Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

ENVIRONMENTAL POLICY

Renewable energy sources in figures - national and international development

Status: May 2006

IT'S OUR FUTURE.

Imprint

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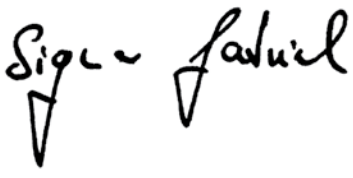
Dear Reader,

Energy is essential for our economy and everyday life. We need primary energy sources for heat, electricity and mobility. In the past, we have used energy almost exclusively from conventional raw materials like coal, oil, gas and uranium. But these reserves are finite. Furthermore, we burden our descendants with climate change and thousands of years of radioactive atomic waste. Fairness requires us to change our energy policy fundamentally: to expand the share of renewable energy sources and to increase efficiency in the conversion and use of energy. The combination of both strategies brings supply security, cost stability and climate protection.

The share of renewable energy sources again strongly increased in 2005. Solar, wind and hydropower, bio and geothermal energy now contribute 6.4 % to the final energy consumption. They have reached 10.2 % of the gross electricity consumption, 5.3 % of heat allocation and 3.6 % of fuel consumption. In 2005, a total of approximately 84 million tonnes of CO_2 were avoided. The Federal Government has an ambitious expansion goal for renewable energy sources: to cover half of the energy consumption with renewable energy sources by 2050. We are on the right track for achieving this goal – together with all those who have invested in renewable energy sources – be it companies or consumers.

Renewable energy sources are an important economic factor for Germany. In 2005, the industry had a turnover of approximately 16.4 billion euros. It provides 170,000 jobs for men and women. The demand for renewable energy installations is growing on the global market. Our companies now lead technologically in the field of wind, hydro and solar power as well as biomass – a situation which is reflected in full order books. Reinforcing the expansion of renewable energies in our own country and thus developing our position on the global market protects the environment and offers advantages for the German economy and for countries which cannot invest in the development of new technology but suffer the effects of climate change.



Sigmar Gabriel

Federal Minister for the Environment, Nature Conservation
and Nuclear Safety

Working Group on Renewable Energies/Statistics (AGEE-Stat)

The Federal Environment Ministry agreed to set up a Working Group on Renewable Energies/Statistics (AGEE-Stat) with the Federal Ministry of Economics and Technology and the Federal Ministry of Food, Agriculture and Consumer Protection, to put the statistics of renewable energy sources on a comprehensive, up-to-date and coordinated basis. The results of the work of the AGEE-Stat are incorporated into this brochure.

The AGEE-Stat is an independent expert committee which has been working since 2004. The members are experts of the

- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU),
- Federal Ministry of Economics and Technology (BMWi),
- Federal Ministry of Food, Agriculture and Consumer Protection (BMELV),
- Federal Environmental Agency (UBA),
- Federal Statistical Office (StBA),
- Agency of Renewable Resources (FNR),
- Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW),
- Working Group on Energy Balances (AGEB) and the
- German Renewable Energy Federation (BEE).

Dr. Staiss (Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg, ZSW) was appointed the head of AGEE-Stat.

The work of AGEE-Stat focuses on the statistics of renewable energies. Furthermore, the committee has the task

- to lay the foundation for the Federal Government's various national, EU-wide and international reporting obligations in the field of renewable energies and
- to provide general information and public relations work.

Within the framework of the AGEE-Stat a variety of research work is being undertaken to improve the databases. Workshops and hearings on specified subjects also support the work of the committee.

Further information on the AGEE-Stat and renewable energy sources are available on the website of the BMU www.erneuerbare-energien.de.

Housing estate with solar power plant

Barrage Iffezheim/Rhein
with dam, watergate,
hydroelectric power plant and fish pass

Fueling with biodiesel

Forestry office Grunewald, Berlin

Wind energy plant

Installation of solar thermal collectors in Crailsheim

Offshore
research
platform
FINO 1 in
the North Sea

Renewable energy sources in Germany: Guarantees for climate protection and supply security

An intelligent provision and economical use of energy – these are the main challenges of the 21st century. In many regions of the world energy demand is growing due to rapid industrialisation. At the same time industrialized nations face the challenge of drastically reducing their energy consumption. Only then can we succeed in alleviating the consequences of the greenhouse effect and become more independent of oil, gas, coal and uranium imports.
Alongside the important strategy of an economical use and efficient conversion of raw materials, the Federal Environment Ministry is focussing on the use of renewable energy sources. In recent years renewable energies have made a considerable impact not only on the transport and heating sector but also especially on the electricity market. With a share of more than 10 % of the German electricity supply, they have become an indispensable part of the energy industry. Renewable energies contribute in all manner of ways to a sustainable energy supply:

- They make a considerable contribution to climate protection, because no fossil fuels are burned – in 2005, they prevented the emission of approximately 84 million tonnes of CO_2. Without renewable energy sources Germany's climate protection goal, in the framework of the Kyoto Protocol, would be a distant prospect.
- They diversify the variety of raw materials, increase independence from fossil fuels, make a contribution to supply security and prevent raw material conflicts.
- In the medium term, renewable energy sources safeguard against cost increases which unavoidably occur with the use of fossil and nuclear resources.
- Renewable energy facilities can, at the end of their lifespan, be deconstructed and recycled. They are not a radioactive legacy like nuclear power plants and leave behind no coal cavities.
- Renewable energy sources are, in many cases, domestic energy sources that contribute to the regional added value and secure jobs. In Germany in 2005, renewable energy sources achieved a total turnover of 16.4 billion euros; in the same year 170,000 people were working in this sector.
- Renewable energy sources can show poor countries the way out of poverty, furthermore they simplify access to energy for large parts of the population, for example through rural electrification.

Renewable energy sources in Germany

The expansion of renewable energies has so far been a success story. But the goals of the Federal Government are even more ambitious: to double the share of renewables in the energy supply by 2010 compared to the year 2000: with at least a 12.5 % share of electricity. By 2020 their share of primary energy consumption should amount to at least 10 % and the share of electricity supply to at least 20 %. By 2050 half of the German primary energy consumption should derive from renewable energy sources. The BMU considers it feasible to cover 25 % of the electricity supply with renewables by 2020. Further innovative measures, for example a law for the intensified expansion of renewable energy sources in the heating sector, can bring the breakthrough for renewable energies also on the heating market.

Wind power

Wind power leads the way in the dynamic expansion of renewable energies. With 18,428 megawatts of installed capacity in 2005, Germany is the global leader; in 2005, these power plants produced 26.5 TWh of electricity, that is 4.3 % of total electricity generation.
In the years to come the contribution of wind power will continue to grow. The development of offshore wind parks will be a new emphasis: the wind conditions are excellent in both the North and Baltic Seas. In the framework of its sustainability strategy "Perspectives for Germany" the German Government, under the auspices of the Federal Environment Ministry, has presented a strategy for the use of wind power at sea and identified the first suitable areas for wind parks and sanctuaries.
In the coming years, alongside offshore utilisation and further expansion on land, emphasis will also be placed on the modernisation of existing power plants and the considerable increase in output ("repowering").

Biomass

Biomass is a climate compatible and local energy resource that can be used 24 hours a day. It makes an important contribution to a safe energy supply.
The Biomass Ordinance that entered into force on 28 July 2001 and the improved fees under the 2004 amendment to the Renewable Energy Sources Act (EEG) paved the way for electricity generation from renewable raw materials and biogenic residues and wastes. In addition biofuels are tax privileged; a blending obligation for biofuels is currently being developed. Already wood heating and wood-fired power plants, biogas installations and biofuels contribute a share of 3.3 % to the energy supply in Germany.

Geothermal energy

The heat from the earth's interior can be used for heating buildings or the local heating grid but also for electricity generation. In 2003, the first German geothermal power station was inaugurated. Geothermal heating stations were already in existence. To advance the technology and develop the sizable German geothermal potential in multiple sites, the Federal Government supports various projects for geothermal electricity generation. Furthermore, the EEG establishes a feed-in tariff.

Hydropower

For the expansion of hydropower, the most important potential lies in replacing and modernising present facilities. Increasing capacity combined with improving watercourse ecological conditions are the declared goals of the Federal Government.

Photovoltaics/solar thermal energy

Electricity generation from solar power with solar cells has trippled within two years as a result of the support through the EEG. Approximately one billion kilowatt hours of solar electricity were generated in 2005. Technical innovation and growing markets will continue to reduce the costs of electricity from photovoltaic facilities.
Solar collectors are enjoying growing popularity. In Germany approximately 1 million installations support the heating of process and heating circuit water. The costs for solar collectors have halved in the last 12 years. High oil and gas prices and the support under the Federal Government's market incentive programme will continue to advance the installation of solar thermal facilities.

Further pillars of the transformation of the energy system

The Federal Government consistently exploits the potential for rational, economical use of energy and for improving energy efficiency. Pivotal to this are the eco-tax reform introduced in 1999 and the measures contained in the climate protection programme of October 2000. These include the Energy Saving Ordinance, the Combined Heat Power Act and measures in the field of energy consumption labelling. The building modernisation programme to cut CO_2 emissions has been extended considerably in 2006. Emissions trading will be further developed this year so that German industry can attain its climate protection targets even more cost-effectively and efficiently than before.
The revised Atomic Energy Act (AtG) of 22 April 2002 transposed the phase-out of nuclear power into German law. Under this Act, existing nuclear power plants will be decommissioned once they have generated the volume of electricity specified for each plant. In November 2003 the nuclear power plant Stade and in May 2005 the oldest operating nuclear power plant Obrigheim were decommissioned after the operators definitively renounced the reconnection of the legally disputed nuclear power plant Müllheim-Kärlich. It is estimated that the last nuclear power plant will be shut down in less than 20 years' time. The protection of the global climate, the protection of valuable resources and a global sustainable development – these are the important challenges we must overcome in the 21st century. A central condition for this is the transformation of the energy system. On the road to a sustainable energy supply, the Federal Government is focussing on the phase-out of nuclear energy, energy saving, energy efficiency and the expansion of renewable energy sources.

The most important developments in 2005 at a glance!

Germany making further advances in solar energy utilisation

Photovoltaics world champion: newly installed capacity of 600 MW_p (2004: 500 MW_p), higher than in Japan (approximately 330 MW_p) [BSW 73];
newly installed **solar thermal collector area**: approximately 960,000 m^2 (2004: 750,000 m^2) of a total of over 7 million m^2.

Wind energy ahead of hydropower

Gross newly installed capacity of 1,808 MW approximately 20 % less than in the previous year, however this matches expectations; in total (including the replacement of facilities) 18,428 MW installed.

Biofuels and bioelectricity gaining ground

EEG amendment strengthens expansion in the electricity market;
the 2 million tonnes mark for biofuels has been exceeded;
sales of pellet heaters climb further (approx. 10,000 systems).

Hydropower stabilised

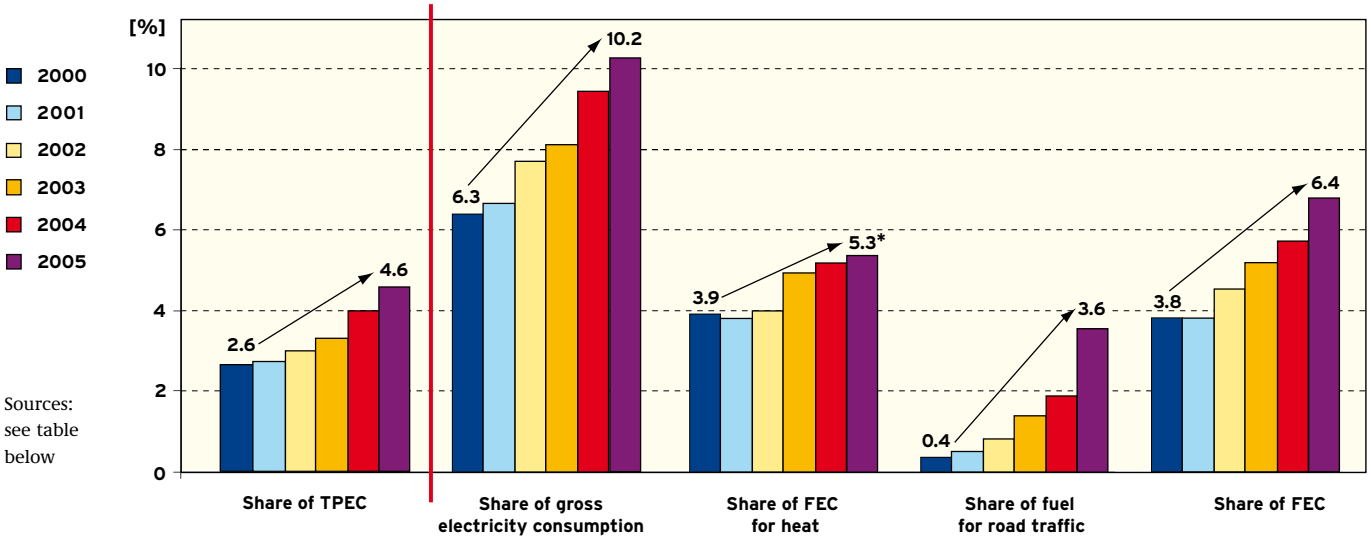
Better weather conditions have led to higher returns.

Geothermal energy in position

On the electricity market numerous projects planned;
sales of heating pumps continue to rise (over 18,000 systems) [BWP 26].

Share of renewable energy sources in the energy supply

- ✔ 4.6 % share of total primary energy consumption (2004: 4.0 %)
- ✔ 10.2 % share of gross electricity consumption (2004: 9.5 %)
- ✔ 5.3 % share of final energy consumption for heat (2004: 5.1 %)
- ✔ 3.6 % share of fuel consumption for road traffic (2004: 1.9 %)
- ✔ 6.4 % share of total final energy consumption (electricity, heat, fuel 2004: 5.7 %)



Sources: see table below

TPEC Total primary energy consumption FEC Final energy consumption
* Since 2003 new data based on the Energy Statistics Act (EnStatG) are taken into account.

Contribution of renewable energy sources to energy supply, 2005

		Final energy	Primary energy equivalent [1]		Share of final energy consumption		Share of total primary energy consumption [12]	
			acc. to physical energy cont. method	acc. to substitution method			acc. to physical energy cont. method	acc. to substitution method
		[GWh]	[PJ]	[PJ]	[%]		[%]	
Electricity generation	Hydropower [2]	21,524	77.5	211.7	Share of electricity consumption [8]	3.53	0.54	1.5
	Wind energy	26,500	95.4	251.5		4.34	0.67	1.7
	Photovoltaics	1,000	3.6	8.9		0.16	0.025	0.1
	Biogenic solid fuels	5,400	44.9	44.9		0.88	0.3	0.3
	Biogenic liquid fuels	430	3.6	3.6		0.07	0.03	0.02
	Biogas	2,500	20.8	20.8		0.41	0.15	0.14
	Sewage gas	864	7.2	7.2		0.14	0.05	0.05
	Landfill gas	2,200	18.3	18.3		0.36	0.1	0.1
	Biogenic share of waste [3]	2,050	17.0	17.0		0.34	0.1	0.1
	Geothermics [4]	0.2	0.0	0.0		0.00	0.0	0.0
	Total	**62,468**	**288.2**	**583.8**		**10.2**	**2.0**	**4.0**
Heat generation	Biogenic solid fuels (households)	56,000	201.6		Share of FEC for heat [9]	3.70	1.4	1.4
	Biogenic solid fuels (industry) [5]	10,833	39.0			0.72	0.3	0.3
	Biogenic solid fuels, CHP/ HP plants [6]	1,993	7.2			0.13	0.05	0.05
	Biogenic liquid fuels [7]	417	1.5			0.03	0.01	0.01
	Biogenic gaseous fuels [7]	3,194	11.5			0.21	0.08	0.08
	Biogenic share of waste [3]	3,577	12.9			0.24	0.09	0.09
	Solar thermal en.	2,960	10.7			0.20	0.07	0.07
	Deep geothermal en.	114	0.4			0.01	0.003	0.003
	Near-surface geothermal energy	1,472	5.3			0.10	0.04	0.04
	Total	**80,560**	**290.0**			**5.3**	**2.0**	**2.0**
Fuel	Biodiesel	18,600	67.0		Share of FEC attributable to road transport [10]	2.99	0.5	0.5
	Vegetable oil	2,047	7.4			0.33	0.05	0.05
	Bioethanol	1,683	6.0			0.27	0.04	0.04
	Total	**22,330**	**80.4**			**3.6**	**0.6**	**0.6**
Total		**165,358**	**658.6**	**954.2**	**FEC [11]**	**6.4**	**4.6**	**6.6**

The current method of calculating the primary energy equivalent of electricity generation from renewable energy sources is the physical energy content method. The substitution method, which for example is applied for calculation of avoided emissions by renewable energies and the fuels provided, is also given here.

