a total capacity of 1600 MW. It is expected that PPC will build in the future 1200 MW of combined cycle gas plants and a new 400 MW lignite plant. New coal plants are expected to emerge beyond 2015. New hydro-reservoir lakes are practically not possible. There are no prospects about the deployment of nuclear energy in Greece.

Despite its considerable wind power potential and the subsidisation support schemes that are in place, the development of wind power is progressing slowly. This is mainly due to two reasons: the implementation difficulties related to land use planning and other administrative procedures, and; to the lack of high voltage power grid in the windy areas. More than 4,000 MW of wind parks are in the pipeline, but it is expected that less than 2,000 MW will be effectively constructed in the next 5-10 years. The realistic potential for small hydro plants is not higher than 200 MW. The development of biomass plants is also slowly progressing, except for plants exploiting landfill gas. There are prospects for the development of high enthalpy geothermal energy (up to 100 MW), but this is expected beyond 2010.

Since 2002, Greece is linked with Italy through a 500 MW of DC power interconnection. This cable has allowed for extensive transit flows from the Balkans to Italy, an activity which is expected to continue in the future. It is expected that by 2008 Greece will also be connected with Turkey through a new high voltage line currently under construction. The total capacity of power imports of Greece from the northern system cannot exceed 750 MW (this is the NTC capacity)

although the physical interconnections have a capacity of 1500 MW. This limited capacity and the constraints from the transit flows to Italy restrict the overall contribution of imported electricity to the Greek electricity balance to less than 7-8%. This is not likely to change unless new interconnections with the North are built, a process which might take more than 7-8 years. The electricity system of Greece, as well as the Balkan grid, are operating, since 2004, under the full synchronous mode of UCTE.

The main electricity balances and indicators are summarised in the table below.

	2000	**2005**
Electricity Net Imports [TWh]	0	3.5
Electricity Generation [TWhe]	**53.4**	**62.2**
Hydro	2.11	3.82
Small scale renewables	0.9	1.9
Thermal	49.3	57.0
- of which lignite	34.2	34.4
- of which gas	5.4	10.7
- of which oil	9.2	11.4
Grid losses [TWhe]	**4.3**	**5.3**
Self consumption incl. pumping [TWhe]	**4.3**	**4.6**
Efficiency for thermal electricity production [%]	**32**	**33**

1.1.5. Environmental issues

As mentioned before, the rich lignite endowments put a considerable load on the environment, both by the mining industry as by the electricity production. Greece has a commitment to limit the increase of greenhouse gas emissions in 2010 to a level of 25% compared to the 1990 level. This commitment has been reflected in the recently approved National Allocation Plan submitted to the European Commission. Achieving this objective raises important policy concerns regarding power generation from lignite. The current national plan states that generation from solid fuels should stagnate over the next 20 years.

The main balances and indicators concerning the CO_2-emissions are summarised in the table below.

	2000	**2005**
CO_2-emissions [Mt of CO_2]	**89.2**	**97.8**
Electricity and Steam production	44.0	48.3
Energy Branch	3.4	3.3
Industry	9.6	9.7
Residential	4.8	7.4
Tertiary	3.3	3.9
Transport	21.2	24.5
CO_2-emissions Index (1990 = 100)	**125.4**	**137.5**

Carbon intensity [t of CO_2/toe of GIC]	**3.2**	**3.0**
CO_2-emissions/Capita [t of CO_2/inhabitant]	**8.4**	**8.9**
CO_2-emissions to GDP [t of CO_2/MEuro '00]	**725.6**	**641.0**
Carbon Intensity indicators		
Electricity and Steam production [t of CO_2/MWh]	0.82	0.70
Final energy demand [t of CO_2/toe]	2.28	2.12
Industry	2.29	2.09
Residential	1.66	1.25
Tertiary	1.39	1.34
Transport	2.95	2.93

1.2. Trends

Growth rates [% per year]	**'90-'00**	**'00-'05**	**'05-'10**
TPES	**2.4**	**3.1**	**2.0**
Coal	1.1	1.5	0.8
Oil	2.2	0.7	0.9
Gas	28.6	20.2	7.6
Electricity	-	-407.4	4.6
Total Renewables	2.4	9.0	3.0
TFC	**2.4**	**3.3**	**2.1**
Electricity Consumption	4.2	4.6	3.2
Oil	2.3	0.8	1.2
Gas	32.9	46.9	8.4
GDP	2.3	4.4	3.5
Growth in the TPES/GDP Ratio	0.0	-1.3	-1.5

