

GREECE

The country report for Greece was prepared by the Center of Renewable Energy.

Current situation on CHP and biomass CHP in the national energy sector.

The land area of Greece consists of a peninsula and 2,000 islands that occupy one-fifth of its territory. This geographical setting with so many isolated islands and mountains areas poses a challenge to energy policy planners. In 2000 per capita GDP, measured using current purchasing power parities, was almost two thirds of the OECD and EU averages. Over the last few years, Greece has enjoyed strong economic growth, with the GDP growing at an average 3.5% a year in 1996-2001. Energy use has been growing together with the economy.

Energy balances in Greece (Source: Energy Policies of IEA Countries, Greece 2002)

	2000	%		2000	%
Population (millions)	10.56		Total final consumption	19.51	
Energy consumption/capita	1.85		Coal	0.88	4.5
Total energy production (Mtoe)	9.99		Oil	13.46	69.0
Coal	8.22	82.3	Gas	0.38	1.9
Oil	0.26	2.6	Biomass & Wastes	0.95	4.9
Gas	0.04	0.4	Geothermal	0.00	0.0
Biomass & Wastes	1.01	10.1	Solar/Wind/Other	0.10	0.5
Nuclear	-	-	Electricity	3.71	19.0
Hydro	0.32	3.2	Heat	0.03	0.2
Geothermal	0.00	0.0	Total industry consumption	5.19	26.6
Solar/Wind/Other	0.14	1.4	Coal	0.85	16.4
Net energy imports (Mtoe)	18.13		Oil	2.57	49.5
Coal	0.77	4.2	Gas	0.37	7.1
Oil	15.67	86.4	Biomass & Wastes	0.24	4.6
Gas	1.69	9.3	Geothermal	-	-
Electricity	0.00	0.0	Solar/Wind/Other	-	-
Total supply - TPES (Mtoe)	27.82		Electricity	1.17	22.5
Coal	9.04	32.5	Heat	-	-
Oil	15.61	56.1	Transport consumption	7.36	
Gas	1.70	6.1	Total other sectors consumption	6.95	
Biomass & Wastes	1.01	3.6	Coal	0.03	0.4
Nuclear	-	-	Oil	3.56	51.2
Hydro	0.32	1.2	Gas	0.01	0.1
Geothermal	0.00	0.0	Biomass & Wastes	0.71	10.2
Solar/Wind/Other	0.14	0.5	Geothermal	0.00	0.0
Electricity Trade	0.00	0.0	Solar/Wind/Other	0.10	1.4
Electricity generation	4.59		Electricity	2.53	36.4
Electricity generation (TWh)	53.43		Heat	0.03	0.4

TPES has grown at an average annual rate of 2.5 % over the past decade, but higher growth of 3.8% per year has been forecast by the Greek government for the decade 2000-2010. Greece's dependence on oil has declined since the early 1970s (77.7% in 1973), but oil still represents 56.1% of all energy. Domestic energy production accounted for 35.9% of TPES in 2000. Although it is expected to increase in volume indigenous production's share in TPES is expected to fall to 27.5% by 2010. The most important domestic energy source is coal, followed by small contributions from renewables and oil.

Total final energy consumption followed average annual increases of 2.6% since 1990, leading to a 30% increase in 2000. Transport is the largest energy-consuming sector (38%), followed by the residential, services and agricultural sectors (36%) and the industrial sector (27%). Changes in the proportions of different final energies in the 1990s were small.

TFC of the transport sector grew by 24% in 1990-2000, with an average annual growth rate of 2.1%. An increase of 55% is forecast by the government for 2010. In the industrial sector, energy consumption grew moderately by 12% between 1990 and 2000. The largest energy consuming industries are the non-metallic minerals industry (which represents 28% of all industrial consumption), the non-ferrous minerals industry (with an 18% share) and the food industry (with 14% share). TFC growth was strong in the residential sector – 66% between 1990 and 2000 but it was even stronger in the services sector, where the increase was 102% over the same period.