TPEC Total primary energy consumption
14,238 PJ, status January 2006
FEC final energy consumption

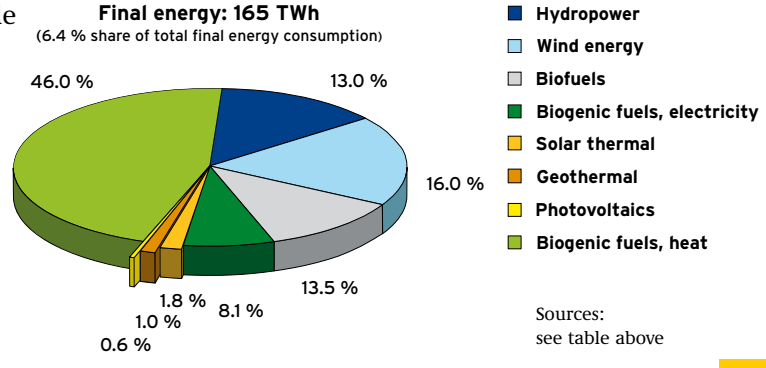
1) For an explanation of the methods used to determine primary energy equivalent, cf. Appendix, No. 4; for heat and fuels final energy is here equated with primary energy
2) For pumped-storage power stations, only electricity generation from natural inflow
3) Biogenic share estimated at 50 %
4) Electricity generation from geothermal energy in a pilot phase to date
5) Industry = operation of mining, extraction of stone and earth as well as the processing industry, Art. 8 Energy Statistics Act, value of 2005 estimated on the basis of 2003 data
6) Pursuant to Art. 3 and 5 Energy Statistics Act
7) Partly estimated, gases include the direct use of sewage gas
8) In relation to the gross electricity consumption 2005 of 611 TWh
9) In relation to FEC of space heating, hot water and other process heat 2003 of 186 million t C.E. or 5,451 PJ
10) Based on fuel consumption in road traffic 2005 of 2,239 PJ
11) In relation to FEC 2004 of 9,237 PJ
12) With a substitution factor of 8,309 kJ/kWh (status 2004, provisional), refer to Appendix, No. 4

For electricity generation from photovoltaics and for heat supply from solar thermal energy, cf. also Appendix, No. 5.

Sources:
ZSW [3]; after BSW [10]; IE [20]; AGEB [1], [18]; DIW [11]; StBA [5]; FNR [7]; ZfS [19]; VDEW [17]; ISI [41]; VDN [9]; BMELV [15]

Structure of energy supply from renewable energy sources, 2005

Around 68 % of all final energy from renewable energy sources is provided by biomass.
In terms of heat generation from renewable energy sources, biomass (primarily wood) accounts for a share of 94 %.
In terms of electricity generation from renewable energy sources, wind power with a share of 42 % and hydropower with 35 % are of great importance.



Sources:
see table above

Development of energy supply from renewable energy sources and installed capacity, 1990 to the end of 2005

Final energy

1) In the case of pumped-storage power stations, electricity generation from natural inflow only
2) For 2005 new construction of 1,808 MW, minus 9 MW dismantled wind energy installations
3) Until 1998 only feed in the grid of public utilities
4) Share of biogenic waste estimated at 50 %
5) Differing from the previous years, as of 2003 data pursuant to Art. 3, 5 (cogeneration and heating plants) and 8 (industry) Energy Statistics Act of 2003 as well as direct use of sewage gas and heat from the biogenic share of waste
6) For 2005 corresponds to: biodiesel: 1,800,000 tonnes approximately 2,045 million litres; vegetable oil: 196,000 tonnes approximately 213 million litres; bioethanol: 226,000 tonnes approximately 286 million litres

Installed capacity data refers to the status as per the year-end in each case; N/A not available

Sources:
ZSW [3]; EnBW [12]; BWE [16]; VDN [9]; StBA [5]; BMVEL [15]; IE [8], [20], [13]; AGEB [2], [18]; FNR [7]; SFV [28]; DIW [11]; DEWI [69]

	Hydropower[1]		Wind energy[2]		Biomass electricity[3]		Biogenic share of waste, electricity[4]	Photovoltaics		Geothermal electricity		Total electricity generation	Share of gross electricity consumption
	[GWh]	[MW]	[GWh]	[MW]	[GWh]	[MW]	[GWh]	[GWh]	[MW_p]	[GWh]	[MW]	[GWh]	[%]
1990	17,000	4,403	40	56	222	190	1,200	1	2	0	0	18,463	3.4
1991	15,900	4,403	140	98	250	N/A	1,200	2	3	0	0	17,492	3.2
1992	18,600	4,374	230	167	295	227	1,250	3	6	0	0	20,378	3.8
1993	19,000	4,520	670	310	370	N/A	1,200	6	9	0	0	21,246	4.0
1994	20,200	4,529	940	605	570	276	1,300	8	12	0	0	23,018	4.3
1995	21,600	4,521	1,800	1,094	670	N/A	1,350	11	16	0	0	25,431	4.7
1996	18,800	4,563	2,200	1,547	853	358	1,350	16	24	0	0	23,219	4.2
1997	19,000	4,578	3,000	2,082	1,079	400	1,400	26	36	0	0	24,505	4.5
1998	19,000	4,601	4,489	2,875	1,642	409	1,750	32	45	0	0	26,913	4.8
1999	21,300	4,547	5,528	4,444	1,791	604	1,850	42	58	0	0	30,511	5.5
2000	24,936	4,572	7,550	6,112	2,279	664	1,850	64	100	0	0	36,679	6.3
2001	23,383	4,600	10,509	8,754	3,206	790	1,859	116	178	0	0	39,073	6.7
2002	23,824	4,620	15,786	11,965	4,017	952	1,945	188	258	0	0	45,760	7.8
2003	20,350	4,640	18,859	14,609	6,970	1,137	2,162	333	408	0	0	48,674	8.1
2004	21,000	4,660	25,509	16,629	8,347	1,550	2,116	557	908	0.2	0.2	57,529	9.5
2005	21,524	4,680	26,500	18,428	11,394	2,192	2,050	1,000	1,508	0.2	0.2	62,468	10.2

	Biomass heat[5]	Solar thermal energy			Geothermal heat	Total heat generation	Biodiesel[6]	Vegetable oil[6]	Bioethanol[6]	Total biofuels	Total final energy supply	Share of final energy consumption	Share of primary energy consumption
	[GWh]	[GWh]	[1,000m^2]	[MW]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[%]	[%]	[%]
1990	N/A	130	340	238	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A
1991	N/A	166	468	328	N/A	N/A	2	0	0	2	N/A	N/A	N/A
1992	N/A	218	590	413	N/A	N/A	52	0	0	52	N/A	N/A	N/A
1993	N/A	279	749	524	N/A	N/A	103	0	0	103	N/A	N/A	N/A
1994	N/A	351	946	662	N/A	N/A	258	0	0	258	N/A	N/A	N/A
1995	N/A	440	1,159	811	1,425	N/A	310	0	0	310	N/A	N/A	N/A
1996	N/A	550	1,457	1,020	1,383	N/A	517	0	0	517	N/A	N/A	N/A
1997	48,546	695	1,821	1,275	1,335	50,576	827	0	0	827	75,908	2.9	2.0
1998	51,613	857	2,194	1,536	1,384	53,854	1,033	0	0	1,033	81,800	3.1	2.2
1999	50,951	1,037	2,641	1,849	1,429	53,417	1,343	0	0	1,343	85,271	3.3	2.3
2000	54,314	1,279	3,284	2,299	1,433	57,026	2,583	0	0	2,583	96,288	3.8	2.6
2001	55,326	1,626	4,199	2,939	1,447	58,399	3,617	0	0	3,617	101,089	3.8	2.7
2002	54,626	1,955	4,749	3,324	1,483	58,064	5,683	0	0	5,683	109,580	4.3	3.0
2003	70,346	2,465	5,478	3,835	1,532	74,343	8,267	52	0	8,319	131,336	5.1	3.6
2004	72,259	2,573	6,235	4,365	1,558	76,390	10,850	52	484	11,386	145,305	5.7	4.0
2005	76,014	2,960	7,197	5,038	1,586	80,560	18,600	2,047	1,683	22,330	165,358	6.4	4.6

The energy supply from hydropower, wind energy and solar energy is subject to natural fluctuations, which may have both a short-term and seasonal effect, and which may also affect the entire annual energy yield.

Renewable energy sources as a share of energy supply

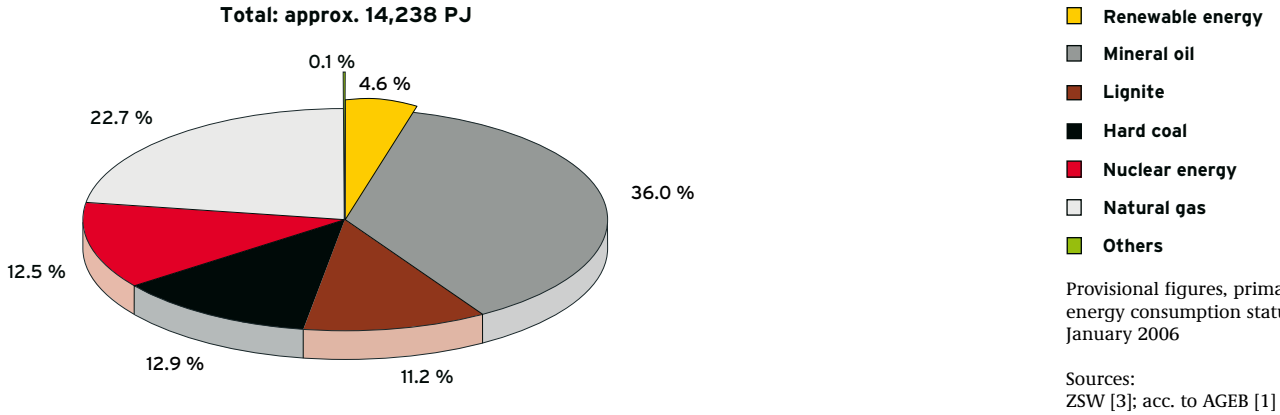
	1998	1999	2000	2001	2002	2003	2004[1]	2005[1]
Final energy consumption (FEC)				[%]				
Electricity generation (in relation to gross electricity consumption)	4.8	5.5	6.3	6.7	7.8	8.1	9.5	10.2
Heat supply (in relation to total heat supply)	3.5	3.5	3.9	3.8	3.9	4.9	5.1	5.3
Fuel consumption (based on the fuel consumption in road traffic)	0.2	0.2	0.4	0.6	0.9	1.4	1.9	3.6
RES share of total FEC	**3.1**	**3.3**	**3.8**	**3.8**	**4.3**	**5.1**	**5.7**	**6.4**
Primary energy consumption (PEC)								
Electricity generation (in relation to total PEC)	0.8	0.9	1.1	1.1	1.4	1.6	1.8	2.0
Heat supply (in relation to total PEC)	1.3	1.3	1.4	1.4	1.5	1.9	1.9	2.0
Fuel consumption (in relation to total PEC)	0.03	0.03	0.06	0.1	0.1	0.2	0.3	0.6
Share of total PEC[2]	**2.2**	**2.3**	**2.6**	**2.7**	**3.0**	**3.6**	**4.0**	**4.6**

RES
renewable energy sources

1) Reference year for heat 2003
2) According to physical energy content method, see Appendix, No. 4

Sources:
acc. to previous tables;
acc. to VDEW [17];
acc. to AGEB [18], [1];
BMELV [15]; BMVBW [68];
DIW [11]; FNR [7]; ZSW [3]

Structure of primary energy consumption, 2005



Provisional figures, primary energy consumption status January 2006

Sources:
ZSW [3]; acc. to AGEB [1]

Fossil fuels saved via the use of renewable energy sources, 2005

	Lignite	Hard coal	Natural gas	Heavy oil / light fuel oil	Diesel fuel	Petrol fuel	Total
	Primary energy [TWh]						
Electricity	88.1	67.9	10.7	-	-	-	**166.7**
Heat[1]	1.7	0.4	45.9	37.1	-	-	**85.2**
Fuel	-	-	-	-	25.5	1.2	**26.7**
Total	**89.8**	**68.3**	**56.6**	**37.1**	**25.5**	**1.2**	**278.6**
	Primary energy [PJ]						
Total	**323.3**	**245.9**	**203.8**	**133.7**	**91.7**	**4.4**	**1,002.8**
that equals	**35.9 mill. t**	**8.5 mill. t**	**6,029 bn m³**	**3,733 mill. litre**	**2,562 mill. litre**	**137 mill. litre**	

For the calculation of economisation of fossil fuels, cf. also Appendix, No. 6.

1) The substitution of electrical heaters not included here.

Sources:
ZSW [3]; IZES [22];
Öko-Institut [24];
acc. to ISI [41]

Emissions avoided via the use of renewable energy sources, 2005

Electricity generation from hydropower, wind power, biomass, solar energy and geothermal energy: 62,468 GWh

Emissions arising from electricity generation from biomass included here. Biomass is CO_2 neutral.

1) Other greenhouse gases (SF_6, PFC, HFC) are not included
2) Other air pollutants with acidification potential (NH_3, HCl, HF) not included here
3) Precursor substance for ground-level ozone

For calculation of the emission factors and avoided emissions, see Appendix, No. 1.

Sources:
ZSW [3]; IZES [22]; ISI [41]; Öko-Institut [24]

Greenhouse gas/ air pollutant		Emission factor [kg/GWh]	Avoided emissions [1,000 t]
Greenhouse effect[1]	CO_2	929,147	58,042
	CH_4	12.3	0.8
	N_2O	32.1	2.0
	CO_2 equivalent	938,942	58,654
Acidification[2]	SO_2	510.8	31.9
	NO_x	568.8	35.5
	SO_2 equivalent	907.3	56.7
Ozone[3]	CO	282.6	17.7
	NMVOC	12.0	0.7
	Dust	27.6	1.7

Heat supply from biomass, solar thermal energy and geothermal energy: 80,560 GWh

1) In relation to final energy, only space heating plus central hot water supply to private households; heat supply mix excluding renewable energy sources, 2003
2) Other greenhouse gases (SF_6, PFC, HFC) not included
3) Other air pollutants with acidification potential (NH_3, HCl, HF) not included here
4) Precursor substance for ground-level ozone

For the calculation of the emission factors and avoided emissions, cf. Appendix, No. 2.

Sources:
ZSW [3]; Gemis, Öko-Institut [14]; Stat. Bundesamt [44]; VDEW [17]

Greenhouse gas/ air pollutant		Emission factor[1] [kg/GWh]	Avoided emissions [1,000 t]
Greenhouse effect[2]	CO_2	228,555	18,412
	CH_4	8.3	0.7
	N_2O	1.9	0.2
	CO_2 equivalent	229,308	18,473
Acidification[3]	SO_2	140.8	11.3
	NO_x	88.3	7.1
	SO_2 equivalent	203.6	16.4
Ozone[4]	CO	297.0	23.9
	NMVOC	11.6	0.9
	Dust	2.9	0.2

Combusted biomass is CO_2-neutral due to the fact that it emits into the atmosphere the same quantity of CO_2 as was absorbed during its growth.

