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## **EUSUSTEL**

**European Sustainable  
Electricity; Comprehensive  
Analysis of Future European  
Demand and Generation of  
European Electricity and its  
Security of Supply**

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**WP1: Country-wise  
analysis for EU-25**

**GERMANY**

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

## 1.1 Geographical Description

Germany is a federal country comprised of 16 federal states each responsible for the government of its own state and with the capital Berlin. The reunification of West and East Germany took place on October 3, 1990, /1/. Germany is located in Central Europe and covers about 357 031 km<sup>2</sup>, making Europe's sixth largest nation measured by area. The longest distance from north to south as the crow flies is 876 km, and from west to east, 640 km, /2/. In the northwest Germany is bordered by the North Sea and to the northeast by the Baltic Sea and Denmark. Poland and the Czech Republic surround the eastern border, with Austria and Switzerland to the south and France, Luxemburg, Belgium and the Netherlands to the west. The total land boundary is about 3 757 km, /3/.



Figure 1: Map of Germany /2/

From the North and Baltic Seas to the Alps in the south, Germany is divided geographically into the North German Plain, the Central Upland Range, the Southwest German Central Upland Scarps, the South German Alpine Foreland and the Bavarian Alps, /3/. About 29.5% of the total area of Germany is afforested. The North German Plain boasts hilly landscapes with many lakes and is interspersed with heaths and moors as well as fertile land. It stretches down as far as the edge of the Central Upland Range. The Central Upland Range shows a considerable variety of landscapes. It includes the Rhenish Slate, the Hessian and the Weser /Leine Mountain Ranges. It comprises different areas, like the Rhön, the Bavarian Forest and the Ore Mountains. The Central Upland Range divides northern Germany from the south. The narrow Central Rhine valley between Bingen and Bonn and the Hessian depressions, serve as the main natural arteries of north-south traffic. The Southwest German Central Upland Scarps embrace the upper Rhine valley, whose boundaries are formed by the mountain ranges of the Black Forest, the Oden Forest and Spessart, the Palatinate Forest and the Swabian-Franconian scarpland. The broad South-German Alpine Foreland boast hills and great lakes in the south, as well as broad gravel plains, the hilly landscape of lower Bavaria and the Danube valley. Characteristic features of this landscape are moors, dome-

shaped hill ranges with lakes and small villages. The Alpine region of Germany between Lake Constance and Berchtesgaden embraces only a narrow section of this mountain range. The Zugspitze is the highest point and reaches almost 2 962 m, /3/. Germany has about more than 12 000 lakes, of which 750 of them are bigger than 0.5 km<sup>2</sup>. The biggest lake of Germany, the Lake Constance, is situated at the border triangle of Germany-Switzerland-Austria.

Germany's climate is determined by its location in a zone of temperate climatic conditions with frequent weather changes. There is precipitation all the year round. Progressing from the northwest to the east and southeast, the maritime climate gradually changes into a more continental climate. Prone to rapid weather variations from merging of Gulf Stream and extreme northeastern climate conditions. Considerable snowfall occurs in east and south. However, neither the daily variations of temperatures nor the seasonal ones go to extremes anywhere. The annual mean temperature is about 9°C, /1/.

The major natural resources of Germany are: the hard coal deposits of the Rhenish-Westphalian industrial area and the Aachen and Saar fields; the large lignite fields in the Rhenish and Leipzig Basins and in Lower Lusatia; the iron ore deposits in the Rhenish Slate Mountains, in the east of the Franconian Alp and the northern periphery of the Harz; the rock salt deposits in Lower Saxony and Bavaria and the potash fields in Lower Saxony, Hesse, Thuringia and South Baden, /3/.

## 1.2 Demographics

There are some 82.5 million people (2004) living in Germany with an average population density of 231 persons per km<sup>2</sup>, /1/. Germany is one of the most densely populated countries in Europe, although the population in Germany is very unevenly distributed. Almost 88% of the population lives in urban centers. Thereof, approximately one third of inhabitants, about 25 million people, live in large towns and some 50.5 million people live in communities and towns with between 2 000 and 100 000 inhabitants. The three biggest cities of Germany and their 2004 populations are Berlin with 3.3 million; Hamburg with 1.7 million and Munich with 1.3 million. About 6.4 million have their homes in villages with up to 2 000 inhabitants. Having experienced rapid growth since German unification, the area in and around Berlin currently boasts more than 4.3 million inhabitants. The industrialized region on the Rhine and the Ruhr rivers, where the towns merge into one another without clear boundaries, is home to more than 11 million people i.e., some 1 100 per km<sup>2</sup>. These densely populated regions contrast with very thinly populated areas such as large sections of the March of Brandenburg and Mecklenburg-Western Pomerania, /2/.

The most striking demographic feature of the country, observed across Europe, is the increasing proportion of elderly people in the population over the past 20 years. With nine births per 1 000 inhabitants per year, Germany has one of the world's lowest birthrates. However, over the past years Germany's population has remained at a stable level. The deficit in births was compensated for by the immigration of some three million migrants, respectively about 200 000 persons p.a. The low birthrate is coupled with an increasing life expectancy which affects the age distribution of the population. It is projected that in 2030 the percentage of over-60-year-olds will have grown from today's figure of 23% to around 30%. This over-aging of the population causes tremendous problems for the future, for example for the existing social security system, /3/.

The number of single and small sized households has grown within the last decades (in particular in big cities), whereas the number of larger households has diminished steadily. About two thirds of the households have less than three members; the average household size is 2.1 persons (2004).

The literacy rate in population over age fifteen is about 99%. In Germany there is an education compulsory until age eighteen. At age ten, after primary school (Grundschule), students attend one of five schools: short-course secondary school (Hauptschule), intermediate school (Realschule), high school (Gymnasium), comprehensive school (Gesamtschule), or a school for children with special educational needs (Sonderschule). At about age fifteen, students choose among a variety of vocational, technical, and academic schools. Higher education consists of many kinds of technical colleges, advanced vocational schools, and universities.

### 1.3 Economical Situation

Germany is one of the largest economies in the world and a founding member of the European Union (EU). It joined the common European currency on January 1, 1999 and Frankfurt/Main is the seat of the European Central Bank.

In 2004 the GDP reached an increase of about 1.6% and totaled 2 078.6 bn Euro<sub>2000</sub> (refer to Table 1). In the past few years Germany and its citizens have had to master considerable economic changes brought on by unification. Based on the amount of population the GDP was about 25 200 Euro<sub>2000</sub>/inhabitant. About 69.9% of the gross value added was generated within the service sector, whereas the industry sector produced 29.0% and the agriculture, forestry and fishing sector about 1.1% /2; 3; 4/. Compared with other industrial nations, the German economy has an almost unprecedented international focus. Foreign trade is exceedingly important for both growth and employment. Companies generate almost a third of their profits through exports, and almost one in four jobs are dependent on foreign trade. In manufacturing this dependence is even stronger, with over one third of the sector's produce being exported. Germany's foreign trade surplus illustrates the strong competition of German firms: Imports totaling 704.2 bn Euro<sub>2000</sub> were offset by the export of goods and services totaling 820.7 bn Euro<sub>2000</sub>, /3/.

**Table 1:** Socio-economic data of Germany in 2002 to 2004 taken from /4; 5; 6 /, own calculations

Index	Unit	2002	2003	2004
<b>inhabitants</b>	million	82.48	82.52	82.50
employee	million	38.64	38.3	38.40
unemployed persons	million	3.44	3.84	3.92
households	million	38.72	38.94	39.12
<b>gross domestic product</b>	Euro <sub>2000</sub> bn	2 049.2	2 046.7	2 078.6
<b>gross value added</b>	Euro <sub>2000</sub> bn	1 909.7	1 913.2	1 949.0
agriculture, forestry and fishing sector	Euro <sub>2000</sub> bn	21.5	21.3	21.5
industry sector	Euro <sub>2000</sub> bn	551.5	547.9	565.3
- <i>manufacturing industry</i>	Euro <sub>2000</sub> bn	464.7	466.7	487.2
- <i>construction</i>	Euro <sub>2000</sub> bn	86.7	81.2	78.1
service sector	Euro <sub>2000</sub> bn	1 336.8	1 343.9	1 362.3
- <i>trade and transport</i>	Euro <sub>2000</sub> bn	344.4	344.7	350.3
- <i>financial, renting and business service activities</i>	Euro <sub>2000</sub> bn	576.5	583.5	598.6
- <i>public and private service activities</i>	Euro <sub>2000</sub> bn	415.8	415.7	413.4
<b>heating degree days</b> <sup>1)</sup>	Kd	2 721	2 794	2 618

<sup>1)</sup> For Frankfurt/Main, the longtime average value between 1970 and 2004 amounts to 2 930 Kd

The economy is based on several industries including steel, ships, vehicles, machinery, electronics, coal, and chemicals; and the chief crops are grains, potatoes, sugar beets, and livestock. Major export goods are cars and car parts, machines as well as chemical products. In future, the support of German companies engaged in exporting new technologies such as renewable energy will become a focal point in the promotion of exports. The western industrialized countries are Germany's most important trading partners. The closest trading relationships continue to be those with EU member states, with whom more than half of all foreign trade is conducted /5/.

