GERMANY

The energy sector

In 1960, 75% of the primary energy demand in the then Federal Republic - West Germany - was met by domestic coal. Since then, hard coal mining has been in a constant decline, due to high costs. To keep this process under control, public utilities were required to continue using domestic hard coal for a large fraction of electricity production, and large utilities were also urged to invest in nuclear power to complement coal. After installation of nuclear capacity, the construction of gas- and oil-fired power stations was banned. After the reunification of the country in 1990, the East German electricity system was handed over to the large West German utilities. They were required to generate electricity predominantly from domestic lignite, since its consumption was rapidly declining in other sectors.

Energy balances in Germany (Source: Energy Policies of IEA Countries, 2001)

	1999	%
Population (millions)	**82.09**	
Energy consumption/capita	**2.92**	
Total energy production (Mtoe)	**133.0**	
Coal	62.2	46.8
Oil	3.4	2.6
Gas	16.7	12.6
Biomass & Wastes	4.1	3.1
Nuclear	44.3	33.3
Hydro	1.7	1.3
Geothermal	-	-
Solar/Wind/Other	0.6	0.5
Net energy imports (Mtoe)	**201.8**	
Coal	17.1	8.5
Oil	127.4	63.1
Gas	57.3	28.4
Electricity	0.1	0.0
Total supply - TPES (Mtoe)	**337.2**	
Coal	79.4	23.5
Oil	135.1	40.1
Gas	72.0	21.4
Biomass & Wastes	4.1	1.2
Nuclear	44.3	13.1
Hydro	1.7	0.5
Geothermal	-	-
Solar/Wind/Other	0.6	0.2
Electricity Trade	0.1	0.0
Electricity generation	**47.4**	
Electricity generation (TWh)	551.3	

	1999	%
Total final consumption	**239.7**	
Coal	10.4	4.3
Oil	125.3	52.3
Gas	53.1	22.2
Biomass & Wastes	1.4	0.6
Geothermal	-	-
Solar/Wind/Other	0.1	0.0
Electricity	40.2	16.8
Heat	8.0	3.3
Total industry consumption	**76.8**	
Coal	9.0	11.7
Oil	28.0	36.5
Gas	20.9	27.2
Biomass & Wastes	0.1	0.1
Geothermal	-	-
Solar/Wind/Other	-	-
Electricity	17.7	23.0
Heat	1.1	1.4
Transport consumption	**68.3**	
Total other sectors consumption	**94.7**	
Coal	1.4	1.5
Oil	30.4	32.1
Gas	33.4	35.3
Biomass & Wastes	1.3	1.4
Geothermal	-	-
Solar/Wind/Other	0.1	0.1
Electricity	21.1	22.3
Heat	7.0	-

From 1990 to 1998, total primary energy supply (TPES) decreased more than 3 per cent. In 1998, gross electricity generation in Germany increased 0.8 per cent. Coal accounted for 54.2 per cent, natural gas for 9.8 per cent and nuclear power for 29.3 per cent. The share of nuclear decreased while that of natural gas and coal increased. Non-hydro renewable energy was 2.4 per cent of electricity supply, while hydropower remained modest with 3.1 per cent of electricity supply.

Policy for renewables and CHP

As part of the EU process of liberalising the energy markets, a reform process lead to a new law for the electricity market on 19 February 1997, and subsequently for gas on 10 August 1998.The new initiatives became national energy law on 1 April 1998, and thereby fundamentally reformed the German energy market. The so-called demarcate supply areas, local/regional monopolies, were abolished.

The Federal Government's economic policy priorities for 1999 included the introduction of an Ecological Tax (Eco-Tax). The law provides for special incentives for highly efficient co-generation and for gas turbine equipment. A special programme to promote renewable energies is financed with revenues from the Eco-Tax.

Because cogeneration is able to contribute to a cut of carbon dioxide emissions a law was enacted to protect cogeneration systems (Kraft-Wärme-Kopplungsgesetz) on 24th March 2000. It stipulates that grid providers have to pay a minimum of 4.6 Cent/kWh$_e$ for power produced by cogeneration systems. This amount will be reduced by 0.26 Cent/kWh$_e$ in every following year. The owners of the networks will share the costs. The law affects only cogeneration schemes that were installed before 1st January 2000. The law comprises mainly regulations concerning the remuneration of Pf/ kWh CHP electricity, if the installed CHP capacity is above 25% of its total installed generation capacity ,and the produced quantity of electricity of the CHP systems are at least 10%. The law is valid at most until the end of 2004 <KWK-Gesetz00>.

The existing CHP support law is a temporary one. A lasting solution is planned with a so-called CHP expansion law. A study of AGFW concluded that use of modern CHP systems ranks among the cheapest solutions for reducing CO_2 emissions. Refurbishment and expansion of district heating/CHP systems would mean that the sector would reduce emissions corresponding to approximately 60 mln. tons CO_2. Based on the analyses of the study, it was concluded that CHP can positively contribute to environmental protections and it identified a number of measures that would ensure expansion and strengthening of district heating/CHP in the market place. Based on the preliminary analyses, a larger study is presently being carried out in a joint effort by Ministry of Economic Affairs and AGFW. The study looks at the longer perspective and the view of the government and governing political parties is that the study will results in a new law supporting CHP.