Other greenhouse gases (methane, nitrous oxide) as well as further air pollutants (especially carbon monoxide and dust) arising during the combustion of biomass are disregarded here because their valuation, including the preliminary process chains, is currently being updated in the framework of a research project for the Working Group on Renewable Energies/ Statistics.

In the case of older combustion plants or when wood is burned in tile stoves or fireplaces these pollutants are significantly higher than in the fossil heat supply mix. However, modern wood-fired systems (heaters and heating plants) may substantially reduce emissions.

Biofuels: 22,330 GWh (1,800,000 t biodiesel, 196,000 t vegetable oil, 226,000 t bioethanol)

Today, the predominant use of the biofuel biodiesel is not classed as CO_2-neutral, because amongst other things methanol of fossil origin is used in its manufacture. However, this can be at least partially compensated through appropriate use of the by-products of biodiesel production, glycerine and rapeseed waste.

Laughing gas (N_2O) emissions are responsible for the existing differences in the emission factors of CO_2 and CO_2 equivalent that arise mainly from the fertilisation of plants. For the CO_2 equivalent emission factor given in the table, it is assumed that approximately 80 % of the equivalent climate gas emissions of fossil fuels are currently avoided through the use of biofuels.

Greenhouse gas/ air pollutant		Emission factor [kg/GWh]	Avoided emissions [1,000 t]
Greenhouse effect[1]	CO_2	338,055	7,549
	CH_4	260.2	5.8
	N_2O	-382.0	-8.5
	CO_2 equivalent	230,970	5,157
Acidification[2]	SO_2	609.2	13.6
	NO_x	128.9	2.9
	SO_2 equivalent	-287.1	-6.4
Ozone[3]	CO	50.6	1.1
	NMVOC	91.1	2.0
	Dust	3.6	0.1

Emission factors incl. pre-stages and biodiesel comprising credits for byproducts (colza cake, glycerine) in the pre-stages. In terms of emissions, vegetable oil is equated with rape seed oil.

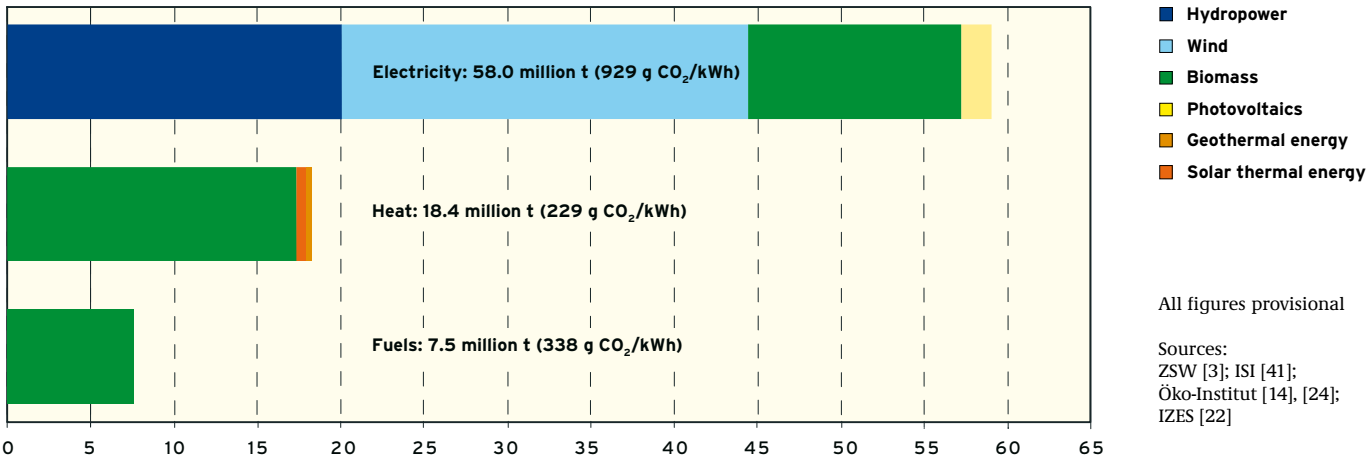
1) Other greenhouse gases (SF_6, PFC, HFC) not included
2) Other air pollutants with acidification potential (NH_3, HCl, HF) are not declared here, however they are contained in the calculation of the SO_2 equivalent
3) Precursor substance for ground-level ozone

Sources:
ZSW [3];
Öko-Institut [24]

Along with the SO_2 and NO_x emissions described here, other acidifying pollutant emissions are also included in the calculation of the SO_2 equivalents, above all ammonia (NH_3). The balance of biogenic fuels is less favourable here than for fossil fuels due to the NH_3 emissions arising during the plant cultivation, so that excess emissions (negative reduction factor) result from the acidification.

In the future, improved methods of energy plant cultivation, crop rotation and cropping systems will be applied to allow excess emissions to be avoided in the medium term.

Total CO_2 reduction through the use of renewable energy sources



All figures provisional

Sources:
ZSW [3]; ISI [41];
Öko-Institut [14], [24];
IZES [22]

The contribution of renewable energy sources to climate protection is clearly larger than to the energy supply. In 2005, around 84 million tonnes of CO_2 were avoided through the use of renewable energies. That means without their use total CO_2 emissions (approx. 786 million tonnes) would be around 10.7 % higher. In contrast, the contribution of renewables to primary energy consumption accounts for only 4.6 %.

Development of energy-related emissions, 1990 to 2005

Status March 2006; figures including diffuse emissions in the generation, conversion and distribution of fuels.

1) Includes CO_2, CH_4 and N_2O
2) Calculated as NO_2
3) Includes SO_2, NO_X and NH_3
4) Calculation/estimate DIW

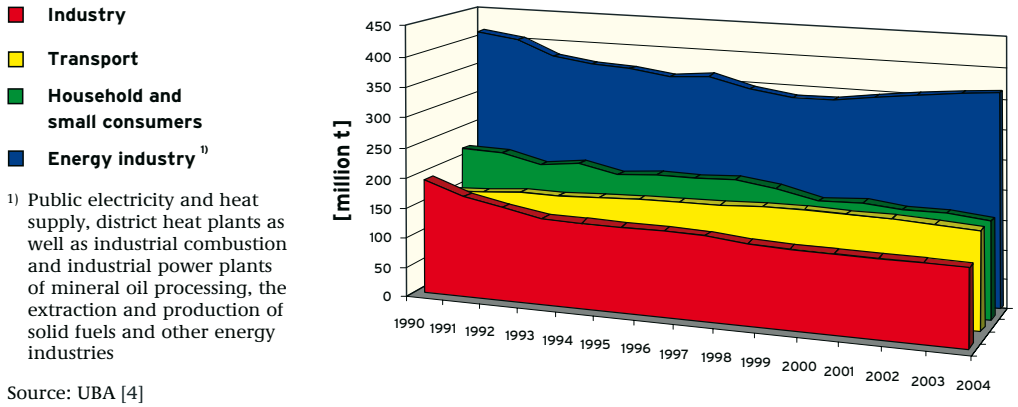
For the significance and calculation of CO_2 and SO_2 equivalents, see Appendix, No. 3.

The Federal Environmental Agency undertook a retrospective methodological change in the calculation of CO_2 emissions. Due to new research findings, emission factors were updated and the separation in process and energy-related emissions were brought into line with the data of emissions trading. Therefore, the figures differ from those of previous years.

Sources:
UBA [4]; DIW [40]; ZSW [3]

	CO_2	CH_4	N_2O	CO_2 equivalent[1]	SO_2	NO_X[2]	NH_3	SO_2 equivalent[3]	CO	NMVOC	Dust
	[million t]	[1,000 t]	[1,000 t]	[million t]	[1,000 t]	[1,000 t]	[1,000 t]	[1,000 t]	[1,000 t]	[1,000 t]	[1,000 t]
1990	946	1,513	25	985	5,231	2,727	15	7,185	11,413	2,174	2,364
1991	916	1,425	24	953	3,835	2,513	16	5,646	9,252	1,684	740
1992	872	1,288	24	906	3,144	2,366	17	4,855	7,971	1,462	427
1993	864	1,325	23	899	2,785	2,263	18	4,429	7,215	1,209	276
1994	844	1,199	23	877	2,326	2,124	19	3,874	6,263	937	188
1995	840	1,141	23	871	1,641	2,027	18	3,121	5,785	832	154
1996	867	1,125	23	898	1,361	1,945	19	2,788	5,512	745	146
1997	833	1,117	22	863	1,130	1,874	20	2,509	5,426	683	142
1998	826	1,011	22	854	887	1,837	20	2,241	5,061	619	130
1999	804	1,062	22	833	709	1,811	20	2,045	4,726	549	127
2000	803	995	22	831	563	1,749	20	1,855	4,386	465	123
2001	821	941	22	847	564	1,661	20	1,795	4,110	434	120
2002	808	931	21	834	528	1,575	19	1,698	3,849	394	117
2003	814	888	22	839	530	1,506	19	1,649	3,730	362	115
2004	805	771	21	828	505	1,457	18	1,588	3,515	339	114
[4] 2005	786	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Development of energy-related CO_2 emissions, 1990 to 2004

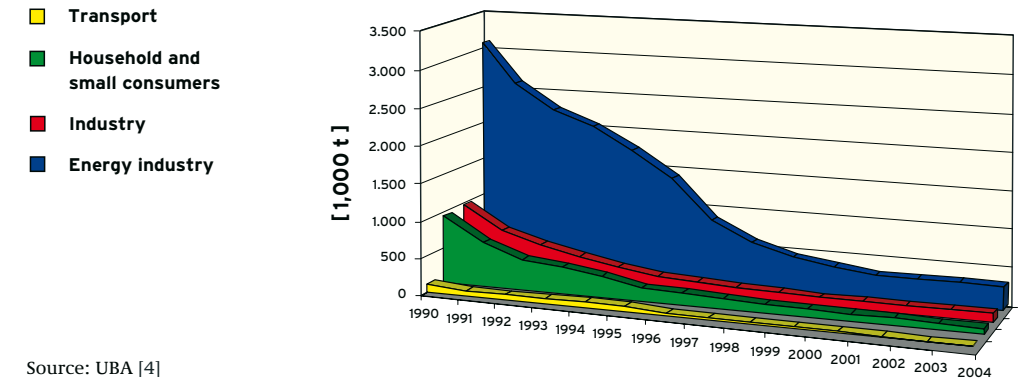


1) Public electricity and heat supply, district heat plants as well as industrial combustion and industrial power plants of mineral oil processing, the extraction and production of solid fuels and other energy industries

Source: UBA [4]

Between 1990 and 2005, energy-related CO_2 emissions were cut by around 15 %; total energy-related greenhouse gas emissions were cut by around 16 % up to the year 2004.

Development of energy-related SO_2 emissions, 1990 to 2004



Source: UBA [4]

Energy-related emissions of sulphur dioxide were reduced by around 90 % between 1990 and 2004.

Energy-related emissions according to source groups, 2004

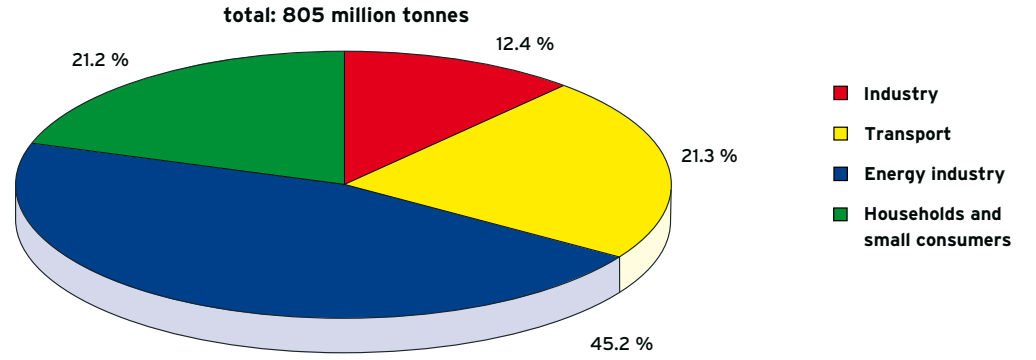
		Energy industry [1]	Households and small consumers [2]	Transport [3]	Industry [4]	Total [5]	Savings from RE [6] (2005)
CO_2	[million t]	363.8	170.7	171.2	99.5	805.2	84.0
CH_4	[1,000 t]	6.0	30.7	10.0	5.7	52.6	7.2
N_2O	[1,000 t]	12.6	1.7	4.4	2.8	21.4	-6.4
CO_2 equivalent [7]	[million t]	367.7	171.9	172.7	100.4	812.7	82.3
SO_2	[1,000 t]	316.7	77.6	1.5	91.4	487.2	56.9
NO_X [8]	[1,000 t]	276.1	188.5	846.8	145.9	1,457.3	45.5
SO_2 equivalent [9]	[1,000 t]	519.6	220.7	632.6	197.5	1,507.4	66.6
CO	[1,000 t]	134.4	1,001.9	1,750.0	619.7	3,506.1	42.7
NMVOC	[1,000 t]	8.6	87.2	185.0	6.0	286.8	3.7
Dust	[1,000 t]	12.6	33.8	61.0	2.5	109.9	2.0

Status beginning of 2006

1) Public electricity and heat supply, district heating stations as well as industrial combustion and industrial power stations for mineral oil processing, extraction and production of solid fuels and other energy industries
2) Private households, trade, commerce, services and military, additionally agricultural and forestry transportation as well as military ground and air transport
3) Including rail traffic, national aviation, coastal and inland shipping
4) Manufacturing industry; exclusive process-related emissions
5) Figures without diffused emissions during the extraction, conversion and distribution of fuels
6) Electricity and heat generation as well as fuels from renewable energy sources
7) Includes CO_2, CH_4 and N_2O
8) Calculated as NO_2
9) Includes SO_2, NO_X and NH_3 (NH_3 is not illustrated here), for the saving through renewable energy sources see notes on the previous pages, emissions through heat supply from biomass not included.

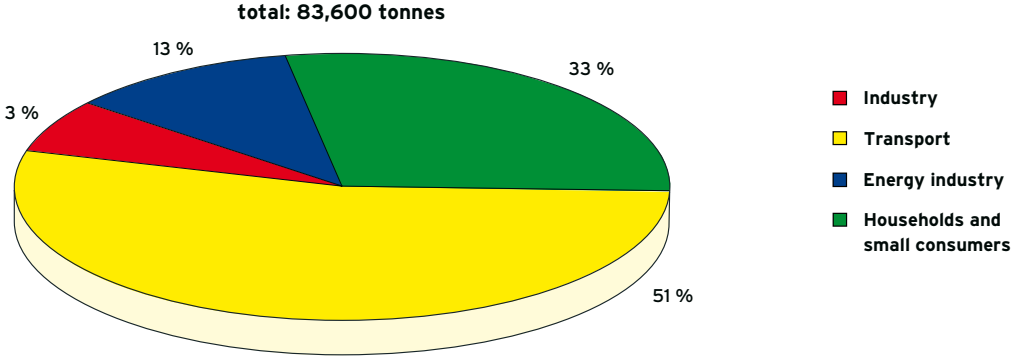
Sources:
UBA [4]; ZSW [3]

Source group shares of energy-related CO_2 emissions, 2004



Source: UBA [4]

Source group shares of energy-related particulate matter emissions, 2004



Only the emissions of particulate matter for sizes up to 10 microns (PM_{10}) are given, as specified by the European Particulate Matter Directive (1999/30/EC) in force since 1 January 2005.