The unemployment rate in 2004 was about 9.3% (3.92 million person), an increase of about 2.1% of the previous year.

The total consumer price index in 2004, as an indicator of the inflation rate in Germany was about 1.6% compared to the previous year 2003. It is estimated as an average of indices within twelve different sections. Table 2 gives an overview of selected consumer price indices and their trend since the year 2002.

**Table 2:** Trend of consumer price indices 2002-2004 of selected sections /3/

Year	Total index (all sections)	Food and nonalcoholic beverages	Clothing and footwear	Housing, water, electricity, gas and other fuels	Miscellaneous goods and services
% change on the previous year					
2004	1.6	-0.4	-0.7	1.5	1.4
2003	1.1	-0.1	-0.8	1.5	1.7
2002	1.4	0.8	0.7	1.0	1.9

## 1.4 Energy

Despite an overall economic expansion of 1.6% and a slight population growth in the year 2004 the total primary energy consumption in Germany has been relatively stagnant. The effects which result to an increase of the consumption based on the economic situation and were almost absorbed by the high energy prices during the course of 2004. In absolute terms the total primary energy consumption was about 14 438 PJ (345 Mtoe), /7/ and the primary energy consumption per capita amounts to 175.0 GJ (4.2 toe). Based on the total GDP the primary energy consumption in Germany is about 6.9 MJ/Euro<sub>2000</sub> (0.2 Mtoe/bn Euro<sub>2000</sub>) and shows that energy in Germany is used very efficiently.

With limited domestic hydrocarbon reserves, other than coal, Germany relies on imports to meet most of its energy needs. The reserves of hard coal comprise of about 674 EJ (16.1 Gtoe) in 2003, however according to their unfavorable geological conditions they are not enough economical. The reserves of lignite amount to about 375 EJ (9 Gtoe, 2003). Although oil was Germany's most important primary energy source in 2004, its share has decreased, albeit slightly, from 36.5% in 2003 to 36.4% in 2004. Germany's onshore oil fields are located primarily in the north and northeast of the country, many of which are depleted and producing only small volumes of oil.

The primary energy consumption of crude oil and oil products dropped scarcely by about 0.4% to 5 258 PJ (126 Mtoe). However the progression of the consumption of different oil products rather differs from each other. Thus the sales of light fuel oil decrease strongly by about 9.3% mostly according to the market price of crude oil; likewise the sales of heavy fuel oil (-5.3 %) and of petrol (-2.7 %) decreased. But on the other hand the consumption of Diesel (3.4 %) and gasoline (4.7 %) increased obviously /8/. Natural gas was the other important fuel, accounting for 22.4% of the total primary energy consumption in 2004 but with different progressions within the seasonal quarters and consumption sectors. Due to the economic situation more natural gas was used in the industrial sector, while the use of gas

remained almost constant in the power stations and the demand of gas slightly decreased in the household sector according to the higher temperatures during the heating season. Compared to the year 2003 the consumption of hard coal decreased by about 3.6% because of the less use in the electricity supply sector whereas at the steel industry the consumption exceeded slightly the amount of the previous year due to the favorable economic situation. In the same time the consumption of lignite increased by about 0.5% because more lignite was supplied to the power stations and the primary energy consumption of nuclear power station rose by about 1.2%. The contribution of hydro power plants and wind-powered devices to the total primary energy consumption strongly increased by about 21.5% compared to 2003. The reason for the strong growth is seen in the unfavorable weather conditions of 2003; in the combination of less wind and less water appearance than in a 10 years-average /9/. The consumption of other sources of energy (primarily firewood and other renewable sources of energy) increased by about 1.6% (refer to Table 3). In 2003 the consumption of primary energy comprises 29% of consumption and losses in the energy sector, 7% of non-energetic consumption and 64% of the final energy consumption.

**Table 3:** Primary energy consumption by energy carriers in Germany in 2002 to 2004 /7/

Energy carrier	2002			2003			2004		
	[PJ/a]	[Mtoe]	[%]	[PJ/a]	[Mtoe]	[%]	[PJ/a]	[Mtoe]	[%]
Hard coal	1 885	45	13.2	2 013	48	13.9	1 940	46	13.4
Lignite	1 659	40	11.6	1 638	39	11.3	1 647	39	11.4
Mineral oil	5 349	128	37.3	5 281	126	36.5	5 258	126	36.4
Natural gas	3 142	75	21.9	3 224	77	22.3	3 236	77	22.4
Nuclear	1 800	43	12.6	1 802	43	12.5	1 823	44	12.6
Hydro / Wind	143	3.4	1.0	135	3.2	0.9	164	3.9	1.1
Balance of foreign trade	3	0.1	0.02	-29	-0.7	-0.2	-23	-0.5	-0.2
Other <sup>1)</sup>	343	8	2.4	387	9	2.7	393	9	2.7
<b>Total</b>	<b>14 324</b>	<b>342</b>	<b>100</b>	<b>14 451</b>	<b>345</b>	<b>100</b>	<b>14 438</b>	<b>345</b>	<b>100</b>

<sup>1)</sup> Other energy carrier like solar, biomass, waste

Due to the lack of domestic energy resources Germany has to import most of its required primary energy carriers. In 2004 about 35.5% of the primary energy consumption (without nuclear energy) is covered by domestic energy carrier and the rest has to be imported from abroad. Energy imports are widely diversified between energy carrier and origin country. Currently there are four crude oil and one petroleum product import pipelines operating in Germany. Moreover, Germany has a comprehensive pipeline network for natural gas, allowing the country to import and to transit large volumes of natural gas. The most important foreign energy supplier for Germany is the Russian federation, followed by Norway, the Netherlands and Great Britain.

## 1.5 Electricity

In 2004 the total gross electricity consumption from the net of the public supply (including grid losses) increased by about 0.7% to 599.3 TWh (51.5 Mtoe). According to this growth about all consumer groups might have contributed to some extent as seen in Table 4. Thereby, the electricity consumption in the year 2004 rose less strongly than the economic growth which had increased by 1.6% in 2004.

**Table 4:** Electricity consumption by customer groups from the net of the public supply in 2002 to 2004 /10/, own calculations

Customer groups	2002			2003			2004		
	[TWh]	[Mtoe]	[%]	[TWh]	[Mtoe]	[%]	[TWh]	[Mtoe]	[%]
Industry	226.4	19.5	38.7	228.5	19.6	38.4	230.2	19.8	38.4
Transport	16.0	1.4	2.7	16.1	1.4	2.7	16.2	1.4	2.7
Public facilities	42.2	3.6	7.2	42.9	3.7	7.2	43.2	3.7	7.2
Agriculture	8.0	0.7	1.4	8.2	0.7	1.4	8.1	0.7	1.4
Households	136.5	11.7	23.3	139.1	12.0	23.4	140.4	12.1	23.4
Trade/ Commerce/ Services	70.4	6.1	12.0	72.9	6.3	12.3	73.3	6.3	12.2
<b>Sum</b>	<b>499.5</b>	<b>42.9</b>	<b>85.4</b>	<b>507.7</b>	<b>43.7</b>	<b>85.3</b>	<b>511.4</b>	<b>44.0</b>	<b>85.3</b>
Losses / Own consumption <sup>1)</sup>	85.5	7.4	14.6	87.2	7.5	14.7	87.9	7.6	14.7
<b>Total</b>	<b>585.0</b>	<b>50.3</b>	<b>100.0</b>	<b>594.9</b>	<b>51.2</b>	<b>100.0</b>	<b>599.3</b>	<b>51.5</b>	<b>100.0</b>

<sup>1)</sup> Include pump and distribution losses

## Gross electricity generation

Germany has Europe's largest electricity market and is based on several production forms and fuels. In the year 2004 the total gross electricity generation increased by about 0.6% compared to 2003 to about 606.6 TWh (52 Mtoe). The distribution of gross electricity supply by energy carriers in Germany is shown in Table 5.