In 2000, gross electricity generation was 53.4 TWh. Lignite is the main fuel used for power generation in the mainland, while island systems principally operate with heavy fuel oil and diesel and, increasingly, renewables. Between 1990 and 2000, lignite use in generation grew by 19%, although its share fell by some 8-percentage points. The share of oil in power generation has been steady at around 16.5% over the decade. There has been some annual variation in hydropower production, which had a 6.9% share in 2000. Depending on the weather, power generation by hydro can fluctuate significantly. The share of natural gas in electricity production increased from only 0.3% in 1990 to 11.1% in 2000.

Three large generation units were commissioned after 1997 (CC gas and hydro: 1GW) and one unit has gone through fuel conversion. PPC will commission an additional three new units for the mainland system by 2003. In the non-interconnected islands, several small generation units, with a total electric capacity of 241 MW, started operation since 1997.

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

Industrial installations per industry sector (1997)

Sector	No of systems	MWe installed
Food	5	56
Textiles	2	5.9
Primary metal	1	11.6
Petroleum	3	89.5
Chemicals	3	47.8
Others	1	9.5
Total	15	220.3

Despite the benefits of cogeneration of heat and power, little has been realised so far in this sector in Greece. While the average of the electricity generating capacity from cogeneration within the EU is about 10% (Cogen Europe, 2000), the figure in Greece is only about 2.5%. This compares with an EU target of 18% for 2010, and some countries, such as Finland, Denmark and the Netherlands, already exceeding 30%.

Before 1990, most of the CHP plants that were operating in Greece at the time were built in the 1970s and 1980s without any real economic incentives, by industries that saw some kind of advantage that could guarantee profits in the long term (cheap fuel, waste heat, etc.).

The total installed electrical capacity in 1997 was 346.8 MW. Five of these industrial installations, with a total capacity of 124.3 MW, were not in operation whilst some of the rest operated at significantly lower level than their nominal capacity. The most efficient ones were the refineries, because of their continuous operation, the cheap fuel (distillery by-products) and the good thermal-to-electrical energy rate.

Very few installations exist in the commercial sector. Case studies for specific enterprises have shown that cogeneration investments are not viable, unless the produced heat is used also for cooling purposes during the summer.

In 2000, the installed electric capacity of the CHP was 708 MW_e, with electricity production amounting to 3122 GWh and heat production to 1103 TJ. The government estimated that the total potential for CHP is 400-700 MW_e in the industrial sector and 100 MW_e in the services sector if current policies to support CHP are taken into account. With milder winters than most other European countries, the economic potential of CHP in Greece is considered limited without some financial support from the government. In 2001, generation licenses were granted for the construction of 400 MW_e of CHP capacity including small and large plants.

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

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

Considering **biomass fired CHP**, only biogas from sewage plants and a landfill site is exploited for CHP. 21.9 MW_e are already installed, while future projects for another 83.2 MW_e from biomass CHP have already acquired power production permits from the Regulatory Authority of Energy (www.rae.gr).

RTD and Demonstration projects on biomass CHP

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

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

- Improvement of power quality, optimization of local load factors, increase of capacity utilization, and integration of renewables with the electricity grids.
- Development of new technologies and applications for saving energy in buildings, transport and industry.

For implementing these policies, financial support is provided mainly by the general state budget, competitive programmes, and EU research programmes. Some 57.8% of all energy R&D financing is national, and 42,2% comes from the EU. The Greek State's energy R&D budget is very small and varies significantly from year to year. The budget is essentially used for making national contributions to projects financed under the EU programmes, including the Operational Programmes, and as direct financial support to the Centre for Renewable Energy Sources (CRES) and the Centre for Solid Fuels Technologies and Applications (CSFTA). In the 2000 estimate, 37% of the budget is allocated to power and storage technologies, 31% to renewables, 16% to nuclear technologies, 9% to energy conservation and 8% to fossil fuel technologies.