Source: UBA [4]

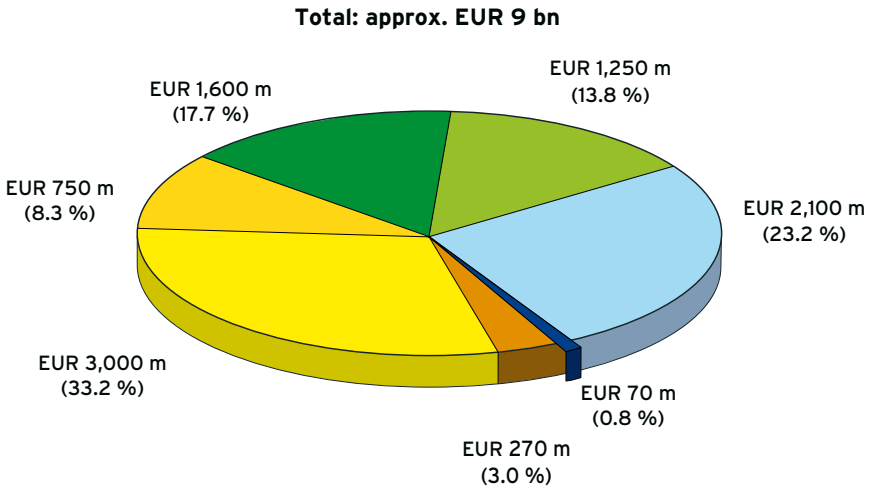
Turnover from the construction of plants for the use of renewable energy sources, 2005

- Wind
- Hydropower
- Geothermal energy[1)]
- Photovoltaics
- Solar thermal energy
- Biomass electricity
- Biogenic heat

Estimate

1) Large installations and heat pumps

Source: ZSW [3]



This primarily concerns the construction of new plants and to a small extent the expansion or upgrading of existing plants, such as the reactivation of old hydropower plants.

Turnover from the operation of plants for the use of renewable energy sources, 2005

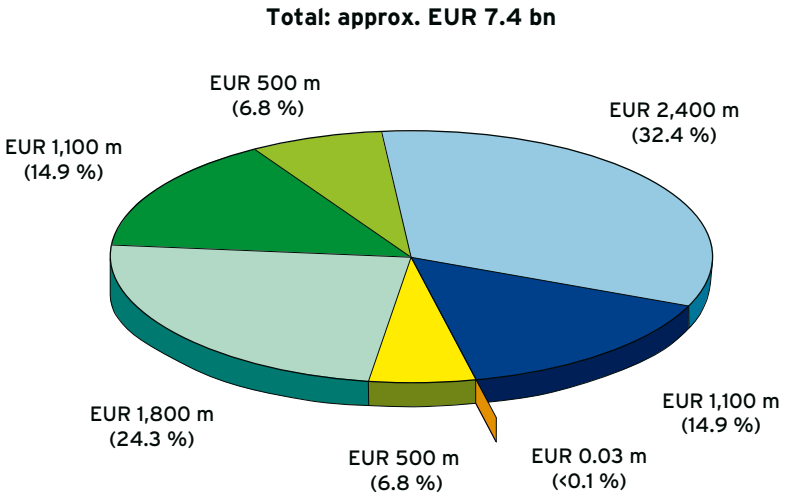
- Wind
- Hydropower
- Geothermal energy
- Photovoltaics
- Biofuels
- Biomass electricity
- Biogenic solid fuels[1)]

Estimate

1) Only fuels used exclusively for the supply of heat

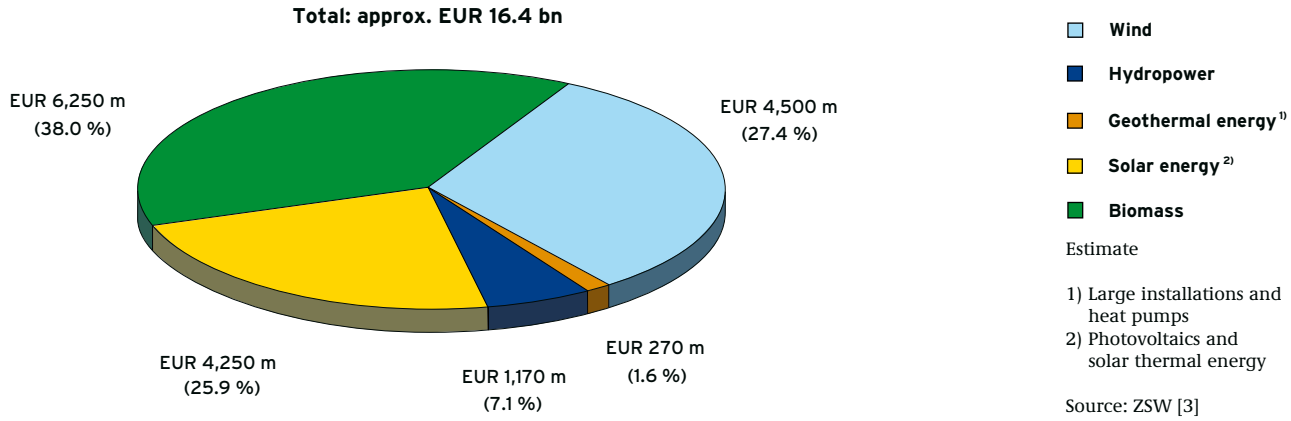
For explanatory comments cf. Appendix, No. 7.

Source: ZSW [3]



In the case of electricity generation, turnover is generated from the feed-in fees payable under the Renewable Energy Sources Act or from the price attainable on the open electricity market, and in the case of fuel, from the sale of biofuels. For heat generation, turnover only refers to the sale of fuels, i.e. as a rule wood, since in the majority of cases the heat produced is not sold, but used internally.

Total turnover with renewable energy sources, 2005



Estimate

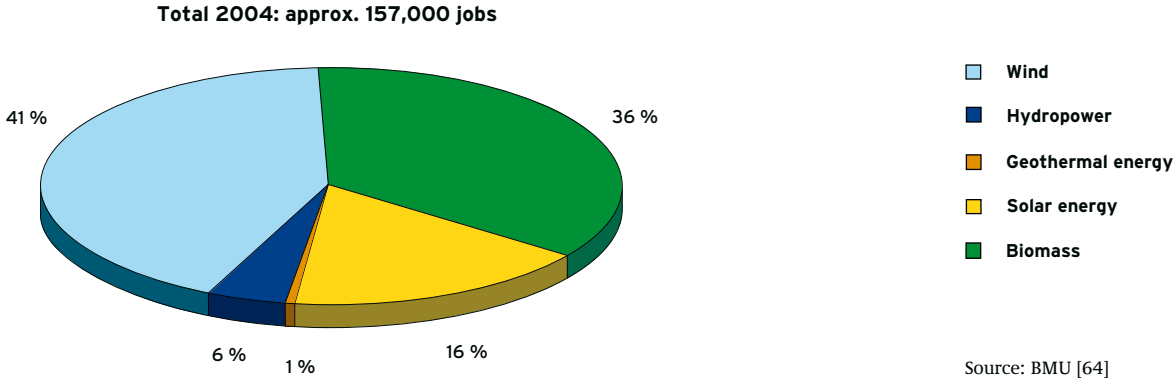
1) Large installations and heat pumps
2) Photovoltaics and solar thermal energy

Source: ZSW [3]

Employment effects from the use of renewable energy sources

Renewable energies are a job creator for Germany. Their continuous expansion in Germany has led to a noticeable growth in employment.

In **2004**, 157,000 jobs could be assigned to the renewables sector. The branch with the largest employment is still wind power (64,000 jobs). This is followed by the biomass branch (57,000 jobs) – including the employment effects created by the demand for biogenic fuels and biofuels – and the solar industry (25,000 jobs), which have both recently grown faster than the wind power branch in view of the activated employment impetus. Hydropower and geothermal energy are responsible for approximately 11,000 jobs. These figures are based on an ongoing BMU research project which conducted a broad survey of companies in summer 2005 to indicate the flow of goods and services in the various branches of the renewable energies sector.



Source: BMU [64]

Due to the broad empirical database, the results only have limited comparability to previous employment figures of renewable energy sources.

In **2005**, the employment effect can be estimated at approximately 170,000. That equals a rise of almost 10 % compared to 2004.

Support programmes for renewable energy sources

The Federal Government supports renewable energies through research and development as well as various measures for market development. The main impact on the electricity market has been from the Renewable Energy Sources Act, while biofuels for the transportation sector profit from the mineral oil tax exemption under the eco-tax reform. In future the market launch of biofuels will be supported with a compulsory blending regulation. The Market Incentive Programme for the support of measures for the utilisation of renewable energy sources, which is also financed through the eco-tax reform, serves primarily for the expansion of heat generation from biomass, solar power and geothermal energy. In 2005 around 193 million euros were allocated to this.
Smaller installations of private investors are supported with grants, larger installations with loans at a reduced rate of interest and partial debt acquittal. Details of the support are stated in the support guidelines.
In the residential sector the main focus is especially on the promotion of solar thermal collector systems and biomass heaters (pellet systems and wood gasification boilers). Furthermore, biogas plants (limited until the end of 2006) as well as plants for the utilisation of solid biomass and geothermal energy are supported, in part with district heating systems. In the course of the programme, the support guidelines were repeatedly adjusted to market development.

As of March 2006, new support guidelines apply to the Market Incentive Programme (guidelines of 14 March 2006). The increases in prices for fossil energy generation led to the clear decrease of the additional costs of renewables. Therefore it was possible to lower the grants for solar facilities, pellet and wood gasification boilers by 20 % in comparison to the 2005 guidelines without affecting the attractiveness of the support programme. The new rates allow the support of considerably more facilities than in previous years and a corresponding market growth. In future too, market developments will be quickly met with new guidelines to assure the efficient use of the federal budgetary funds.

In the building sector, the Reconstruction Loan Corporation (KfW) has attractive financing programmes. These also include the use of renewable energy sources and the conversion of heating systems. Furthermore, investment credits are granted for photovoltaic systems (“solar power generation”), for the new construction of energy-saving houses (“ecological construction”) and for modernisation measures in the housing inventory (“housing modernisation”) (further information under: www.kfw-foerderbank.de).

Information on the grants under the Market Incentive Programme is issued by the Federal Office of Economics and Export Control (BAFA), phone: +49 (0)6196 908-625 (www.bafa.de).

Questions on the granting of low-cost loans for commercial or municipal applicants are answered by the Reconstruction Loan Corporation (KfW) information centre, phone: +49 (0)1801 335577 (www.kfw-foerderbank.de). In addition, whoever wishes to access comprehensive energy consultation for older residential buildings will receive a grant for the cost of the advice (programme “local consultations to save energy” www.bafa.de).

Support at federal level is supplemented by numerous measures in different federal states and local authorities. The nationwide campaign “climate seeks protection” provides on overview at www.klimasuchtschutz.de, where information regarding energy saving in the household can also be found.

In cooperation with the BINE information service (www.bine.info) the Federal Environment Ministry has published an extensive brochure about all support possibilities at EU, national, state and local level as well as those of energy supply companies (www.bmu.de/klimaschutz/).

A comprehensive database on support is provided by the Federal Ministry of Economics and Technology (http://db.bmwi.de).

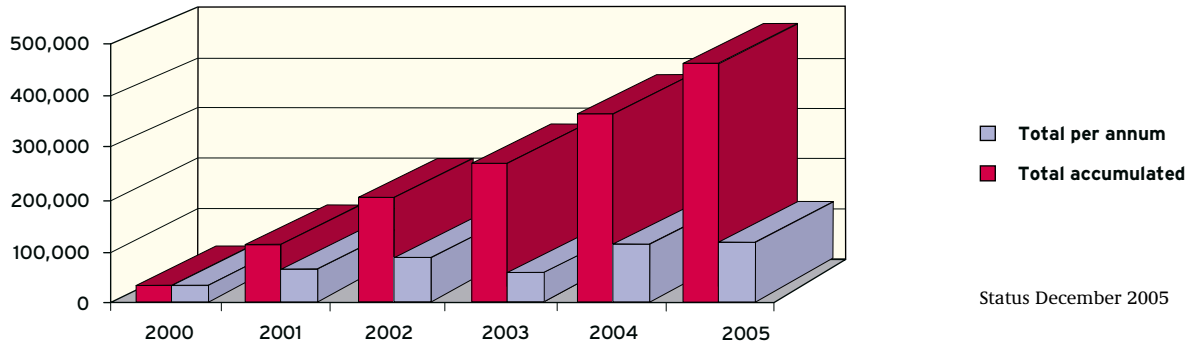
The Market Incentive Programme

The Market Incentive Programme for the promotion of measures for the utilisation of renewable energies, which is financed through the ecological tax reform, supports the construction of plants for generating heat and/or electricity from renewable energy sources. The programme for the market launch of heat generating technologies is particularly important. From the beginning of the programme up to the end of 2005, over 421,500 solar collectors with an area of 3.6 million square metres and over 60,000 small biomass boilers were installed.

The Reconstruction Loan Corporation (KfW Kreditanstalt für Wiederaufbau) grants supplementary loans for biogas plants, larger plants for the incineration of solid biomass and plants for the utilisation of geothermal energy. Between 2000 and 2005 2,567 loans amounting to 741 million euros were approved. Since the beginning of the programme more than 485,000 investment projects for the use of renewable energies have been promoted by the Market Incentive Programme.

Since the beginning of the programme in the year 2000, funds amounting to 665.4 million euros have triggered an investment volume of almost 5 billion euros, of which approximately 3.2 billion euros were used for solar collectors and 0.96 billion euros for small biomass facilities. In 2005, approximately one third of the calculatory revenue from the taxation of electricity from renewables, amounting to 659 million euros, went into the Federal Market Incentive Programme. As from March 2006, new support guidelines apply to the Market Incentive Programme (see page 20).

Number of installations supported with investment grants



Status December 2005

Biofuels

Since 1 January 2004, also biogenic blend fractions of e.g. biodiesel, bioethanol or bio-ETBE in fossil fuels are exempt from the mineral oil tax in Germany, alongside the already exempt biogenic undiluted fuels.
Directly after this the petroleum industry began adding biodiesel to fossil diesel fuel in noticeable amounts up to the permitted maximum of 5 %. In 2005 the share of biogenic fuels in the fuel supply was approx. 3.6 % and increased considerably compared to the previous year's figure. Worldwide Germany is the largest biodiesel producer. Plant capacity for the production of biodiesel increased tenfold in the last 10 years. Compared with biodiesel the significance of bioethanol and vegetable oil as a fuel was still low last year.

In the long term, development will move towards second generation biofuels. Second generation biofuels are to be understood as fuels that can access a wider raw material basis thus noticeably increasing the potential of biofuels compared to today. Furthermore, a wider raw material basis leads to a considerably better CO_2 balance than is possible for biofuels of the first generation.

BTL (Biomass-to-liquid) and bioethanol that is obtained by enzymatical decomposition of cellulose belong to the second generation of biofuels.

Research and development for renewable energies technology

Research and development projects for the use of renewable energy sources can be promoted through the Energy Research Programme of the Federal Government. The necessary cost-cutting and the degression of the payment rates for renewable electricity as defined in the EEG have to be achieved, i.a. through technical innovation.
The support of research is also significant with regard to job market policy. Companies based in Germany directly benefit from this and in turn so does employment security.

Main focus of research support

Goals and main focus of research support are

- lowering costs for renewable energy systems,
- ecologically sound and nature-friendly further development,
- integration into the electricity grid and
- quick technology transfer from research to the market.

In 2005, 102 new projects with a total volume of over 98 million euros were approved in the fields of photovoltaics, wind, geothermal, low temperature solar thermal energy, solar thermal power stations as well as overall strategy and overarching issues.

The main areas of research support lie in photovoltaics and wind energy. In photovoltaics research and development activities are required because the EEG fees show the highest degression and corresponding cost reductions have to be achieved. Moreover the largest innovation potential exists here. Ultimately it is a matter of securing the international leading position of German photovoltaics research and improving the competitiveness of German companies on a rapidly growing global market.

The high significance of wind energy research arises from the major technical challenge especially in the offshore sector and the research need as regards the environmentally sound development of the potential. At the same time, the integration of wind power into the grid plays a deciding role.