Coal and nuclear power plants are the pillars of Germany's power generation. Coal is the most important energy source, accounting for 48.9% of the country's gross electricity production in 2004 (lignite 26.1% and hard coal 22.7%). Nuclear power was the second most important energy source, providing 27.5% of total gross electricity production. Compared to the year 2003 the electricity generation of nuclear power rose by about 1.2% to 167.1 TWh (14.4 Mtoe). Particularly in November and December the nuclear power plants operated well at full capacity.

The biggest increase in electricity generation is contributed by wind and hydro-power plants. As regards the use of renewable energies for electricity production, Germany can point to very high growth rates especially for wind energy. The built-up of wind energy power plants, which has been promoted by the determination of feed-in tariffs and the priority to grid-access on the one hand and the more favorable wind conditions on the other hand result to a rise of the electricity generation of about 25.0 TWh and/or 2.1 Mtoe (32.3%). Even so, hydro-power with a share of 4.5% (27.0 TWh, 2.3 Mtoe) (including pump storage) of the total gross electricity production is still number one of the renewable energy carriers in Germany in 2004. About 78.0% of the electricity generation of hydro power plants is produced by pump storage power plants. Other renewable energy carriers like biomass, photovoltaic and the electricity generation of waste incineration power plants account for about 3.2% of the total gross electricity generation.

**Table 5:** Gross electricity generation by energy carriers in 2002 to 2004 /11/, own calculations

Energy Carrier	2002			2003			2004		
	[TWh]	[Mtoe]	[%]	[TWh]	[Mtoe]	[%]	[TWh]	[Mtoe]	[%]
Nuclear	164.8	14.2	28.2	165.1	14.2	27.4	167.1	14.4	27.5
Hard coal	134.6	11.6	23.0	146.6	12.6	24.3	138.0	11.9	22.7
Lignite	158.0	13.6	27.0	158.2	13.6	26.2	158.5	13.6	26.1
Natural gas	56.3	4.8	9.6	61.5	5.3	10.2	62.0	5.3	10.2
Mineral Oil	8.7	0.7	1.5	9.7	0.8	1.6	9.5	0.8	1.6
Hydro <sup>1)2)</sup>	28.9	2.5	4.9	24.1	2.1	4.0	27.0	2.3	4.5
Wind <sup>1)</sup>	15.9	1.4	2.7	18.9	1.6	3.1	25.0	2.1	4.1
Other <sup>3)</sup>	17.1	1.5	2.9	18.8	1.6	3.1	19.5	1.7	3.2
<b>Total gross generation incl. feed-ins</b>	<b>584.3</b>	<b>50.2</b>	<b>100</b>	<b>602.9</b>	<b>51.8</b>	<b>100</b>	<b>606.6</b>	<b>52.2</b>	<b>100</b>
Balance of foreign electricity trade	0.7	0.1		-8.0	-0.7		-7.3	-0.6	
<b>Total gross consumption incl. grid losses</b>	<b>585.0</b>	<b>50.3</b>		<b>594.9</b>	<b>51.2</b>		<b>599.3</b>	<b>51.5</b>	

<sup>1)</sup> Feed-ins of private producers to the public supply grid are included

<sup>2)</sup> Running river and pumped storage hydro power plants

<sup>3)</sup> Other energy carriers like solar, biomass, waste, and other gases

As of the year 2004, Germany had an installed net electric generating capacity of about 129.5 GW<sub>net</sub> which is rather similar to the year 2003 (126.5 GW<sub>net</sub>). About 78% of this amount (101.1 GW<sub>net</sub>) is installed for the public supply. In comparison to the year 2003 the biggest growth of net electric capacity of about 11.7% is scheduled by the private operators.

**Table 6:** Installed net power capacity by sectors in 2002 to 2004 /10, 12/

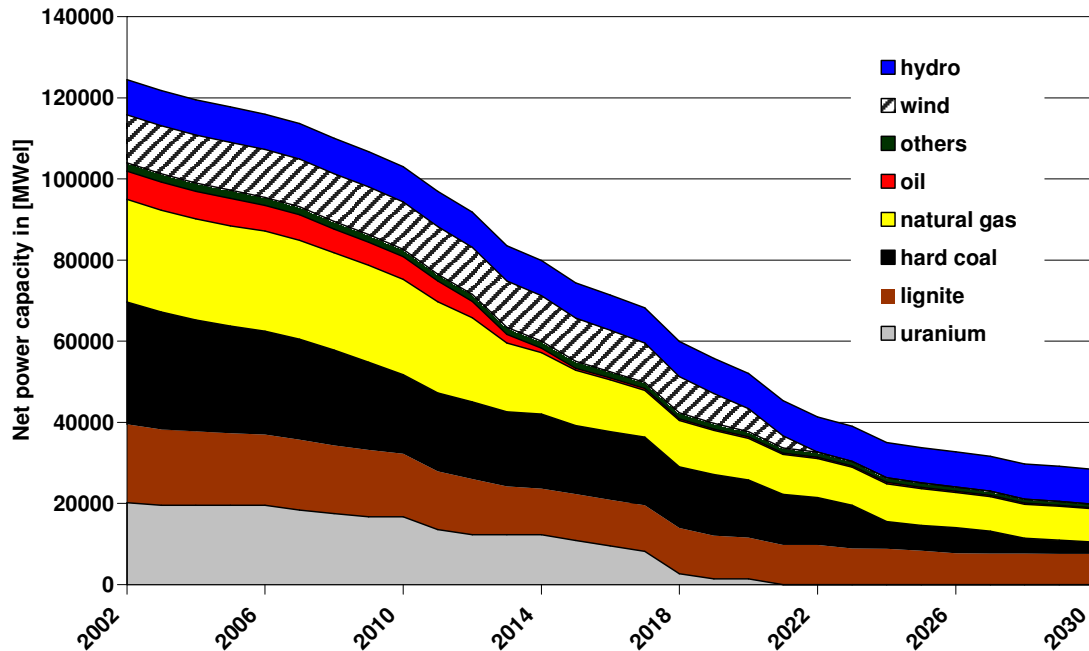
Sectors	2002		2003		2004	
	[GW] <sub>net</sub>	[%]	[GW] <sub>net</sub>	[%]	[GW] <sub>net</sub>	[%]
Public power plants <sup>1)</sup>	101.0	81.2	100.3	79.3	101.1	78.1
Industry	10.3	8.3	10.3	8.2	10.4	8.0
Private <sup>2)</sup>	13.1	10.5	15.9	12.6	18.0	13.9
<b>Total</b>	<b>124.4</b>	<b>100.0</b>	<b>126.5</b>	<b>100.0</b>	<b>129.5</b>	<b>100.0</b>

<sup>1)</sup> Include the national railway organization

<sup>2)</sup> Include the private power plants of water, wind, photovoltaic and biomass; not included are any private cogeneration units.

At the end of 2004 there were 18 nuclear power plants in use with a total capacity of 20.6 GW<sub>net</sub>. While nuclear power scheduled to be completely phased out in Germany until 2022, electricity generated from natural gas, coal and renewables, particularly wind, are expected to increase.

In Germany there are plenty of power plants especially in the base and mid load range which were built in the 1970s. Because of the old inventory, there will be a need of replacement of about 40.0 GW of new capacity which has to be installed at least by 2020, refer to Figure 2. Additionally, there will be a capacity of about 20.0 GW of the remaining nuclear power plants which have to be substituted by alternative power plants if the agreement on the phase out of nuclear energy is completely realized.



**Figure 2:** Chart of decommission of the power plants in Germany, /13/, own calculations

In Table 7 the installed net capacity of the power plants in Germany for the years 2003 and 2004 are shown for the public supply sector. In 2004, thermal sources (coal, natural gas, and oil) accounted for 66.4% of the country's installed capacity, followed by nuclear with 20.5%, hydro with 9.8% and other renewables (mainly wind) with 3.3%. While the biggest increase of installed capacity is shown for hydro (including pump storage) followed by natural gas in comparison to the year 2003, the biggest decrease is scheduled for hard coal. The growth of wind power plants is mainly performed in the private sector.