2. Energy studies

3. Policy

3.1. General framework

Greece's energy policy fits in the EU-integration and the fulfilment of international obligations concerning environmental issues. The energy policy is based on four objectives:

- Security of energy supply
- Economic efficiency – low prices
- Environmental protection
- Regional development

Despite the considerable lignite reserves of Greece, security of supply is an important policy issue because of dependence on imports of hydrocarbons. In relation to environmental policy restrictions, natural gas is considered as the strategic fuel for the medium term, since natural gas is expected to cover the rather fast growing incremental energy needs of Greece, including incremental needs for power generation. Security of supply of gas imports, increase of competition in the upstream gas supply and new interconnections are among the key issues of the energy policy.

The public administration involves the Ministry of Development who has probably the entire decisional power to set the legislation, supervise and control the state-owned companies (who control all energy markets in Greece) and regulate the market and the prices, including the supply prices of gas and electricity. The Regulatory Authority for Energy (RAE) has been established in 2000, but its decisional powers have been extremely limited. In most cases, RAE is only allowed to submit an opinion to the Minister who takes the decisions. The new electricity and gas directives have not yet been transposed to the Greek legal system. The three state-owned energy companies, namely PPC (electricity), DEPA (gas) and ELPE (oil) are dominating the energy markets.

3.2. Electricity and gas market policy

Since February 2001, liberalisation started in the electricity sector. Until July 2004 only customers connected to high and medium voltage grids were allowed to select their supplier. From July 2004, all consumers except the residential ones became eligible. However, a very small number of industrial customers have bought electricity from non PPC supply and all of them for small amounts on top of their current PPC supply contracts. The Greek electricity TSO is an independent state-owned company with no ownership of the grid. To provide third party access, the TSO rents the grid from PPC according to regulated tariffs.

The lack of private investments in power generation is probably the most important policy issue. It was expected that such investments would enable both security of electricity supply and competition in the electricity market. This expectations proved to be wrong for various reasons, such as: a) the dominance of PPC in the supply market; b) the regulation of supply prices to a low level, below the costs calculated with private rates of return on capital, and c) the difference between PPC's power mix which hedge against price variability (as lignite has a substantial part in the mix) and the mix of private competitors which is based on gas produced electricity and little imports. This policy failure explains the reform of the power market organisation that took place in 2003 but has not been yet implemented. According to the new amended electricity law, a

mandatory electricity pool will be established in Greece. The pool will probably operate in 2006 and will involve all PPC's plants, one plant of the state-owned refinery company and few traders who import electricity. In 2006, no more than 600 MW over a total of 12,000 MW will be managed by non PPC entities. The amended law also envisages the establishment of a capacity certificate system which will impose on suppliers the obligation to hold an adequate number of certificates issued by Greek power plants. The certificates will be tradable and the possible contracts for differences may provide financial security to future investors. In addition, the Greek TSO who will also be manager of the pool will put in place partial revenue guarantees for some of the new power plants to be constructed by private entities. It is expected that these incentives will be put in place in 2006. Their outcome is however still uncertain.

In the gas market, the entire infrastructure is owned by a vertically integrated state-owned company (DEPA). The gas market is still under a monopoly regime, as Greece being considered as a gas emerging market got an exemption from the previous gas directive. The tariffs for gas transportation and LNG are five times more expensive than in the rest of the EU because of the investment cost of the over-dimensioned infrastructure as compared with the current gas consumption. This is one of the major obstacles to rapid expansion of the use of gas in power generation. However, in order to facilitate gas procurement from new power generation investors, the amended law of 2003 provided for gas market liberalisation for power generation users by 1st July 2005. The legislation about gas market organisation is still pending. Regarding gas distribution in the cities, a monopoly regime is established which will last for thirty more years.

The most important policy development in Greece relates to the establishment of an internal energy market in the South East of Europe. It is expected that in late 2005, a legally binding treaty will be signed to establish the so-called Energy Community of South East Europe.

3.3. Environmental policy

Greece has a target for renewable electricity generation of 14% of total electricity in 2010. This is considered as a very ambitious target. Policy measures in place provide for a system of feed-in tariffs for renewable electricity, except large hydro, and for small scale CHP. In addition, subsidies are provided to capital costs of renewable, CHP and energy efficiency investments, covering up to 40% of investment costs. The available funds for subsidisation are significant.

As mentioned, Greece participated to the EU emission trading scheme and is expected to be a net buyer of emission rights.

4. Peculiarities

5. Bibliography

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