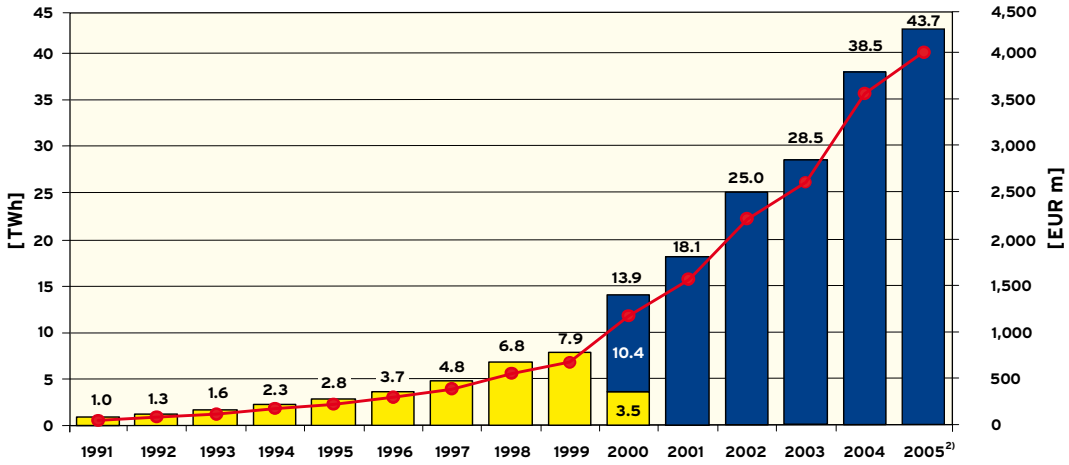
In other fields research support is also being carried forward on a high level. To achieve the ambitious expansion goals of the Federal Government, all renewable energy sources are needed. For geothermal energy the emphasis is on demonstrating the economic feasibility of geothermal electricity generation in various geological formations – the Upper Rhine Graben, the South German Molasse Basin and the North German Basin. An overview of the ongoing research projects can be found under www.erneuerbare-energien.de/inhalt/36049/.

Approved, ongoing and completed projects 2005

	newly approved projects		current projects		completed projects	
	[number]	[1,000 EUR]	[number]	[1,000 EUR]	[number]	[1,000 EUR]
Photovoltaics	21	32,277	115	119,912	38	30,311
Wind	24	22,649	226 [1)]	74,711	130 [2)]	34,725
Geothermal energy	11	18,027	31	41,982	7	12,454
Low temperature solar thermal energy	12	3,903	42	21,629	4	1,896
Solar thermal electricity generation	20	7,531	46	17,961	10	2,028
Cross-sectoral research and other	14	13,632	21	17,268	3	9,019
Total	**102**	**98,019**	**481**	**293,463**	**192**	**90,433**

1) Of these 169 individual schemes within the scope of the 250 MW wind energy programme
2) Of these 122 individual schemes within the scope of the 250 MW wind energy programme

Feed-in and fees under the Electricity Feed Act and the Renewable Energy Sources Act (EEG)



2004 for first time fee taking into consideration the avoided grid usage fee

1) Private and public feed-in
2) Estimation

Sources:
VDEW [55]; VDN [9]; ZSW [3]

On 1 April 2000, the Electricity Feed Act was replaced by the Renewable Energy Sources Act (EEG), with improved fees. Around two-thirds of the total electricity subject to the fixed rates is currently attributable to electricity from wind power and only 2 % to electricity from photovoltaics. In 2004 for the first time, fees were paid under the EEG for geothermal electricity, following commencement of operations of the first geothermal electricity generating plant in Germany. About 80 % of electricity from hydropower derives from older plants with more than 5 MW capacities. This electricity is not covered by the fees under the EEG.

The contribution of private generators to the electricity supply through renewable energies is very high. According to the VDEW [21], about 37 TWh of electricity were provided in 2005.

Structure of electricity volumes paid for under the EEG

			2000 1)	2001	2002	2003	2004	2005 2)
Total end consumption		**[GWh]**	**344,663**	**464,286**	**465,346**	**478,016**	**487,627**	**483,886**
Privileged end consumption 3)		[GWh]	-	-	-	6,552	36,865	60,633
EEG electricity quantity	**Total**	**[GWh]**	**10,391**	**18,145**	**24,970**	**28,496**	**38,511**	**43,690**
	Hydropower, gases	[GWh]	-	6,088	6,579	5,874	7,205	7,711
	Gases 5)	[GWh]						147
	Biomass	[GWh]	-	1,472	2,442	3,469	5,241	8,330
	Geothermal en.	[GWh]	-	-	-	-	0.2	0.2
	Wind energy	[GWh]	-	10,509	15,786	18,859	25,509	26,500
	Solar irradiation energy	[GWh]	-	76	162	294	557	1,002
EEG quota 4)		**[%]**	**3.01**	**3.91**	**5.37**	**6.03**	**8.48**	**10.0**
Average fee		**[ct/kWh]**	**8.50**	**8.69**	**8.91**	**9.14**	**9.29**	**9.58**
Total fee		**[bill. EUR]**	**0.88**	**1.58**	**2.22**	**2.60**	**3.61**	**4.19**

1) Body of the year: 01.04. - 31.12.2000
2) Figures 2005 adjusted on the basis of the VDN prognosis from 04.11.2005 particularly as a result of lower electricity production of wind power in 2005 (estimated 26,500 GWh instead of 29,593 GWh) and an upper electricity production of biomass paid for under the EEG (estimated 8,330 GWh instead of 6,993 GWh). Final values with certificate of a chartered accountant will presumably be available in October 2006. The figures of the previous years correspond with the year statements (certificates of the chartered accountant)
3) Due to the equalisation provision (Art. 16 EEG) privileged end consumption (since July 2003)
4) Quota for not privileged end consumption
5) Landfill, sewage and pit gas first mentioned in 2005, only for additional generation

Sources:
acc. to VDN [9]; ZSW [3]

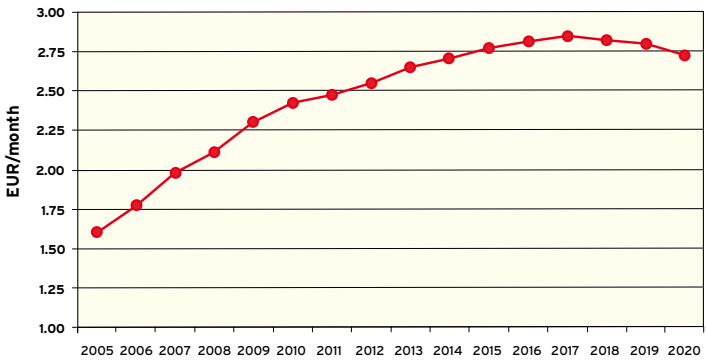
Costs for the electricity consumer

Today, electricity from renewable energy sources is still more expensive than that from conventional energy sources[1]. Its average additional costs (EEG apportionment) per kilowatt hour electricity are calculated as follows:

EEG apportionment = EEG quota x (EEG average fee - avoided energy purchase price)

The EEG average fee and the EEG quota are being published by the Association of German network operators (VDN) firstly as prognoses and will be finalised by 31 October of the following year in the annual statement. The avoided electricity purchase price that is due to the EEG feed-in has to be approximately determined because as yet no solid database exists. The published figures concerning the level of the EEG apportionment at times diverge clearly from each other because different assumptions are made.
In a research project of the BMU concerning the expansion of renewable energy sources until 2020 [6], the value of the avoided electricity purchase price is set e.g. for 2005 at 4.3 cents per kWh. With a provisional EEG quota of 10 % (for not privileged end users according to Art. 16 EEG) and a provisional average fee of 9.58 cents per kWh, the EEG apportionment provisionally amounts to approximately 0.53 cents per kWh[2].

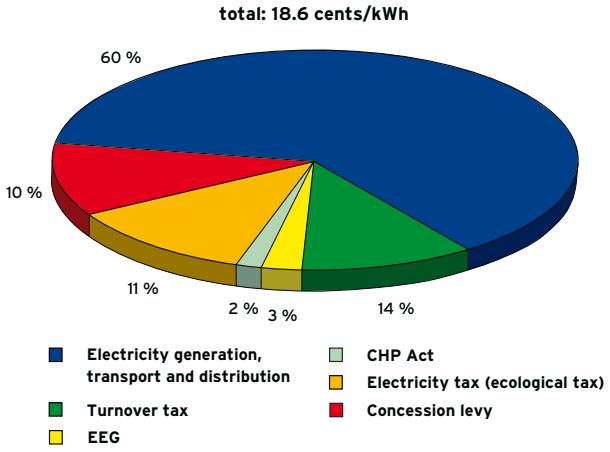
Expected development of monthly EEG apportionment of an average household



Average household: annual consumption of 3,500 kWh/a

Source: BMU [43]

Composition of the electricity price in the household sector, 2005



Average electricity price of a 3-person household with an annual consumption of 3,500 kWh/a in Cent/kWh
CHP Act Combined Heat and Power Act

Source: BMU [43]

With a provisional EEG electricity amount of approximately 43.7 TWh, the EEG causes additional costs of approximately 2.3 billion euros – noticeably less than the EEG fees of 4.2 billion euros paid to operators of EEG electricity generation plants. Therefore, the EEG only has a share of approximately 3 % of the costs for a kilowatt hour of household electricity in 2005 (on average 18.6 cents/kWh). Despite the further increasing feed-in of electricity from renewable energy sources, the share will not rise significantly in the future. For a household with 3,500 kWh of electricity consumption per year the EEG causes additional costs of approximately 1.55 euros per month. With a continuing vigorous expansion of renewable energies, these EEG related costs will peak at approximately 2.80 euros in the middle of the next decade and then fall again [6].

1) A detailed description of the costs of renewable energy sources is given in the BMU publication “What electricity really costs”.
2) If the avoided electricity purchase price were set to only 3.3 cents/kWh, the EEG apportionment would rise to approximately 0.63 cents/kWh.

Macroeconomic external costs

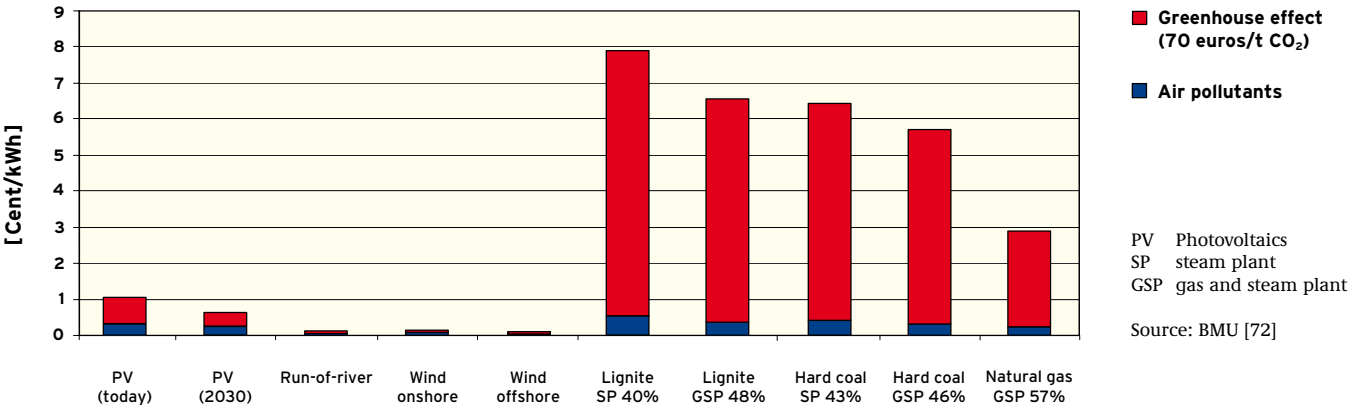
The costs of the EEG that were derived from the figures of the previous page are not sufficient for a comprehensive economic evaluation of renewable energy sources. As microeconomic dimensions, they do not reflect the fact that conventional electricity generation still causes significantly more environmental damage than electricity from renewable energy sources, despite all environmental progress in the last decades. These so-called external costs (negative external effects) are not yet incorporated into the electricity prices as required by the polluter pays principle.

According to a current scientific survey for the BMU [72], greenhouse gas emissions play a key role: the best estimate for the costs of climate damage arising from this can currently be set to 70 euros/t CO_2. In addition, health and material damage caused by air pollutants are important, and, to a lesser extent, agricultural revenue losses. External costs for electricity generation from hard coal and lignite - even taking modern technology into consideration - amount to 6 to 8 cents/kWh. For modern, gas-fired gas and steam plants the external costs are still approximately 3 cents/kWh[1)].

In contrast, electricity generation from renewable energies causes comparatively minor external costs (generally under 0.5 cents/kWh; only photovoltaics at present approximately 1 cent/kWh). The construction and disposal of the plants are included in these calculations[1)].

1) Due to a lack of solid data, further external effects of fossil electricity generation (damage to biodiversity, ecosystems and supply security as well as geopolitical risks) can hardly be quantified. The values mentioned above are only a sub-total of the currently expected actual external costs.

External costs of electricity generation for various options



PV Photovoltaics
SP steam plant
GSP gas and steam plant

Source: BMU [72]

Under the – scientifically proven – assumption that the electricity paid for pursuant to the EEG at present fully displaces fossil generated electricity, the above mentioned survey estimates the external costs avoided in the electricity sector through renewables in 2005 to be at least 2.8 billion euros. This is considerably higher than the EEG expenditure for the promotion of renewables in the same period (according to the survey approximately 2.4 billion euros) and shows that the promotion of renewable energy sources through the EEG is worthwhile due to the avoided external costs alone. Numerous other strategic and economic advantages of renewable energy sources can be added.

Long-term utilisation potential of renewable energy sources for electricity, heat supply and fuel production

	Utilisation 2005	Potential Yield	Potential Capacity	Comments
Electricity generation	[TWh]	[TWh/a]	[MW]	
Hydropower [1]	21.5	24	5,200	Run-of-river plants and natural inflow to reservoirs
Wind energy				
onshore	26.5	55	25,000	
offshore	-	110	30,000	
Biomass	13.4	60	10,000	Generation partly in combined heat/power generation
Photovoltaics	1.0	105	115,000 [2]	Only suitable roof, facade and human settlement areas
Geothermal energy	0.0002	200	30,000	Bandwidth 66 - 290 TWh depending on heat utilisation requirements (combined heat/power)
Total	**62.5**	**554**		
Proportion in relation to gross electricity consumption 2005	**10.2 %**	**91 %**		
Heat generation	[TWh]	[TWh/a]		
Biomass	76.0	200		Including useful heat from combined heat/power generation
Geothermal energy	1.6	330		Only energy supply from hydrothermal sources
Solar thermal energy	3.0	290		Only suitable roof and human settlement areas
Total	**80.6**	**820**		
Share in relation to final energy consumption for heat [3] 2003	**5.3 %**	**54 %**		
Fuels	[TWh]	[TWh/a]		
Biomass	22.3	60		
Total	**22.3**	**60**		
Share in relation to fuel consumption of road traffic 2004	**3.6 %**	**10 %**		
Share in relation to final energy consumption 2004	**6.4 %**	**56 %**		

Imports of energy sources on the basis of renewables not included in the figures.

1) excluding ocean energy
2) Figures in relation to modular capacity (MW_p), the corresponding A/C capacity is 106,000 MW
3) Space heating, hot water and other process heat

Sources:
Work group DLR, ifeu, WI [27];
Work group Öko-Institut, FhG-Umsicht, IE, ifeu, izes, TU Berlin, TU Braunschweig, TU München [38]; ZSW [3]

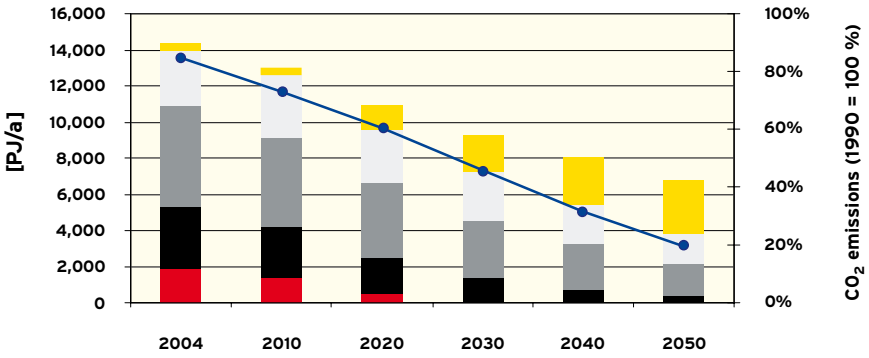
Due to varying assumptions regarding the availability of suitable locations, the technical characteristics of the utilising technologies, combined with a number of other factors, the results of potential estimates may vary considerably.
The guideline values given here make particular allowance for the requirements of nature and landscape conservation, and hence represent the lower limits of the technically feasible potential.