**Table 7:** Installed net power capacity of the public supply including the national railway organization by energy carrier in 2003 and 2004 /10, 12/

Energy Carrier	2002		2003		2004	
	[GW] <sub>net</sub>	[%]	[GW] <sub>net</sub>	[%]	[GW] <sub>net</sub>	[%]
Nuclear	22.4	22.0	20.6	20.6	20.6	20.5
Lignite	19.8	19.4	19.7	19.7	19.7	19.5
Hard coal <sup>1)</sup>	25.1	24.6	25.1	25.1	25.1	24.9
Natural gas	16.2	6.5	16.0	16.0	16.2	16.1
Oil	6.7	15.9	6.0	6.0	6.0	5.9
Hydro <sup>2)</sup>	8.9	8.7	9.4	9.4	9.9	9.8
Other <sup>3)</sup>	2.9	2.8	3.2	3.2	3.3	3.3
<b>Total <sup>4)</sup></b>	<b>101.0</b>	<b>100.0</b>	<b>100.3</b>	<b>100.0</b>	<b>101.1</b>	<b>100.0</b>

<sup>1)</sup> Include hybrid-combustion

<sup>2)</sup> Include pump storage

<sup>3)</sup> Include wind, solar and waste incineration power plants

<sup>4)</sup> Differences in sums are based on rounding errors.

## Use of fuels for electricity generation

In 2003 the use of fuels in the electricity industry comprises of about 5 471 PJ (130.7 Mtoe). The major parts of fuels were provided by coal with about 51.9% (about 23.7% of hard coal and 28.1% of lignite) and nuclear with about 32.9% (refer to Table 8).

**Table 8:** Use of fuels of the electricity generation in 2003 in PJ (Mtoe) /7/, own calculation

Unit	Nuclear	Hard coal	Lignite	Natural gas	Oil	Hydro/Wind	Other	Total
PJ	1 802.0	1 298.0	1 539.0	510.0	73.0	158.0	91.0	<b>5 471.0</b>
Mtoe	(43.0)	(31.0)	(36.8)	(12.2)	(1.7)	(3.8)	(2.2)	<b>(130.7)</b>
Share	32.9%	23.7%	28.1%	7.5%	1.3%	2.9%	3.5%	<b>100%</b>
Averaged efficiency	33	41	37	43	48	98	74	<b>40</b>

### Electricity exchange with foreign country

In 2004 the electricity exchange (physical electric flows) obtained an export surplus. However, both the total electricity exports from Germany of about 51.5 TWh (4.4 Mtoe) and the electricity import to Germany of about 44.2 TWh (3.8 Mtoe) decreased by 4.3% and 3.4% respectively compared to 2003. The total electricity balance is -7.3 TWh (-0.6 Mtoe), refer to Table 5. The exports in 2004 amounted to about 8% of the total electricity supply in Germany.

Based on the physical electric flows over the frontiers France remains the largest electricity exporter to Germany, /11/. Its portion of the total electricity imports of Germany amounts to 35%, followed by the Czech Republic (30%), Denmark (12%), Austria (10%) and Switzerland (6%). However large parts of the physical imports, particularly from France, might have flowed over Germany into Switzerland and Austria to Italy and/or over Germany into the Netherlands. The Netherlands is the country which the largest electricity imports from Germany (34%), followed by Switzerland (23%) and Austria (17%). In the physical exports of Germany the transits over Germany to other countries are included.

### Electricity Prices

Between 1995 and 2000 electricity prices for both industrial and private consumer decrease drastically. Reduction rates up to about 37 % (compared to 1995) within the industrial sector seemed to be possible. However, till 2004 electricity prices increment gradually and particularly for private households prices have already exceeded the price level of 1995.

**Table 9:** Trend of electricity prices for industrial and household customers' /10, 14/

Electricity Prices	Unit	1995	1998	2000	2002	2003	2004
Industry <sup>1)</sup>	Euro-Ct <sub>2000</sub> /kWh	7.90	7.05	4.95	5.56	6.40	6.70
Households <sup>2)</sup>	Euro-Ct <sub>2000</sub> /kWh	17.14	16.00	15.10	15.30	16.92	17.20

<sup>1)</sup> Prices without equalization tax and VAT for an averaged annual consumption of 50 GWh

<sup>2)</sup> Prices include equalization tax and VAT for an averaged annual consumption of 3 500 kWh

### 1.6 Environmental Issues

Germany has a strong commitment to protect the environment. From the early 1990s, the federal government's environmental policy has given increased emphasis to global warming issues. Germany signed the Framework Convention on Climate Change in Rio de Janeiro in June 1992 and ratified it on December 9, 1993. Signers of the agreement pledged to stabilize CO<sub>2</sub> emissions in the year 2000 and beyond at 1990 levels. In 1995 Germany established a demanding national target of reducing CO<sub>2</sub> emissions from 1990 levels by 25% by 2005 and in 2000, Germany set a goal of reducing the six greenhouse gases cited in the Kyoto

Protocol by 21% between 2008 and 2012, within the context of the EU burden-sharing agreement (EC, 2002). To fulfill these commitments, German energy policy is increasingly influenced by environmental concerns. The government has been promoting renewables and energy efficiency initiatives. The mid-term goal of the government is to increase electricity generation of the renewable energy carriers to 12.5% till 2010 and to 20% till 2020 /15/.

The energy-related CO<sub>2</sub> emissions have decreased in Germany since 1990, even though GDP has grown. In the Old Laender, CO<sub>2</sub> emissions increased by 2% between 1990 and 1995, whereas in the New Laender they decreased by 44%, mainly thanks to economic restructuring and significant energy efficiency improvements. Total CO<sub>2</sub> emissions fell by 12% between 1990 and 1995. By the end of 1995, per capita emissions in the New Laender were very close to those in the Old Laender. The average per capita emission value in 1995 was about 10.68 CO<sub>2</sub> per inhabitant and decreased gradually till 2002 to about 10.11 CO<sub>2</sub>. However, in 2003 the energy-related CO<sub>2</sub>-emission in Germany increased by about 0.4% (3.0 Mt CO<sub>2</sub>) compared to the previous year (refer to Table 10). In absolute terms it was about 837 Mt CO<sub>2</sub>, /16/. Thus, the per capita emission value increases slightly by about 0.3% to 10.14 CO<sub>2</sub> per inhabitant. The growth of emissions is particularly due to the cold weather at the beginning of 2003. If the weather condition i.e. the fluctuation of outdoor temperature is deducted the total emissions reduced by about 0.6% (5.4 Mt CO<sub>2</sub>). The ranking of CO<sub>2</sub>-emissions by energy carriers has not changed much in comparison to 2002: with about 35.6% the most part is emitted by the use of mineral oil, followed by gas with about 23%, lignite with about 22% and hard coal with 19.4%.

**Table 10:** Energy-related CO<sub>2</sub>-emissions by energy carriers in Germany in 1990, 2002 and 2003 /16/

Fuels	1990		2001 <sup>1)</sup>		2002 <sup>1)</sup>		2003 <sup>1)</sup>	
	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]
Hard coal	182.5	18.5	162.5	19.1	156.1	18.7	162.7	19.4
Lignite	343.4	34.8	181.1	21.3	186.5	22.4	184.1	22.0
Mineral oil <sup>2)</sup>	315.0	31.9	318.3	37.5	305.9	36.7	298.2	35.6
Gas <sup>1)</sup>	143.8	14.6	185.1	21.8	183.0	22.0	189.5	22.7
Others	2.2	0.2	2.1	0.2	2.1	0.3	2.1	0.3
<b>Total</b>	<b>986.9</b>	<b>100.0</b>	<b>849.1</b>	<b>100.0</b>	<b>833.6</b>	<b>100.0</b>	<b>836.6</b>	<b>100.0</b>

<sup>1)</sup> Preliminary data

<sup>2)</sup> Without fuel consumption for international air traffic

<sup>3)</sup> Include natural gas, coke oven gas / town gas and converter gas

An overview of CO<sub>2</sub>-emissions by sectors is given in Table 11. The main part of CO<sub>2</sub>-emissions is produced within the energy generation and conversion sector. In 2002 about 373.0 Mt CO<sub>2</sub> were emitted, followed by the transport sector of about 172.6 Mt CO<sub>2</sub>. In 2002 Germany's per capita carbon emissions which are emitted within the energy generation and conversion sector was about 4.5 tons of carbon dioxide per person.

**Table 11:** Overview of CO<sub>2</sub>-emissions by sectors in 1990, 2001 and 2002 /16/

Sectors	1990		2001 <sup>1)</sup>		2002 <sup>1)</sup>	
	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]
Energy generation and conversion	439.2	43.3	369.1	42.3	373.0	43.5
- Power plants	353.8	34.9	316.9	36.3	322.0	37.5
- Cogeneration plants / district heating plants <sup>2)</sup>	85.4	8.4	52.2	6.0	51.0	5.9
Industry	169.3	16.7	112.6	12.9	109.1	12.7
Transport (national)	158.8	15.7	174.6	20.0	172.6	20.1
Households	129.0	12.7	129.9	14.9	119.6	13.9
Trade/ Commerce/ Services	90.5	8.9	63.0	7.2	59.0	6.9
<b>Energy-related emissions</b>	<b>986.8</b>	<b>97.3</b>	<b>849.2</b>	<b>97.2</b>	<b>833.6</b>	<b>97.2</b>
Industrial processes	27.6	2.7	24.4	2.8	24.4	2.8
<b>Total <sup>3)</sup></b>	<b>1 014.4</b>	<b>100.0</b>	<b>873.6</b>	<b>100.0</b>	<b>857.7</b>	<b>100.0</b>

<sup>1)</sup> Preliminary data

<sup>2)</sup> Include rest of conversion areas

<sup>3)</sup> Differences in sums are based on rounding errors.