The total budget of the Targeted Programme for R&D on renewable Energy and energy Saving of the Operational Programme for Competitiveness is 16 million Euro during 2000-2006, including a government contribution of 9 mill Euros. The R&D objectives of the Targeted Programme are:

- Improving industrial competitiveness and encouraging links between research organizations and the private sector.
- Upgrading existing laboratories and establishing new ones for testing and certification services.
- Providing support to research units for the standardization and commercial use of research results.
- Creating new employment and new companies using research results, for example through spin-offs originating research organizations and research.
- Development of research centers by supporting laboratories operated by companies and R&D users.
- Providing support for international scientific and technological cooperation and technology transfer.

In addition, 23 RTD projects on CHP were identified, using the CORDIS website (www.cordis.lu). 9 referred to biomass CHP, and 4 out of the 9 were Greek coordinations.

Legislation and support mechanisms

The legislative and support framework affecting RES and CHP includes the following:

- **Law 2773/99** regarding the liberalisation of the electricity market in Greece, **replaces the provisions of Law 2244/94 on the buy-back tariffs for electricity produced by CHP.** The main points are:
 - Priority is given by the system Operator to the electricity produced from RES/CHP.
 - A ten year contract is given to the producers of electricity from RES and CHP by the System Operator. In the interconnected system, the generator receives a compensation rate for energy that represents 90% of the energy part in the medium-voltage end-use tariff, and for capacity the rate is 50% of the capacity part in the same tariff. Prices in the non-interconnected system are based on percentages of the current PPC low-voltage residential tariffs, ranging from 60% for CHP using fossil fuels to 90% for CHP using renewable energy sources.
- **Law 2244/94**, regarding revisions on the electricity production code from RES, and the implementing Ministerial Decision 8295/95, which broke new ground for the promotion of RES in Greece. This was the necessary regulation tool for the production of electricity

by independent producers, making a distinction between independent producers, selling the total of production to PPC, and auto-producers, covering primarily their own energy needs and selling surplus energy to the Public Power Corporation (PPC). This law remained in force only until the end of 2000, when it was replaced by law 2773/99 (described above) for which it still acts as reference.

- The **Renewable Energies Sub-programme of the Operational Programme for Energy (1994-1999)**, which was the main funding mechanism for RES/CHP installations. The programme had a total budget of 340 MEuro (139.6MEuro public funding and 200.4MEuro private funding), and supported mainly RES/CHP investments, but also broad “infrastructure” work, such as the development of the National Certification System, the assessment of the technically exploitable RES potential and the determination of the optimum administrative and legislative framework for RES. Cogeneration was supported in the measures for energy saving (Measure 2.2) and Renewable Energy (Measure 3.2). The total budget for each project should not exceed 293,000 Euro and support was up to 45% of capital costs. In tables 2 and 3 the funded projects are listed with details for the installed capacity as well as electric and thermal output.

Projects funded by Operational Programme for Energy under Measure 2.2

Company	Activity	Installed capacity (MW)	Electrical output (MWh)	Thermal output (MWh)
VIOCARPET	Fabrics	2.5	20,042	43,366
VIOHARTIKI	Paper	4.8	33,718	86,469
ETEM	Aluminium	0.26	1,628	4,142
PROMITHEAS	Natural gas	19.9	173,213	459,179
ATHINEON	Hotel	0.75	6,025	25,596
MAILIS	Packaging	1.6	12,800	31,290
KOTHALI	Ceramics	4.5	35,640	69,300
AMILUM	Food	1.35	9,200	76,684
	Total	35.66	292,266	796,026

Projects funded by Operational Programme for Energy under Measure 3.2

Company	Activity	Installed capacity (MW)	Electrical output (MWh)	Thermal output (MWh)
EYDAP	Public entity of water service	7.37	64,000	70,000
VEAL	Public entity	13	107,000	109,000
	Total	20.37	171,000	179,000

Both projects mentioned in Table 3 use biogas that was previously burnt or released in the open air causing air pollution. The electricity produced by gas turbines will be sold in the grid while the thermal energy will be used for the drying of sludge and for the mechanical recycling of non-organic wastes in the first and second project, respectively.