The energetic use of biomass has a high degree of flexibility. Depending on requirements, therefore, the percentages allocated to the segments electricity, heat and fuel supply may vary. This is particularly applicable to the cultivation of energy crops (based here on a cultivation area of 4.2 million hectares).

Scenario for an intensified expansion of renewable energies

The scenario represents the potential development of energy supply up to the year 2050, facilitating an 80 % reduction in CO_2 emissions compared with 1990 figures through the intensified expansion of renewable energies and a more efficient use of energy. It is hoped that by the year 2020, 12 % of primary energy consumption and 30 % of electricity generation can be met from renewable energy sources. By the year 2050, according to the scenario, the share of electricity generation from renewables will increase to 68 %, while the contribution of renewable energies to heat supply will increase to around 50 %.

Development of primary energy consumption and CO_2 emissions up to 2050

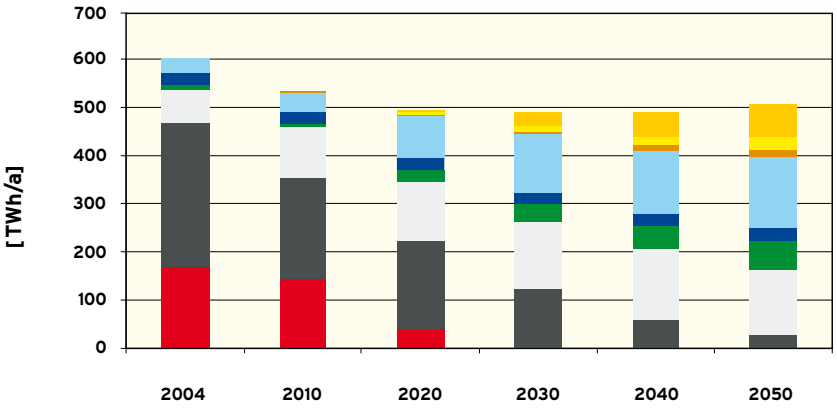


RES, domestic & imported
Natural gas
Mineral oil
Coal
Nuclear energy
CO_2 emissions

RES renewable energy sources

Sources:
DLR, ifeu, WI [27]; AGEB [1]

Development of electricity generation up to 2050



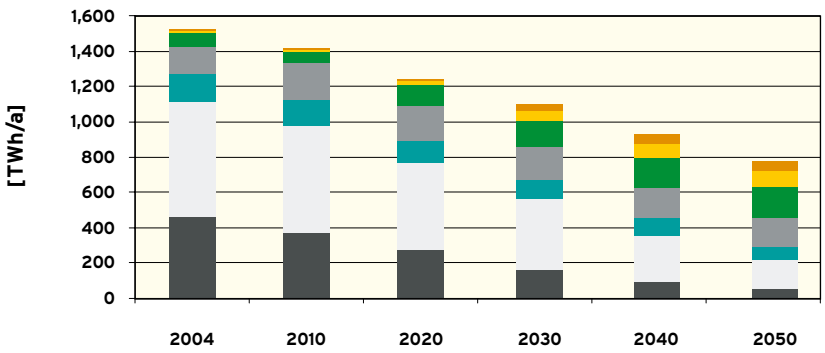
Imported RES
Photovoltaics
Geothermal energy
Wind
Hydropower
Biomass
CHP fossil
Coal/gas
Nuclear energy

From 2030 including the electricity needed for the generation of hydrogen (2050: 70 TWh/a)

CHP Combined heat/ power generation

Sources:
DLR, ifeu, WI [27] ; AGEB [1]

Development of heat supply up to 2050



Geothermal energy
Solar collector
Biomass
District heating
Electricity
Gas
Coal, oil

Sources:
DLR, ifeu, WI [27] ; AGEB [1]

Europe: Share of renewable energy sources in primary energy consumption, 1990 to 2004

The European Parliament and the European Commission already set important goals for the expansion of renewable energy sources in Europe in the past. An example of this is the goal agreed in 1997 to double the contribution of renewables to 12 % by 2010. The main element of the EU directive for promoting renewable energies in the electricity market, which came into effect in 2001, is increasing the share of renewable energy sources in electricity generation from 14 % in 1997 to 22 % in the EU-15 and 21 % in the EU-25 by 2010. The development of renewable energy sources in Europe is illustrated on the following pages, supplemented with a global overview.

Renewable energy sources as a proportion of primary energy consumption in the EU

The data on energy supply and use in Germany contained in European and international statistics may vary from that provided in German sources. Apart from differing data origins, this is also due in part to deviating accounting methods (cf. also Appendix, No. 8).

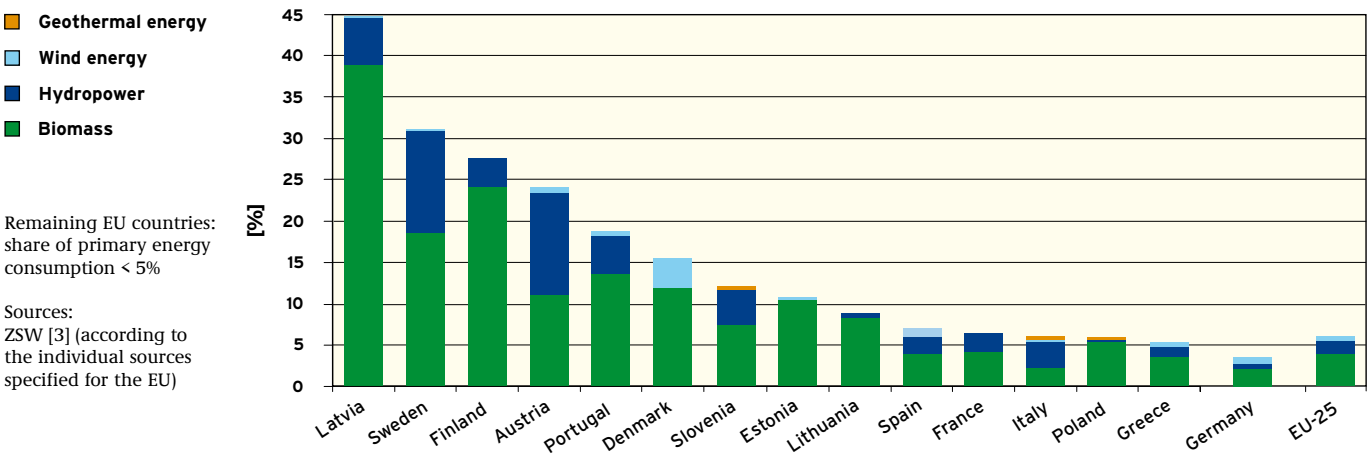
In the following section on Europe, for reasons of consistency, the data for Germany has been taken from the international statistics. As a general rule, however, the detailed data from national sources on the preceding pages is more reliable.

	1990	1995	1996	1997	1998 [%]	1999	2000	2001	2002	2003[1]	2004[1]
Belgium	1.4	1.4	1.3	1.2	1.3	1.3	1.3	1.4	1.6	1.9	2.0
Denmark	6.7	7.6	7.2	8.3	8.7	9.6	10.7	11.1	12.3	13.3	15.6
Germany	1.6	1.9	1.9	2.2	2.4	2.6	2.9	2.8	3.1	3.4	3.5
Finland	19.2	21.3	19.8	20.6	21.8	22.1	24.0	22.7	22.2	21.2	27.7
France	6.9	7.5	7.0	6.8	6.7	6.9	6.8	6.9	6.2	6.4	6.7
Greece	5.0	5.3	5.4	5.2	4.9	5.4	5.0	4.6	4.7	5.1	5.2
United Kingdom	0.5	0.9	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.4	1.4
Ireland	1.6	2.0	1.6	1.6	2.0	1.9	1.8	1.8	1.9	1.7	1.7
Italy	4.2	4.8	5.2	5.3	5.5	5.8	5.2	5.5	5.3	5.9	6.1
Luxembourg	1.3	1.4	1.2	1.4	1.5	1.3	1.6	1.3	1.4	1.4	1.3
Netherlands	1.1	1.2	1.6	1.8	1.9	2.1	2.1	2.1	2.2	2.5	2.6
Austria	20.2	22.0	20.6	21.1	20.8	22.4	22.7	21.8	22.3	20.4	23.4
Portugal	15.9	13.3	16.1	14.7	13.6	11.1	12.9	15.7	14.0	17.0	18.2
Sweden	24.9	26.1	23.6	27.5	28.1	27.8	31.6	28.7	27.0	26.2	31.2
Spain	7.0	5.5	7.0	6.4	6.2	5.2	5.8	6.5	5.6	7.0	6.9
EU-15	**4.8**	**5.3**	**5.2**	**5.5**	**5.6**	**5.6**	**5.8**	**5.9**	**5.8**	**6.1**	**6.4**
Estonia	4.7	9.1	10.4	10.7	9.7	10.4	11.0	10.6	10.5	9.6	11.3
Latvia	21.9	27.4	27.4	31.3	35.0	34.7	34.1	34.3	34.7	33.4	44.8
Lithuania	0.2	0.4	0.3	0.3	6.5	7.9	9.0	8.5	8.0	7.8	8.4
Poland	1.6	4.0	3.6	3.7	4.0	4.0	4.2	4.5	4.6	5.5	5.9
Slovakia	1.5	2.9	2.6	2.5	2.6	2.7	2.9	4.0	3.8	3.3	3.5
Slovenia	4.6	8.9	9.4	7.7	8.2	8.8	11.5	11.4	11.0	10.5	12.0
Czech Republic	0.3	1.5	1.4	1.6	1.6	2.0	1.6	1.8	2.2	2.8	3.6
Hungary	0.1	0.1	0.1	0.1	0.1	1.5	1.7	1.6	3.4	3.4	3.7
Cyprus	0.3	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.9	1.5	1.6
EU-25[2]	**4.4**	**5.0**	**5.0**	**5.2**	**5.4**	**5.5**	**5.6**	**5.8**	**5.7**	**6.0**	**6.3**

1) Provisional
2) In Malta no noteworthy use of renewable energy sources

Sources:
Acc. to Eurostat [34]; EC [47]

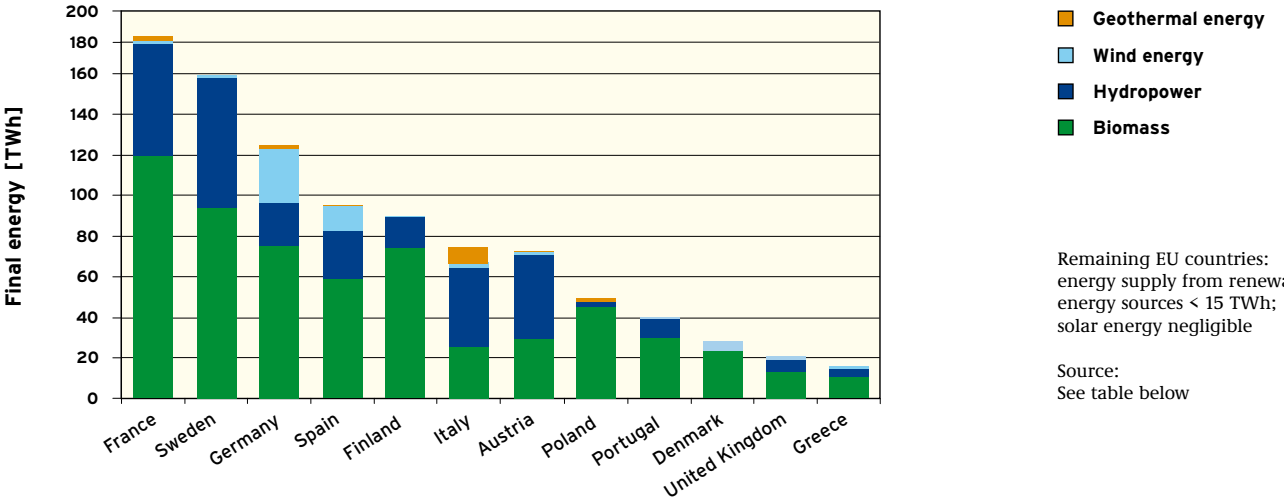
Structure of renewable energy sources as a share of primary energy consumption in selected EU countries, 2004



Remaining EU countries: share of primary energy consumption < 5%

Sources:
ZSW [3] (according to the individual sources specified for the EU)

Use of renewable energy sources in selected EU countries, 2004



Remaining EU countries:
energy supply from renewable energy sources < 15 TWh;
solar energy negligible

Source:
See table below

Use of renewable energy sources in the EU, 2004

	Bio-mass[1]	Hydro-power[2]	Wind energy	Geothermal energy[3]	Total
	Final energy [TWh]				
Belgium	6.4	0.3	0.13	0.01	6.9
Denmark	22.2	0.0	6.61	0.02	28.8
Germany	76.3	20.6	25.00	1.56	123.5
Finland	74.2	14.9	0.12	-	89.3
France	119.9	59.7	0.61	1.53	181.7
Greece	10.7	4.6	1.04	0.01	16.4
United Kingdom	13.4	5.0	1.94	0.01	20.3
Ireland	1.8	0.6	0.66	-	3.1
Italy	22.9	41.3	1.83	7.96	73.9
Luxembourg	0.3	0.1	0.04	-	0.4
Netherlands	5.5	0.1	1.88	-	7.5
Austria	34.6	37.4	1.20	0.23	73.4
Portugal	30.1	9.9	0.78	0.10	40.9
Sweden	94.3	64.2	0.85	-	159.3
Spain	49.6	31.6	14.18	0.09	95.4
EU-15	**562.1**	**290.4**	**56.85**	**11.52**	**920.9**
Estonia	4.8	0.006	0.04	-	4.9
Latvia	11.8	2.1	0.05	-	14.0
Lithuania	6.9	0.3	0.001	-	7.2
Malta	-	-	-	-	-
Poland	45.9	2.1	0.14	1.70	49.8
Slovakia	3.6	4.1	0.004	0.02	7.6
Slovenia	5.1	3.1	-	0.17	8.4
Czech Republic	10.7	2.0	0.01	0.02	12.7
Hungary	9.5	0.2	0.01	0.95	10.7
Cyprus	0.1	-	-	-	0,1
EU-25	**660.5**	**304.3**	**57.10**	**14.39**	**1,044.2[6]**
	Final energy [PJ]				
EU-25	**2,377.9**	**1,095.5**	**205.6**	**51.8**	**3,759.0[6]**