Table 12 shows the factual and expected development of CO<sub>2</sub> emissions and intensities of the German economy till 2030. Accordingly, from 1990 to 2000 total CO<sub>2</sub> emissions decreased up to 15.5% in 2000, whereas in 2002 a slight rise of CO<sub>2</sub> emissions is seen compared to 2000. However, since 1990 CO<sub>2</sub> emission per capita permanently decreased up to about 18.2% in 2002 compared to 1990. Till 2030 CO<sub>2</sub> emissions per capita might reduce further on by about 28.9% compared to 1990 and might reach a value of about 9.04 t<sub>CO2</sub>/inhabitant.

**Table 12:** CO<sub>2</sub> Intensity Indicators – past, present and future /17/, own calculations

Index	Unit	1990	1995	2000	2002	2010	2020	2030
CO <sub>2</sub> emission index <sup>1)</sup>	[%]	100	86.0	84.5	84.6	82.5	78.1	70.7
CO <sub>2</sub> per primary energy consumption	[t CO <sub>2</sub> / GJ]	0.068	0.061	0.060	0.060	0.059	0.061	0.059
	[t CO <sub>2</sub> / toe]	2.85	2.56	2.50	2.51	2.46	2.55	2.48
CO <sub>2</sub> per capita	[t CO <sub>2</sub> / inhabit.]	12.72	10.66	10.42	10.40	10.16	9.75	9.04
CO <sub>2</sub> per GDP	[t CO <sub>2</sub> / kEuro <sub>2000</sub> ]	588.8	469.8	422.0	418.7	362.8	294.4	235.0

<sup>1)</sup> 1990 = 100%

In 2002 the total emissions of greenhouse gases decreased by about 1.1% compared to 2001, /18/. However, the emissions of PFC<sub>s</sub> and SF<sub>6</sub> slightly increased by 8.7% and 13.7% respectively. Determined in CO<sub>2</sub>-equivalent about 1 016 Mt CO<sub>2</sub> was emitted in 2002. Table 13 shows the emissions of GHG for the year 2001 and 2002, whereas Table 14 gives an overview for which activities the GHG appeared. According to Table 14 in 2002 the main part of the GHG emissions of about 82.8% took place in the fuel combustion sector, followed by the agriculture of about 8.6%. Compared to 2001 the GHG emissions slightly decreased by about -1.1%, while the biggest reductions were fulfilled at waste (-5.9%) and at fugitive emissions from fuels (-3.4%).

**Table 13:** GHG emissions in CO<sub>2</sub>-equivalent of Germany in 2001 and 2002 /18/, own calculations

GHG	Base-line <sup>2)</sup>	Baseline year	2001		2002		Change
	[-]		[Mt CO <sub>2</sub> ]	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	
CO <sub>2</sub>	1990	1 023.1	888.1	85.3	878.0	85.2	-1.1
CO <sub>2</sub> * <sup>1)</sup>	1990	1 015.6	874.1	-	864.1	-	-1.2
CH <sub>4</sub>	1990	141.6	84.8	8.1	83.3	8.1	-1.8
N <sub>2</sub> O	1990	81.4	56.1	5.4	55.8	5.4	-0.5
HFC <sub>s</sub>	1995	6.4	8.1	0.8	8.2	0.8	1.4
PFC <sub>s</sub>	1995	1.8	0.7	0.1	0.8	0.1	8.7
SF <sub>6</sub>	1995	4.3	3.3	0.3	3.8	0.4	13.7
<b>Total</b>			<b>1 041.2</b>	<b>100.0</b>	<b>1 029.9</b>	<b>100.0</b>	<b>-1.1</b>
<b>Total*<sup>1)</sup></b>			<b>1 027.4</b>		<b>1 016.0</b>		<b>-1.1</b>

<sup>1)</sup> Without land-use change and forestry

<sup>2)</sup> Baseline year set by the Kyoto Protocol

**Table 14:** GHG emissions in CO<sub>2</sub>-equivalent by sectors in 2001 and 2002 /18/, own calculations

Sector	1990	1995	2001		2002		Change
	[Mt CO <sub>2</sub> ]	[Mt CO <sub>2</sub> ]	[Mt CO <sub>2</sub> ]	[%]	[Mt CO <sub>2</sub> ]	[%]	
Fuel combustion	1 004.5	888.8	862.0	82.8	852.5	82.8	-1.1
Fugitive emissions from fuels	36.1	27.0	17.0	1.6	16.4	1.6	-3.4
Industrial processes	60.3	61.3	42.5	4.1	42.6	4.1	0.3
Solvent and other product use	1.9	1.9	1.9	0.2	1.9	0.2	0.0
Agriculture	109.9	91.1	88.7	8.5	88.3	8.6	-0.5
Land-use change and forestry	7.5	5.7	13.8	1.3	13.9	1.4	0.7
Waste	35.9	28.3	15.3	1.5	14.4	1.4	-5.9
<b>Total</b>	<b>1 256.2</b>	<b>1 104.1</b>	<b>1 041</b>	<b>100.0</b>	<b>1 029.9</b>	<b>100.0</b>	<b>-1.1</b>

## 1.7 Trends

In several studies, for example EWI/PROGNOS /17/, PRIMES /19/, Eurelectric /20/, Enquete /21/ and UBA /22/ projections of the electricity consumption and/or generation and the development of the economy are given. The results of these studies slightly differ from each other according to their underlying assumptions. While the study of PRIMES is the most optimistic study corresponding to the figures for the assumption as well as for the projections, the prognosis of EWI/PROGNOS regarding the main assumption and of UBA regarding the projections are more moderate respectively compared to the average of the studies. Table 15 summarizes the development of the inhabitants and the GDP till 2030 given in the studies. The band of inhabitants in Germany amounts to 81.5 to 83.2 million people in 2010 and might decline slightly to 78.0 to 81.8 million inhabitants in 2030. In the same period the GDP might increase between 32.3% and 49.3%, which will come to an annual growth of the GDP of about 1.6% and 2.5%.

**Table 15:** Basic assumptions of different analyses given in /17; 19; 20; 21; 22/, own calculations

	Unit	EWI / PROGNOS	PRIMES	Eurelec tric	Enquete	UBA
<b>2010</b>						
Inhabitants	Million	82.4	83.2	82.4	82.1	81.5
GDP	Euro <sub>2000</sub> bn	2 307	2 495	2 423	2 514	2 440
GDP per capita	Euro <sub>2000</sub> th /inhab.	28.0	30.0	29.4	30.6	29.9
<b>2020</b>						
Inhabitants	Million	81.3	83.1	81.4	80.8	80.3
GDP	Euro <sub>2000</sub> bn	2 692	3 069	2 887	2 971	2 884
GDP per capita	Euro <sub>2000</sub> th /inhab.	33.1	37.0	35.5	36.8	35.9
<b>2030</b>						
Inhabitants	Million	79.3	81.8	n.a.	77.9	78.0
GDP	Euro <sub>2000</sub> bn	3 052	3 723	n.a.	3 388	3 288
GDP per capita	Euro <sub>2000</sub> th /inhab.	38.5	45.5	n.a.	43.5	42.2

n.a. not available

**Table 16** Projection of electricity consumption, gross electricity generation and net power capacity as results of different analyses, given in /17; 19; 20; 21; 22/, own calculations