- The **development law 1892/90** together with its amendment 2234/94, which was a general “development law” that provided subsidies (40-60%) for investments by the private sector, including renewables and CHP.
- The new **development law 2601/98**, replacing 1892/90, which is expected to be the main funding tool of RES and CHP applications in the future. The law foresees a combination of subsidy options that is either a) capital investment subsidies up to 40%, interest

subsidy up to 40% and subsidy for leasing up to 40% or b) tax deduction up to 100% and interest subsidy up to 40% for investments in RES.

- Another financial instrument to support investment in RES/CHP is the Subprogramme 2 of the present **Operational Programme for Competitiveness (OPC)**, under the third Community Support Framework (2000-2006), as already mentioned. In Measure 2.1 that is devoted to provide State support to private investments in RES and RUE the grants are given following rounds of public calls. For biomass/biogas investments, the public subsidy is 40% of the total eligible investment cost regardless of the geographical region.

In the frame of the first proclamation of Measure 2.1, private investments of 745.4 MEuro were approved by the Minister of Development on June 2002 following the evaluation of proposals of RES, CHP and energy saving, that corresponded to 26% of the total budget of actions of the Energy Sector and Natural Resources programme of the OPC. The approvals concerned 201 investment proposals. Thirteen of the 95 approved initial RES proposals concerned biomass with a total investment of 53.3 million Euro. One project is for production of biofuels, seven projects are cogeneration units and five projects refer to biomass utilisation for heat generation. The maximum eligible costs set are for cogeneration with biomass between 1600 to 1320 Euro/kW_e for agricultural waste to sewage sludge and 440 Euro/tonne for biofuel production.

The fuel efficiency requirements for receiving a subsidy are 60% and 65% for the industrial and services sectors, respectively. For CHP, subsidies of a maximum of 35% of the investment cost have been provided by OPC, and the increase in CHP capacity is estimated to be 375 MWe and 690 MWth. However, most investors prefer the lower subsidies under the Operational Programmes because they are available at the beginning of the investment project and not after it has been completed, as is the case with subsidies under the Development Law.

In February 2001, following the EC Directive 96/92 and the respective Greek Law 2773/99, 34% of the Greek electricity market was liberalised. According to that law big electricity consumers (annual consumption higher than 100GWh) can select their electricity supplier. Further market liberalisation is expected in 2004 according to EC Directive 96/92.

Existing biomass CHP plants

- **Volos**

The plant was constructed in 2001 and it is owned by the Municipal Enterprise for Water and Sanitation of Volos. It is located in Bourmouli. It is a wastewater treatment plant (tertiary treatment) producing biogas via anaerobic digestion. The biogas fuels 2 gas engines, 0.1765 MW_e each. The annual grid electricity production is 2.1 GWh. Heat produced is used internally to heat the digesters.

- **Psytalia, Attiki**

It is located in Psytalia and it is owned by the Water Corporation of Athens. It is a wastewater treatment plant (primary treatment), constructed in 1994. In 2001 started the biogas exploitation. The biogas is produced via anaerobic digestion and fuels 3 gas engines, 2.458 MW_e each. The annual production of heat is 85.67 GWh and the annual production of grid electricity 64.56 GWh. Heat produced is used internally to heat the digesters. A secondary treatment plant is under construction.

- **Ano Liosia, Attiki**

The plant was constructed in 2001 and it is located in Ano Liossia in the area of Attiki. It is a biogas CHP plant using the gas produced by an old sanitary landfill, owned by Biogas Energy Ano Liossia Ltd. The biogas fuels 11 gas engine modules, 1.255MW_e each. The annual production of heat is 134.8 GWh and the annual production of grid electricity 112.5 GWh.