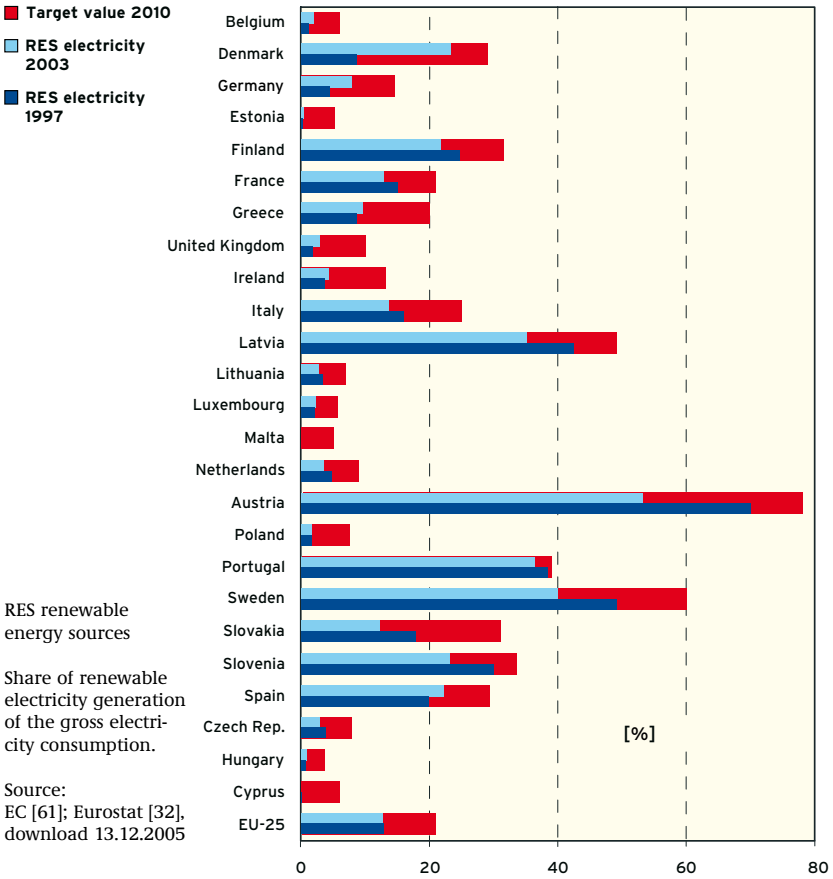
Area/ installed capacity in 2004

	Solar thermal energy[4]		Photo-voltaics[5]
	[1,000 m²]	[MW_{th}]	[kW_p]
Belgium	52	36	1,461
Denmark	328	230	2,245
Germany	6,199	4,339	794,000
Finland	12	9	3,702
France	793	555	20,119
Greece	2,827	1,979	4,544
United Kingdom	176	123	7,803
Ireland	8	5	100
Italy	458	320	30,300
Luxembourg	12	8	26,000
Netherlands	504	353	47,740
Austria	2,400	1,680	19,833
Portugal	109	76	2,275
Sweden	225	157	4,140
Spain	440	308	38,696
EU-15	**14,542**	**10,179**	**1,002,958**
Estonia	1	0	2
Latvia	2	1	4
Lithuania	2	1	17
Malta	15	11	9
Poland	95	66	234
Slovakia	57	40	60
Slovenia	102	71	88
Czech Republic	50	35	363
Hungary	48	34	138
Cyprus	450	315	190
EU-25	**15,362**	**10,754**	**1,004,063**

1) Electricity and heat generation from solid biomass, biogas and biogenic proportion of waste as well as biofuels; missing figures substituted by previous year value
2) Missing figures for EU accession countries substituted by previous year value; for pumped storage stations only generation from natural inflow
3) Heat and electricity generation; electricity generation in Italy 5.4 TWh, Portugal 0.08 TWh, France 0.03 TWh, Austria 0.002 TWh. In 2003, geothermal electricity was produced for the first time in Germany
4) Glazed and unglazed collectors; conversion factor 0.7 kW_{th}/m^2
5) Photovoltaics including plants in overseas departments
6) Total includes 7.1 TWh (25.6 PJ) of solarthermal energy and 0.73 TWh (2.6 PJ) of photovoltaics

Sources:
Biomass: Eurostat [52];
Observ'ER [53] ; IEA [31]
Hydropower: IEA [31]; EIA [33]
Wind power: Observ'ER [46]
Geothermal energy: IEA [31];
Lund [62];
Eurostat [34]; Observ'ER [67]
Solarthermal energy: Observ'ER [36]
Photovoltaics: Observ'ER [37];
Eurostat [52]

Expansion of electricity generation from renewable energy sources in the internal European electricity market



RES renewable energy sources

Share of renewable electricity generation of the gross electricity consumption.

Source:
EC [61]; Eurostat [32], download 13.12.2005

	RES electricity 1997	RES electricity 2003 [%]	Target value 2010
Belgium	1.1	1.8	6.0
Denmark	8.7	23.3	29.0
Germany	4.5	7.9	12.5
Finland	24.7	21.8	31.5
France	15.0	12.9	21.0
Greece	8.6	9.7	20.1
United Kingdom	1.7	2.8	10.0
Ireland	3.6	4.3	13.2
Italy	16.0	13.6	25.0
Luxembourg	2.1	2.3	5.7
Netherlands	3.5	4.7	9.0
Austria	70.0	53.4	78.1
Portugal	38.5	36.4	39.0
Sweden	49.1	40.0	60.0
Spain	19.9	22.3	29.4
EU-15	**13.9**		**21.9**
Estonia	0.2	0.4	5.1
Latvia	42.4	35.2	49.3
Lithuania	3.3	2.7	7.0
Malta	0.0	0.0	5.0
Poland	1.6	1.6	7.5
Slovakia	17.9	12.3	31.0
Slovenia	29.9	23.1	33.6
Czech Republic	3.8	2.8	8.0
Hungary	0.7	0.8	3.6
Cyprus	0.1	0.0	6.0
EU-25	**12.9**		**21.0**

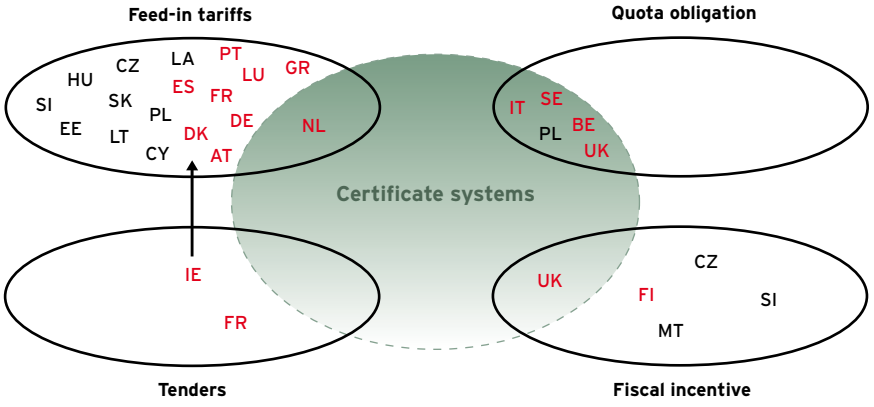
In October 2001, Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market came into effect. The EU's aim is to increase the contribution of renewable energy sources in electricity generation from 14 % in 1997 to 22 % in the EU-15 and 21 % in the EU-25 by 2010. Along with Spain, Finland and Denmark, Germany is on the right path for helping achieve the EU goals for electricity from renewables. Investment security for trade and industry can only be achieved if the expansion goals are updated beyond 2010 and greater support is given to reaching these goals. The integration of renewable energy sources into the electricity sector also requires an EU-wide improvement in the integration into the electricity grid and the expansion of the use of offshore wind power. Additionally the EU needs a regulation that increasingly strengthens the use of heat from renewables. Further measures are necessary for the promotion of biomass use and particularly of biofuels, as announced in the Biomass Action Plan. The Federal Government will advocate setting a clearer priority for energy efficiency and renewable energy sources in the 7th Framework Programme for research.

In its recent green paper "A European strategy for sustainable, competitive and secure energy" the EU Commission acknowledges the contribution that wind power, solar power, biomass, hydropower and geothermal power have made as domestic energy sources to a secure electricity supply, especially in the light of a constantly increasing EU-wide import dependency. The green paper emphasises the relevance of renewable energies for the economy and technological leadership of Europe in this sector with a reference to approximately 300,000 jobs in the EU. To achieve these goals the Commission is called on to submit a timetable for the further expansion of renewable energy sources in the EU.

Instruments for the promotion of renewable energy sources in the electricity market

The prerequisite for raising the share of renewable energy sources in the electricity market to 21 % by 2010 is achieving the national indicative targets for the EU member states that were laid down by the European Commission. The member states are called upon to promote the expansion of renewable energy sources on a national level through appropriate framework conditions.
The example of wind power shows that achievements in individual EU states vary significantly and are far from being on one level. This can be attributed above all to the respective energy policy framework conditions and less to natural potential. In the international comparison of support models the Renewable Energy Sources Act (EEG) stands out. In a report of December 2005, the European Commission determined that feed-in regulations such as the EEG are very effective for promoting wind power. Quota systems with tradable certificates that were implemented in some countries have not shown comparable results. Although in theory the established market mechanisms that are used by quota systems would lead us to expect lower fees, the costs are higher than in countries with feed-in regulations. This reflects the higher risks for operators of facilities. While the EEG guarantees a legally fixed fee for twenty years, the revenues from the sale of electricity and certificates in the quota system are extremely insecure and depend on a multitude of factors that are difficult to assess. Through the EEG Germany will in all likelihood achieve its national expansion goals that were formulated by the European Union. As things stand at present only Denmark and Spain (both countries with feed-in regulations) as well as Finland, where the use of renewable energies is granted tax concessions, are also expected to succeed in reaching their goals. Due to the achievements of national feed-in regulations and the lack of success of other support regulations, the EU Commission is no longer calling for the displacement of the EEG in favour of a Europe-wide harmonized quota system.

Promotion models of renewable electricity in the EU



Source: EC [71]

At the 2004 International Conference for Renewable Energies in Bonn, Spain and Germany decided to share their experience of their feed-in regulations for electricity from renewables and to intensify their cooperation. By signing a joint declaration in 2005, this collaboration was put on a legal basis (International Feed-in Cooperation).

Further goals are to assist other countries in improving and developing a feed-in system and to introduce experience acquired into international forums, especially in the process of political debate in the EU. Altogether more than half of the EU member states have priority and fee regulations that are comparable with the German and Spanish system. Further information on the German-Spanish cooperation is available on the internet at www.feed-in-cooperation.org.

Generation of electricity from renewable energy sources in the EU-15, 1990 to 2004

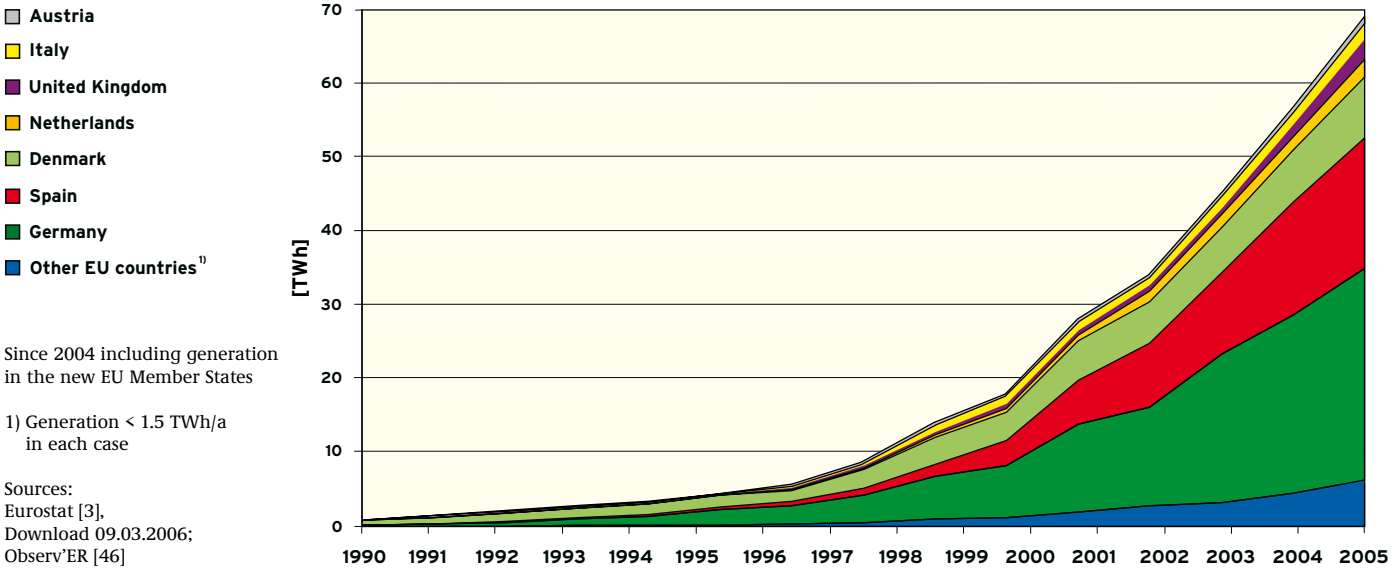
RES renewable energy sources
1) Provisional figures
2) Including municipal waste and biogas
3) For pumped-storage power stations, only generation from natural inflow

Sources:
Biomass: Eurostat [32], download 13.12.2005; IEA [31]
Hydropower: EIA [33]; IEA [31]
Wind energy: Observ'ER [46]; Eurostat [32], download 9.03.06
Geothermal energy: Systèmes Solaires [39]; IEA [31]
Photovoltaics: BSW [74], IEA [31]; DGEMP [54], [66]; Faninger [57]
Share of RES: ZSW [3]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003[1]	2004[1]
	[TWh]														
Biomass[2]	16.6	17.3	18.0	19.4	21.2	23.6	24.4	28.0	31.5	35.0	39.3	39.5	48.4	57.2	55.1
Hydropower[3]	257.2	264.3	282.5	286.9	295.1	288.8	287.5	294.3	302.1	300.8	316.2	335.7	277.6	276.6	290.4
Wind energy	0.8	1.1	1.6	2.4	3.0	4.1	4.8	7.3	11.3	14.2	22.2	27.0	35.6	44.2	56.9
Geothermal en.	3.2	3.2	3.5	3.7	3.4	3.4	3.8	3.9	4.3	4.5	4.8	4.6	4.8	5.4	5.5
Photovoltaics	0.01	0.02	0.02	0.03	0.03	0.05	0.05	0.06	0.08	0.09	0.12	0.19	0.28	0.47	0.73
Total	**277.8**	**285.9**	**305.6**	**312.3**	**322.7**	**319.9**	**320.6**	**333.6**	**349.2**	**354.5**	**382.7**	**406.9**	**366.7**	**383.9**	**408.6**
RE share of gross electricity consumption [%]	**13.3**	**12.8**	**13.6**	**13.9**	**14.1**	**13.6**	**13.3**	**13.7**	**13.9**	**13.9**	**14.5**	**15.0**	**13.5**	**13.7**	**14.6**

Since 1997, electricity generation from renewables in the EU-15 has increased on average 3 % p. a. to 408.6 TWh in 2004 and contributes 14.6 % to the electricity supply. The previous rise is particularly due to the developments in two sectors of renewable energies: wind power, with an average growth of approximately 35 % p. a., and the use of biomass for electricity generation with 10 % p. a. Appropriate growth rates in the other sectors are needed to allow 22 % of the total gross electricity to be replaced by renewables in the EU-15 by 2010. Achieving the objectives will only be possible with an ideal combination of all renewable energy sources.