	Unit	EWI / PROGNOS	PRIMES	Eurelec tric	Enquete	UBA
<b>2010</b>						
Final energy consump. electricity	TWh	515.3	535.9	570.0	511.9	507.5
	Mtoe	44.3	46.1	49.0	44.0	43.6
Gross electricity generation	TWh	617.0	611.7	563.0	557.0	546.0
	Mtoe	53.0	52.6	48.4	47.9	46.9
Import balance	TWh	-23.3	5.1	5.0	0.0	n.a.
	Mtoe	-2.0	0.4	0.4	0.0	n.a.
Net power capacity	GW	n.a.	132.1	131.4	117.6	116.0
<b>2020</b>						
Final energy consump. electricity	TWh	521.1	581.7	585.0	526.7	497.5
	Mtoe	44.8	50.0	50.3	45.3	42.8
Gross electricity generation	TWh	594.0	650.3	578.0	569.5	550.0
	Mtoe	51.1	55.9	49.7	49.0	47.3
Import balance	TWh	-1.4	6.4	10.0	2.2	n.a.
	Mtoe	-0.1	0.6	0.9	0.2	n.a.
Net power capacity	GW	n.a.	150	139.5	117.1	121.0
<b>2030</b>						
Final energy consump. electricity	TWh	515.3	629.3	n.a.	529.4	483.6
	Mtoe	44.3	54.1	n.a.	45.5	41.6
Gross electricity generation	TWh	584.0	697.1	n.a.	568.4	543.0
	Mtoe	50.2	59.9	n.a.	48.9	46.7
Import balance	TWh	-2.7	6.6	n.a.	2.8	n.a.
	Mtoe	-0.2	0.6	n.a.	0.2	n.a.
Net power capacity	GW	n.a.	166.7	n.a.	119.6	128.0

n.a. not available

In Table 16 the projections of the final energy consumption of electricity, the gross electricity generation, the trade balance and the net power capacity from 2010 till 2030 are given. While the studies of PRIMES and Enquete come from an increase of the electricity final energy consumption and generation by about 3.4% and 17.5% (electricity final consumption) and by 2.0% and 14.0% (electricity generation), the studies of EWI/PROGNOS and UBA project a decrease by about -0.1% and -4.6% of the final consumption of electricity and by -0.5% and -5.3% for the electricity generation. All studies project an increase of the installed net power capacity from 2010 to 2030. The increase ranges from about 1.7% to 26.2% with a corresponding annual growth of about 0.1% to 1.3%.

## **2 Policy**

### **2.1 Liberalization**

With the adoption of the Energy Industry Act (Energiewirtschaftsgesetz) in 1998 Germany has opened its electricity and natural gas sectors with 100% full customer choice. At the same time the liberalization led to the privatization of undertakings and an increasing internationalization by the entrance of foreign undertaking. New market entrants were given the right to a wheeling in order to supply customers by the introduction of negotiated third party access (NTPA). The concrete conditions for the access in terms of prices and the relating issues were laid down in the Associations Agreements (Verbändevereinbarungen).

The amendment of the Energy Industry Act (Energiewirtschaftsgesetz EnWG) has passed the German Parliament on June 2005 and will come into force at the beginning of July 2005. The law transposes the EU Acceleration Directive for electricity (Directive 2003/54/EG of the EU Parliament and Council) and gas (Directive 2003/55/EG of the European Parliament) into German national law. The act gives the legal general conditions for generation and distribution of electricity and gas in Germany. Main target of the law is to ensure the non discriminatory network access to both the electricity and gas markets to all suppliers at same conditions. The abuse of market power which might result to bad competition has to be prevented. For this reason a national regulatory authority, the Federal Network Agency (Bundesnetzagentur) has been established to determine network charges in future and to regulate grid operation by means of incentives, /24/.

There are about 1 100 energy companies operating in the German electricity market. The proportion of installed available capacity that is owned by the largest three companies amounts to about 63% (EnBW AG about 13.6%, E.ON AG about 34%, RWE AG about 34%). Regarding the end user supply market the four largest companies have market shares of about 54% (RWE AG 19.6%, E.ON AG 16.3%, EnBW AG 12.2%, Vattenfall Europe AG 6.0%).

### **2.2 The ecological tax reform**

In 1999 the ecological tax reform (Ökologische Steuerreform) was introduced with the goal of encouraging conservation, energy efficiency and the increasing use of renewable energies, /25/. To avoid endangering the German industry's international competitiveness, exceptions will be granted for the entire good-producing industry, public short-range passenger transport, and agriculture and forestry.

Tax benefits are granted for the use of low-sulfur fuels as of November 1, 2001 by way of a tax on conventional fuels. The petroleum tax was increased on fuels (petrol and diesel), fuel oil (light and heavy), gas and electricity. The Eco-tax was applied in five steps until 2003 and remains constant beyond 2004. It envisages the gradual increase of taxes on fossil fuels and electricity. For petrol and diesel the tax was increased annually by 3.07 Euro-Ct/liter and

reached an amount of 15.34 Euro-Ct/liter in 2004. The Eco-tax for light oil was introduced in 1999 with 2.05 Euro-Ct/liter and for heavy oil the tax was levied in 2000 and was augmented in 2003 to a final tax amount of 0.97 Euro-Ct/kg. For gas the final Eco-tax was performed by two steps in 1999 by 0.164 Euro-Ct/kWh and in 2003 by 0.202 Euro-Ct/kWh. The electricity tax was introduced at 1.02 Euro-Ct/kWh with an annual increase of 0.26 Euro-Ct/kWh from 2000-2003; this came up to an Eco-tax of 2.05 Euro-Ct/kWh in 2004, refer to Table 17; /25; 26/.

Since January 2004 all liquid biofuels are exempted from the fuel taxes. This applies for biodiesel (RME), bioethanol as well as for all other fuels from biogenic resources. Fossil fuels may be blended with 5% biofuels without explicit declaration. Moreover, cogeneration installations with efficiency rates of at least 70% are exempt from the petroleum tax. Gas-fired and steam-powered power stations with (net) electric efficiencies of at least 57.5% are to be exempt from the petroleum tax. The tax benefits it to apply to new installations that were completed after December 31, 1999 and whose production of electrical power was used for the first time on an ongoing basis before September 10, 2007.

**Table 17:** Rates of the petroleum and eco-tax for different energy carriers /25; 26/

energy carrier	Petro. tax plus eco-tax	Petro. tax until March 1999	Petro. tax plus 1.step of eco-tax (April 1999)	Petro. tax plus 2. step of eco-tax (Jan. 2000)	Petro. tax plus 3. step of eco-tax (Jan. 2001)	Petro. tax plus 4. step of eco-tax (Jan. 2002)	Petro. tax plus 5. step of eco-tax (Jan. 2003)	Share of the eco-tax 2003
Electr.	[Euro-Ct/kWh]	-	1.02	1.28	1.54	1.8	2.05	2.05
<b>Fuels</b>								
Diesel <sup>1)</sup>	[Euro-Ct/liter]	31.70	34.77	37.84	40.91	43.98	47.04	15.34
gas <sup>1)</sup>	[Euro-Ct/liter]	50.11	53.18	56.25	59.32	62.39	65.45	15.34
natural gas	[Euro-Ct/liter]	6	7	7	8	8	8	2
liquid gas	[Euro-Ct/liter]	6	7	7	7	8	8	2
<b>fuels for heating</b>								
Light oil	[Euro-Ct/liter]	4.09	6.14	6.14	6.14	6.14	6.14	2.05
Heavy oil	[Euro-Ct/kg]	1.53	1.53	1.79	1.79	1.79	2.5	0.97
Natural gas	[Euro-Ct/kWh]	0.18	0.344	0.344	0.344	0.344	0.55	0.37

<sup>1)</sup> Since 2001 for low-sulfur fuels, since 2003 for fuels without any sulfur

### 2.3 Nuclear phase-out

On April 26, 2002 the "Act on the structured phase-out of the utilisation of nuclear energy for the commercial generation of electricity" came into force, /27/. It makes fundamental amendments to the 1959 Atomic Energy Act by stipulating the phase out of the use of nuclear energy in a structured manner. Among the key points of the amendment is the ban on constructing new commercial nuclear power plants. The new act lays down a maximum permitted residual electricity volume for each existing individual nuclear power plant. The electricity volumes of older nuclear power plants can be transferred to other plants and the on-going operation must be ensured up to the date of the plant's discontinuation. The nuclear electricity production of about 2 623.3 TWh (1.1.2000) will gradually decrease and be phased out by the year 2022. At the end of the year 2004 an amount of about 1 829.0 TWh remains

of the electricity generation within the nuclear power plants. On November 14, 2003, E.ON Energie closed its Stade nuclear power plant, marking the first plant to be decommissioned and Germany's oldest nuclear power plant, Obrigheim, closed in 2005. The government plans to compensate for the loss of nuclear power with renewables and increased use of natural gas. Use of coal could also increase slightly.