A list of the various measures existing for the promotion of CHP and renewables is given below:

- **Nachwachsende Rohstoffe**

Contact organization: Fachagentur Nachwachsende Rohstoffe
Short description: Subsidy for R&D and demonstration projects in the agricultural non-food sector

- **Nutzung Erneuerbarer Energien**

Contact organization: Thüringer Aufbaubank Energie und Technologieförderung
Short description: Subsidy to establish an installation for the exploitation of biomass.

- **KFW Umweltprogramm**

Contact organization: Kreditanstalt für Wiederaufbau

Short description: Investments with a positive effect on German environment, including investments in renewable energy generation, can be financed within this program

CHP and biomass-CHP

Between 1970 and 1995, the share of industrial power production in West Germany's power production, which is mainly CHP, declined from 18% to 7%, while the share of district heating CHP increased slightly to 4%. The four large transmission grid operators now produce more than 80% of Germany's electricity. Their expansion was based on strategic pricing to impede industrial and municipal power production, which is mainly cogenerated. The slight increase in district heating CHP - a domain of municipal utilities - was due to subsidies for coal-fired municipal CHP.

The electric capacity of cogeneration plants in Germany reached in 1997 to an amount of 4857 MW_e. The overall capacity of small-scale cogeneration plants ($\leq 1MW_e$) in 1997 was 1012 MW_e, which is about 1% of the national generation capacity.

Since April 1998, when the electricity market has been liberalized, energy prices have fallen drastically. For big industrial companies prices went even down below the short term marginal costs of electricity production. This led to the fact that not only almost no new cogeneration plants have been built in Germany; but in the industrial sector cogeneration systems have been even set out of duty <AGFW 00>.

Combined production of heat and electricity in CHP stations, as compared to the separate production of heat and electricity, allowed in 1999 for energy saving of approximately 149,000 TJ or 21%. The corresponding CO_2 saving amounted to10,8 mln tons CO_2. Detailed information about the methodological background and the data used for the calculations can be retrieved from the AGFW, the German district heating association ,there is also data for the regional levels.

Although there are many biomass CHP units in Germany only three were identified by searching the internet:

- **Sulzbach-Rosenberg, Bavaria**

  Operating since 1995 (6500 h/y), a biomass fired 4.2 MWel CHP plant is run successfully. The plant has two separate moving bed lines with a maximum fuel input of 11 MW (about 15 tons of biomass) each. One line is fed by agricultural and sivicultural residues and energy crops. In the other one woody residues from wood processing industry are burnt. Both combustion lines are connected to a single steam cycle generating steam at 50 bars and 450 °C. The high pressure high temperature steam is expanded in a steam turbine. All steam generated is expanded down to 2 bars and condensation heat is either fed into the district heating system or (if the demand is too low) given to the environment through a dry condenser. Emission standards are met in all stages of operation. The provision of agricultural and silvicultural biomass is carried out by a biomass production community especially founded for this purpose. About 300 participants from the surroundings of the plant belong to the community. They are responsible for production, harvest, storage and delivery of the biofuels. Additionally, several wood processing companies (sawing mills, furniture production, ...) deliver their wood residues to the plant.

- **Pfaffenhofen, Bavaria**

  In Pfaffenhofen a biomass co-generation plant for producing electricity, steam, district heating and cooling has started operation in July 2001. The location of the plant allows easy delivery of energy to the connected customers. The plant

supplies steam to a producer of baby food and to a district heat system for more than 100 customers. The calculated fuel demand will total 80,000 t/y: 30% natural wood and bark, 70% wood waste of sawmills. The continued demand of 250 t per day requires efficient logistics for harvesting, processing and transport of wood. Forest owners can supply wood ranging from intact items to wood chips.

The maximum heating power is 26.7 MW. Its capacity was calculated by means of comprehensive demand – related design. In totally up to 120 GWh of heat are sold every year. With a capacity of about 7.5 MWe, the steam turbine is supposed to supply an amount of more than 40Gwh electricity per year into the grid.

- **Hagenow**

The cogeneration plant of Hagenow (Ludwigslust, Mecklenburg- Western Pomerania) was built on the site of a former brown- coal heating plant and is the first biomass power station in the region.

The cogeneration plant is fuelled by waste wood (75000t/y), and is operating since June 1997. The period of its construction was 17 months, it operates more than 8.000 per year and it has an electrical output of 5 MW using a turbine system. Additionally, a natural gas-fired turbine also operates having an electrical output of 0.5 MW.

Three waste heat boilers fuelled by wood have a combustion heat performance of 12.5 MW and a heat emission performance of 8.5 MW respectively at 64 bar and 450^{o} C. Four boilers are also installed fuelled by oil. The power plant produces process steam for two industrial customers.

Taking account of the generated energy quantities, 40.000 tons of CO_2 are saved per year by cogeneration, compared with oil combustion.