## **2.4 Hard coal subsidies**

In July, 2003 the German Government, the state of North Rhine-Westphalia, the industrial union of mining, chemistry, energy and the RAG Company set the framework for further support of the German hard coal mining industry in the period 2006 to 2012, /28; 29/. The financial aids from the Government and the states will fall from about 2.7 bn Euro in 2005 to 1.83 bn Euro in 2012. Throughout the entire period public financial assistance to support sales of German hard coal and towards expenditure on closures will amount to a total of up to 15.87 bn Euro. The company RAG with its subsidiary DSK (Deutsche Steinkohle AG), which operates the German pits will make a contribution of about 1.13 bn Euro. Output of German hard coal will be brought down to about 469 PJ (11 Mtoe) by the year 2012. The EU Commission has approved the limitation of hard coal subsidies till 2010.

## **2.5 Renewable Energy Sources Act (EEG)**

The aim of the Renewable Energy Sources Act (EEG) is to double at least the amount of electricity generated from renewable energy sources by 2010 (12.5%) compared to 1999 (5.8%), /30/. Thus electricity generation from renewable energy resources in Germany is supported by this act (EEG, renewed in 2004) which guarantees fixed feed-in tariffs.

Therefore, electricity grid operators are obliged to purchase electricity produced with hydropower, landfill gas, sewage treatment plant gas and mine gas, with biomass, geothermal and wind energy as well as electricity produced from solar radiation prior to electricity produced from other resources. Also, grid operators have to guarantee sufficient grid capacity for the transport of this electricity. They have to pay a specific price for this electricity, which is set by the law and is calculated by estimating the production costs for this energy.

The feed-in tariffs are differentiated according to energy forms, size of power plants, applied technology (e. g. innovative technologies, etc) and the use of special subforms of specific energies (e. g. for biomass). The legally fixed feed-in tariffs and the relevant electricity can be passed on by the grid operators to the transport system operators, who afterwards balance the electricity and the tariffs nationwide with regard to the amount of electricity supplied by the relevant suppliers to customers. In the end the customers of the suppliers have to pay the difference between the costs for the feed-in tariffs and the market price for the electricity to their suppliers. Also with regard to costs for grid measures to guarantee the feed-in of the electricity the Renewable Energy Sources Act leads to an increase in electricity prices for customers.

## **2.6 CHP Law**

In April 2002 the new German CHP Law, the "Law on the Conservation, Modernization and Development of Combined Heat and Power" came into force, /31/. The law enacts a duty to connect certain types of CHP units to the grid and to purchase their electricity feed-ins to the public grid. On top of the agreed price for this feed-in, the operators of the units are entitled to obtain supplementary payments on each kWh feed-in as given in Table 18. If an agreement on the feed-in price cannot be reached between the CHP plant operator and the operator of the relevant grid, the plant operator is entitled to claim the stock exchange price for baseload electricity, as traded at the European Energy Exchange (EEX). This measure is

limited to CHP power plants with not more than 2 MW electrical capacity. Thus the law increases the financial returns and it will therefore support the continued operation and modernization of already existing CHP plant regardless of their size. It also aims to encourage the installation of new small-scale CHP units up to 2 MWe electrical capacity and applications based on fuel cell technology.

**Table 18:** Supplementary payment for electricity feed-ins of CHP plants to the public grid /31/

	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Euro-Ct/kWh								
Existing old CHP plant (start of operation until 31/12/89)	1.53	1.53	1.38	1.38	0.97				
Existing new CHP plant (Start of operation between 01/01/90 and the date when the new law comes into effect) or existing old CHP plant modernized within this period of time	1.53	1.53	1.38	1.38	1.23	1.23	0.82	0.56	
Modernized CHP plant (existing old CHP plant modernized after the new law came into effect)	1.74	1.74	1.74	1.69	1.69	1.64	1.64	1.59	1.59
New small-scale CHP plant between >50 and 2000 kWe	2.56	2.56	2.40	2.40	2.25	2.25	2.10	2.10	1.94
New small-scale CHP plant ≤ 50 kWe which start continuous operation before the end of 2005, and fuel cell units	5.11 Euro-Ct/kWh for a period of 10 years beginning from the start of continuous operation								
Supplementary payments for small scale CHP plant up to 2 MWe (this includes also unit <50 KWe) will only be made up to a total electricity feed-in of 17 TWh from these plants									

## 2.7 Federal Immission Protection Law

Recent power plants fulfill the environmental requirements according to the environmental protection limits of the regulation of large combustion plants according to the Federal Immission Protection Law (Bundes-Immissionsschutzverordnung - 13. BImSchV), /32/. Its amendment passed the Parliament on June 2004 and intensifies the reduction of emissions of power plants depending on their combustion capacity. The regulation is based on recent western standards. Future power plants will be designed with the environmental protection systems including pollution control equipment to comply with it.

**Table 19:** Environmental limit values of emissions for large combustion plants as stipulated in /32/

<b>Pollutant</b>		<b>Coal</b>	<b>Oil</b>	<b>Gas</b>
SO <sub>2</sub>	[mg/m <sup>3</sup> ]	850 <sup>1)</sup> / 200 <sup>2)3)</sup>	850 <sup>1)</sup> / 200-400 <sup>2)</sup> / 200 <sup>3)</sup>	35
NO <sub>2</sub>	[mg/m <sup>3</sup> ]	400 <sup>1)</sup> / 200 <sup>2)3)</sup>	180, 200, 250 <sup>1)</sup> / 200 <sup>2)</sup> / 150 <sup>3)</sup>	100 <sup>1)</sup> / 100 <sup>2)3)</sup>
CO	[mg/m <sup>3</sup> ]	150 <sup>1)</sup> / 200 <sup>2)3)</sup>	80	50
Dust	[mg/m <sup>3</sup> ]	20	20 <sup>4)</sup>	5

<sup>1)</sup> Plants with a combustion capacity between 50 and 100 MW

<sup>2)</sup> Plants with a combustion capacity between 100 - 300 MW

<sup>3)</sup> Plants with a combustion capacity bigger than 300 MW

<sup>4)</sup> By the use of light oil the soot value of 1 is valid.

## 2.8 Emission trading

In the context of the implementation of the Kyoto Protocol, the European Union launched its emissions trading scheme on 1 January 2005. On the basis of the Emissions Trading Directive, which came into effect in October 2003, EU Member States are obliged to adopt National Allocation Plans (NAP) to the Commission for notification, /33/. The NAP of Germany was represented on March, 31 2004 to the European Commission. It shows how many CO<sub>2</sub> emission allowances Germany plans to allocate for the 2005-2007 trading period, and how many emission allowances each plant will receive. The emissions trading system provides an economic basis for lowering emissions of climate-damaging CO<sub>2</sub> where such a reduction is most cost-efficient. This means that ecologically effective action is implemented economically.

In general, under the European burden sharing agreement, Germany has pledged to reduce emissions of the six greenhouse gases by the period 2008-2012 by 21% compared with the hybrid baseline year 1990/1995 (refer to Table 13). The National Inventory Report for 2003 gives greenhouse gas emissions for the baseline year as 1 218.2 Mt CO<sub>2</sub> equivalents. Averaged, over the commitment period 2008-2012, this results to an annual emissions budget of 962 Mt CO<sub>2</sub> equivalents. During the initial stage, the EU Emissions Trading Directive is confined to CO<sub>2</sub>-emissions. The German government estimates that total annual emissions of the other five greenhouse gases in the period 2008-2012 will fall to about 116 Mt CO<sub>2</sub> equivalents compared to 203.7 Mt CO<sub>2</sub> equivalents in the baseline year, resp. 127 Mt CO<sub>2</sub> equivalents in the period 1999-2001. This leaves a national CO<sub>2</sub> emissions budget during 2008-2012 of 846 Mt CO<sub>2</sub> per year. Compared to the annual average for 2000/2002, this requires an additional CO<sub>2</sub> reduction of about 17 Mt or 2%. Table 20 sums up the national emissions budgets described for the periods 2005-2007 and 2008-2012.

**Table 20:** Greenhouse gas emissions in Germany 2005-2007 and 2008-2012 /33/

<b>Year</b>	<b>CO<sub>2</sub></b>	<b>CH<sub>4</sub></b>	<b>N<sub>2</sub>O</b>	<b>HFCs</b>	<b>PFCs</b>	<b>SF</b>	<b>Total non CO<sub>2</sub></b>	<b>Total</b>
in Mt CO <sub>2</sub> equivalent								
<b>Base year</b>	1 014.4	101.1	87.9	6.4	1.8	6.6	203.7	<b>1 218.2</b>
<b>Average 2000/2002<sup>1)</sup></b>	863	55	60	7	1	4	127	<b>990</b>
<b>Target 2005-2007</b>	859						123	<b>982</b>
<b>Target 2008-2012</b>	846						116	<b>962</b>

<sup>1)</sup> Average for non-CO<sub>2</sub> emissions during 1999-2001

Specific reduction targets are set for each branch of industry and the individual installations concerned, which will receive this quantity of free emissions allowances (grandfathering) as of September, 30 2004 for the first trading period 2005-2007. In the first trading period one emission certificate authorized the owner to emit 1 t of CO<sub>2</sub> per year. The certificates are tradable. If the company meets the targets by means of its own cost-saving CO<sub>2</sub> reduction measures, it can sell unused certificates on the market. Alternatively, it will buy additional certificates on the market if its own reduction measures become more expensive. If a company does not meet the reduction requirements, sanctions are due, which amount to 40 Euro per ton of carbon dioxide in the first trading period (2005/2007). The failed reduction requirement still has to be fulfilled in the following year.

The CO<sub>2</sub> emissions budgets for the energy and industry sectors during the periods 2005-2007 and 2008-2012 have been determined by defining the budgets for total greenhouse gas emissions and for CO<sub>2</sub> emissions as mentioned above. This automatically also defines the emissions budgets over those two periods for the totality of the remaining sectors (Table 21). For the entire reduction of 17 Mt CO<sub>2</sub> the energy conversion and industry sector has to reduce 10 Mt CO<sub>2</sub> till 2012 and additional 7 Mt CO<sub>2</sub> has to be decreased within the household, transport and trade/commerce/service sector.

**Table 21:** CO<sub>2</sub> emissions budgets 2005-2007 and 2008-2012 in Germany by sectors /34/

Year	Energy conversion / Industry	Households, Transport, Trade/ commerce/ services	Total
Average 2000/2002	505	358	863
Target 2005- 2007	503	356	859
Target 2008- 2012	495	351	846

In Germany, operators of about 1 849 installations are able to participate in emissions trading from 2005 onwards. In particular, this applies to all large combustion plants (thermal output higher than 20 MW) as well as larger installations in the energy-intensive sectors. For the period 2005-2007 about 1 485 millions certificates were distributed to the operators, thereof about 78.9% account for energy generating plants and 21.1% for industrial plants (Table 22).

**Table 22:** Emission certificates for the industry and energy conversion sector taken from /34/

Sector	Emission certificates 2000-2007		Number of plants
	[million]	[%]	[-]
Energy plants	1 171	79	1236
Industrial plants	314	21	613
- Iron / Steel	101	32 <sup>1)</sup>	39
- Refineries	73	23 <sup>1)</sup>	37
- Cement	71	23 <sup>1)</sup>	48
- Lime / Sugar	28	9 <sup>1)</sup>	67
- Paper	15	5 <sup>1)</sup>	122
- Glass	14	4 <sup>1)</sup>	90
- Ceramics	8	3 <sup>1)</sup>	206
- Pulp	4	1 <sup>1)</sup>	4
<b>Totals</b>	<b>1 485</b>	<b>100</b>	<b>1 849</b>

<sup>1)</sup> Based on the number of emission certificates of industrial plants

### 3 Bibliography

- /1/ Deutschland auf einem Blick. <http://www.deutschland.de/aufeinenblick/>
- /2/ Auswärtige Amt: <http://www.tatsachen-ueber-deutschland.de/>
- /3/ Statistisches Bundesamt Deutschland: <http://www.destatis.de/>.
- /4/ Statistisches Bundesamt Deutschland: Volkswirtschaftliche Gesamtrechnungen, Wichtige Zusammenhänge im Überblick 2004. Wiesbaden 2005
- /5/ Bundesministerium für Wirtschaft und Arbeit (BMWA): Zahlen und Fakten Energiedaten - Nationale und internationale Entwicklung, 02.2000. <http://www.bmwa.bund.de/>
- /6/ Institut Wohnen und Umwelt (IWU), Forschungseinrichtung des Landes Hessen und der Stadt Darmstadt: Gradtagszahlen in Deutschland, 05.2005. <http://www.iwu.de/deutsch/arbeitshilfen.htm>
- /7/ Arbeitsgemeinschaft Energiebilanzen (AGEB): <http://www.ag-energiebilanzen.de/>
- /8/ Deutsches Institut für Wirtschaftsforschung (DIW): Primärenergieverbrauch in Deutschland von hohen Energiepreissteigerungen und konjunktureller Belebung geprägt. Wochenbericht des DIW, Berlin. Nr. 7/2005. <http://www.diw.de/>
- /9/ Böhmer, T.: Nutzung erneuerbarer Energien zur Stromerzeugung in Deutschland im Jahr 2003. ew, Heft 10; 2005, S. 14-20
- /10/ Verband der Elektrizitätswirtschaft (VDEW): Stromdaten. Stand: April 2005. Berlin 2005.
- /11/ Verband der Elektrizitätswirtschaft (VDEW): Entwicklung der Stromversorgung 2004. VDEW Materialien, M-01/2005. Berlin 2005
- /12/ Verband der Elektrizitätswirtschaft (VDEW): Stromdaten. Stand: Oktober 2004. Berlin 2004.
- /13/ Blesl, M.; Fahl, U.; Kempe, S.; Voß, A.: Wirtschaftlichkeit neuer Stromerzeugungstechniken im Hinblick auf eine nachhaltige Entwicklung. ew, Heft 13; 2005, S. 32-37
- /14/ Europäische Gemeinschaften, 2005. EUROSTAT: <http://epp.eurostat.cec.eu.int/>
- /15/ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Umweltpolitik; Environmental Policy. Renewable energy sources in figures – national and international development. Berlin 2004
- /16/ Deutsches Institut für Wirtschaftsforschung (DIW): CO<sub>2</sub>-Emissionen in Deutschland im Jahre 2003: Witterungsbedingt leichte Steigerung. Wochenbericht des DIW, Berlin 10/04. <http://www.diw.de/>
- /17/ Prognos AG: Energiereport IV. Die Entwicklung der Energiemärkte bis zum Jahr 2030. Energiewirtschaftliche Referenzprognose. Köln, Basel, April 2005.
- /18/ United Nations Framework Convention on Climate Change (UNFCCC): <http://ghg.unfccc.int/>

- /19/ European Commission: European Energy and Transport – Trends to 2030. <http://europa.eu.int>. Belgium 2005
- /20/ Union of the Electricity Industry (EURELECTIC): statistics and prospects for the European electricity sector (1980-1990, 2000-2020). 32<sup>ND</sup> edition. EURPROG Network of Experts 2004: <http://www.eurelectric.org>. Brussels 2004
- /21/ Enquete Kommission: Nachhaltige Energieversorgung unter Bedingungen der Globalisierung und der Liberalisierung, Abschlussbericht. <http://www.bundestag.de/gremien/ener/schlussbericht/index.htm>. Deutscher Bundestag. Berlin 2002.
- /22/ Umweltbundesamt (UBA): Klimaschutz in Deutschland bis 2030. Endbericht zum Forschungsvorhaben Politikszenerarien III. <http://www.umweltbundesamt.de>. Berlin 2005
- /23/ Energy Information Administration: <http://www.eia.doe.gov/emeu/cabs/germany.html>
- /24/ Umweltbundesamt (UBA): Kurzinformationen zur Neuregelung des Energiewirtschaftsrechts. Juni 2005
- /25/ Umweltbundesamt (UBA): Ökosteuer – sparen oder zahlen? Berlin 2002
- /26/ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Die Ökologische Steuerreform: Einstieg, Fortführung und Fortentwicklung zur Ökologischen Finanzreform. Februar 2004. <http://www.bmu.de/>
- /27/ Bundesregierung: Gesetz zur geordneten Beendigung der Kernenergienutzung zur gewerblichen Erzeugung von Elektrizität. <http://www.bundesregierung.de/>
- /28/ Gutberlet, K.; Hilligweg, G.: Steinkohle. BWK Bd. 57, Nr. 4; 2005, S. 70-75.
- /29/ Bundesministerium für Wirtschaft und Arbeit (BMWA): Annual Economic Report for 2004. Berlin 2004
- /30/ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): Renewable Energies Innovation for the Future. Berlin 2004
- /31/ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung. <http://www.bmu.de/klimaschutz/>
- /32/ Bundes-Immissionsschutzgesetz: Federal Immission Protection Law: Dreizehnte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über Großfeuerungs- und Lastturbinenanlagen – 13. BImSchV. Berlin 2002
- /33/ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU): National Allocation Plan for the Federal Republic of Germany 2005-2007. Berlin 2005
- /34/ Umweltbundesamt (UBA), Deutsche Emissionshandelsstelle (DEHST): Emissionshandel in Deutschland: Verteilung der Emissionsberechtigungen für die erste Handelsperiode 2005-2007. 2004