Generation of electricity from wind energy in the EU, 1990 to 2005

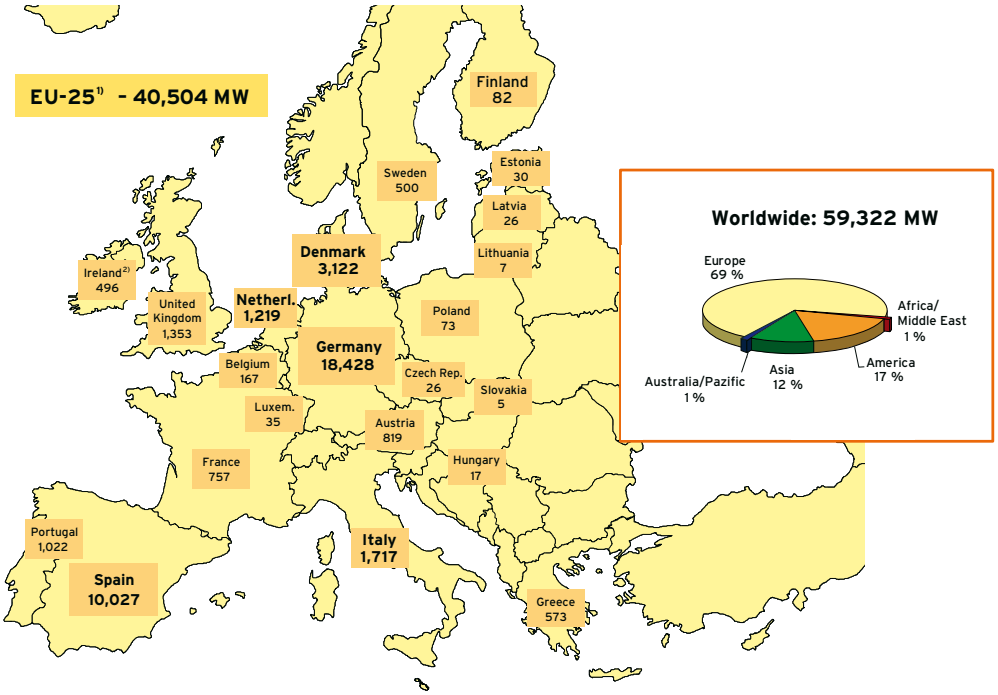


Since 2004 including generation in the new EU Member States

1) Generation < 1.5 TWh/a in each case

Sources:
Eurostat [3], Download 09.03.2006; Observ'ER [46]

Total installed wind power capacity in the EU, end of 2005

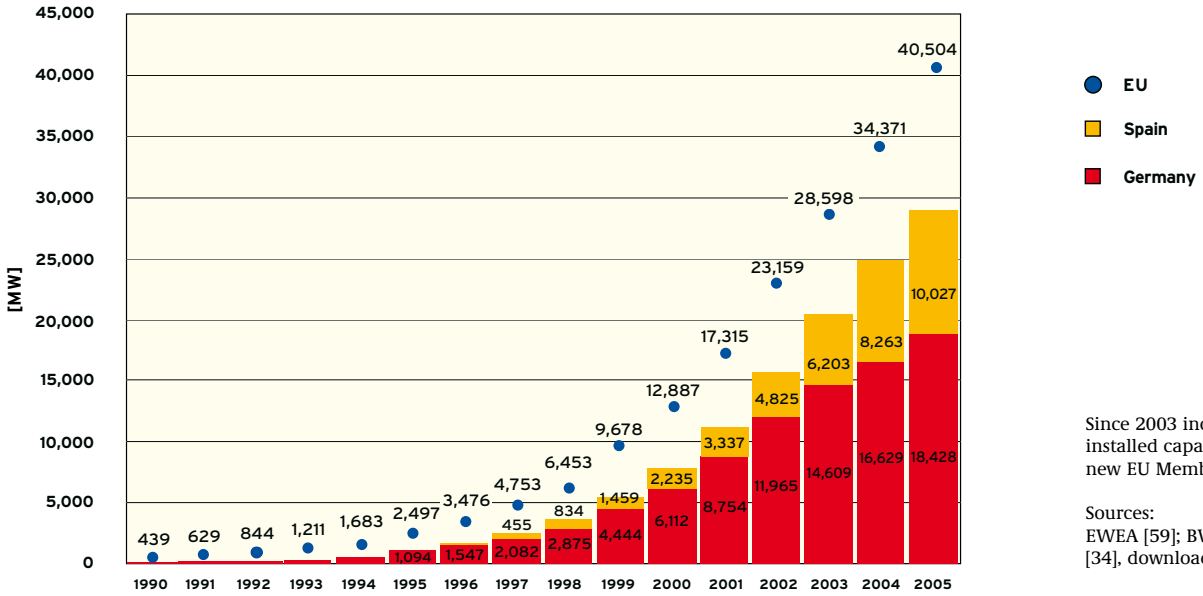


Figures in MW

1) No wind energy use in Malta, Slovenia and Cyprus
2) without figures for December 2005

Sources:
EWEA [50]; GWEC [60]

Development of installed wind power capacity in the EU, 1990 to 2005



Since 2003 including installed capacities in the new EU Member States

Sources:
EWEA [59]; BWE [16]; Eurostat [34], download 22.03.06

Over recent years, the use of wind power has had a very dynamic upturn especially in the countries of the EU. In the last five years alone the installed capacity in the EU has more than doubled to over 40,000 MW. This increase can especially be attributed to growth in the wind power market in Germany and Spain. At the end of 2005 more than 18,000 MW (newly installed capacity 2005: 1,808 MW) were installed. In Spain in 2005, 1,764 MW were installed, whereby Spain crossed the 10,000 MW mark. Therefore these two countries account for almost three quarters of the total installed capacity in the EU. Approximately 60,000 MW were in operation globally, of which more than two thirds in the EU.

Global use of renewable energy sources

The high value of renewable energies for sustainable development is recognised. At present, however, their share of global primary energy consumption remains on a par with that of the early seventies, at 13.3 % (cf. also Appendix, No. 9). Although the supply of energy from renewables has almost doubled since then, the use of fossil energies and nuclear energy has also increased.

In order to meet the challenges of global energy supply and, in particular, climate protection, in addition to using energy more efficiently it is also necessary to increase the development momentum of renewables. This is particularly true of wind, solar and geothermal energy, but also of modern techniques for the use of biomass. The traditional uses which have dominated up until now – the provision of heat from firewood and coal (traditional use of biomass), and the generation of electricity from hydropower – are fast approaching their limits and are sometimes not a sustainable use of renewable energies (see also page 36).

The Federal Government and the European Union have undertaken to double the share of energy supply from renewable energy sources by the year 2010.

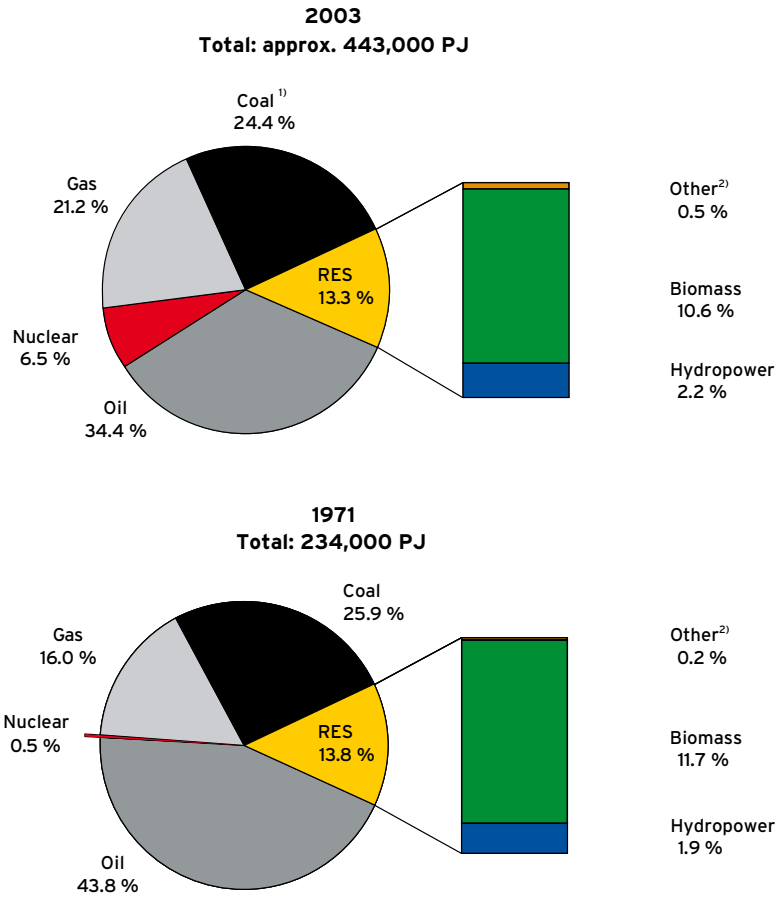
Structure of global primary energy consumption, 2003 versus 1971

RES renewable energy sources

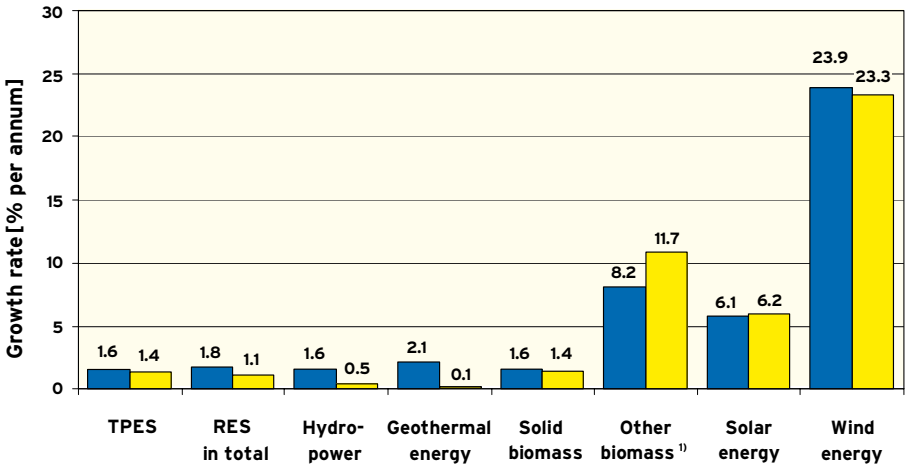
1) Includes non-renewable share of waste
2) Geothermal energy, wind, solar energy, etc.

Sources:
IEA [31]; [23]

In accordance with international agreements, electricity from nuclear energy is valued at an average conversion efficiency of 33 % in terms of primary energy. For hydropower, on the other hand, a figure of almost 100 % is used. For the share of primary energy consumption attributable to nuclear energy, this produces a significantly higher figure, whereas the contributions to electricity generation are almost identical in both cases; cf. Appendix, No. 4.



Average growth rates of primary energy consumption and renewable energy sources for the period 1990 to 2003



RES renewable energy sources
TPES total primary energy supply

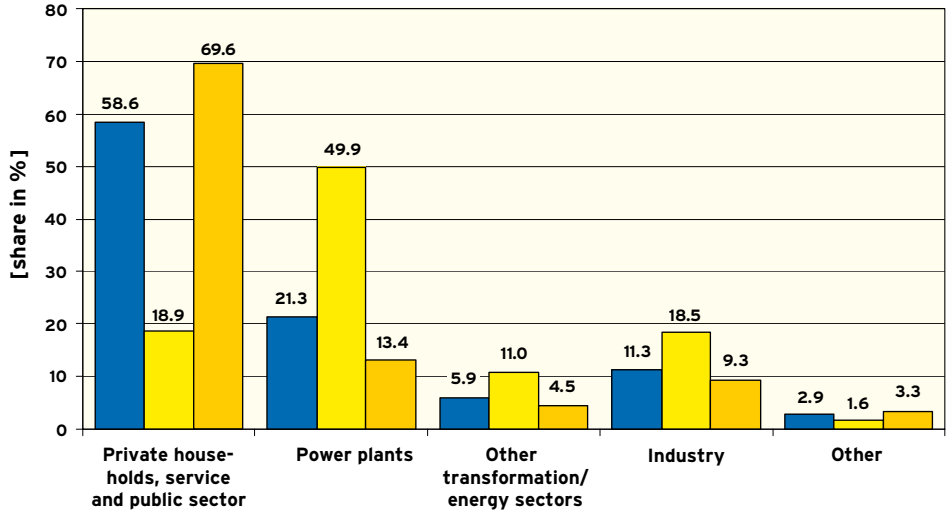
The OECD Member States are listed in Appendix, No. 10.

1) Biogenic share of municipal waste, biogas, liquid biomass

Source: IEA [31]

Against the background of various climate protection targets, i.e. those of the Kyoto Protocol, the development of renewable energies since 1990 is of particular interest. To date, however, efforts to significantly raise their value for energy supply have been unsuccessful. Although global energy supply increased by an average of 1.8 % up to 2003, growth was only slightly higher than that of primary energy consumption as a whole, at 1.6 % p. a. In the western industrialised countries (OECD), the contribution of renewable energy sources actually declined, from 5.9 % in 1990 to 5.6 % in 2003.

Structure of renewable energy use according to application areas, 2003



Source: acc. to IEA [31]

Globally, around 60 % of renewable energies are currently used to supply heat in private households and in the public and services sectors. This essentially refers to wood and coal. The second principal application area is that of electricity generation. However, there are substantial regional differences: whereas in the western industrialised countries (OECD), half of renewable energy sources are used to generate electricity, in Non-OECD countries this figure is only 13.4 %. The proportion attributable to decentralised heat supply in such countries is correspondingly high, at approximately 70 %, compared with only about 19 % in the OECD countries.

Share of renewable energy sources in primary energy consumption, 2003

Transition countries: countries that are in a transition phase from central planned economy to a market economy; under this term the IEA includes countries from non OECD Europe and of the former USSR.

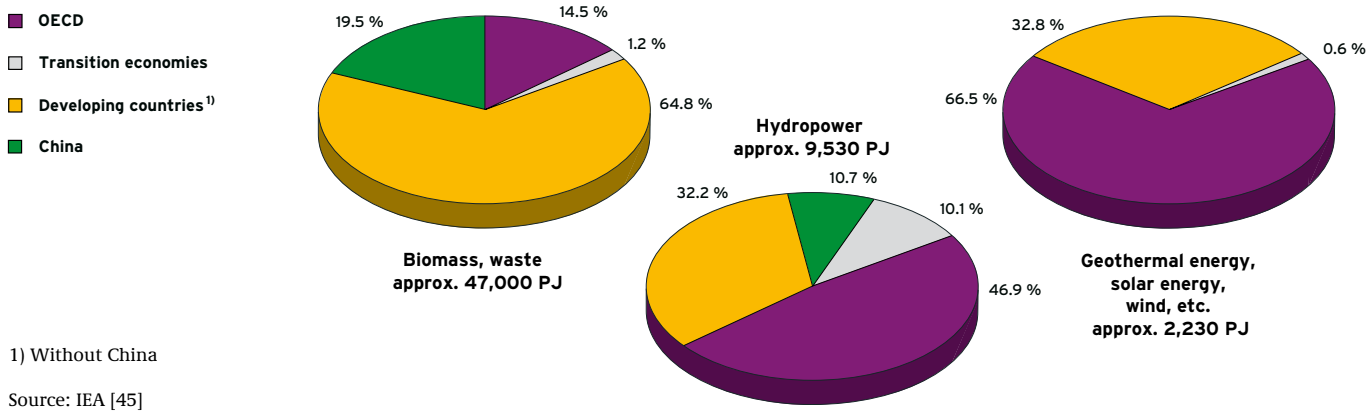
1) Biogenic share of waste; in the Non-OECD countries a clear separation of the biogenic and non-biogenic share is not always possible
2) Geothermal energy, solar power, wind power, etc.

Sources: IEA [31]

	TPES	Thereof RES	Share of RES in TPES	Share of most important RES in total RES [in %]		
	[PJ]	[PJ]	[%]	Hydro-power	Biomass/ waste[1]	Others[2]
Africa	23,400	11,719	50.1	2.6	97.1	0.3
Latin America	19,423	5,673	29.2	35.9	62.6	1.4
Asia	51,263	16,747	32.7	4.0	92.5	3.5
China	59,700	10,191	17.1	10.0	90.0	0.0
Middle East	18,661	134	0.7	42.7	33.2	24.1
Transition economies	44,598	1,557	3.5	62.1	36.8	1.0
OECD	225,865	12,757	5.6	35.1	53.3	11.7
World	**442,909**	**58,770**	**13.3**	**16.2**	**80.0**	**3.8**

The share of energy that is generally considered renewable is particularly high in Africa. The reason for this is the traditional use of biomass that however is not sustainable in the long term. Basic forms of cooking and heating result in health damage through the use of open fires as well as the often irreversible effects of deforestation. Successfully reducing poverty is a basic requirement for the development of a sustainable energy supply. The use of hydropower through large embankment dams is sometimes also an unsustainable use of renewable energies, since they can entail serious social and ecological consequences.

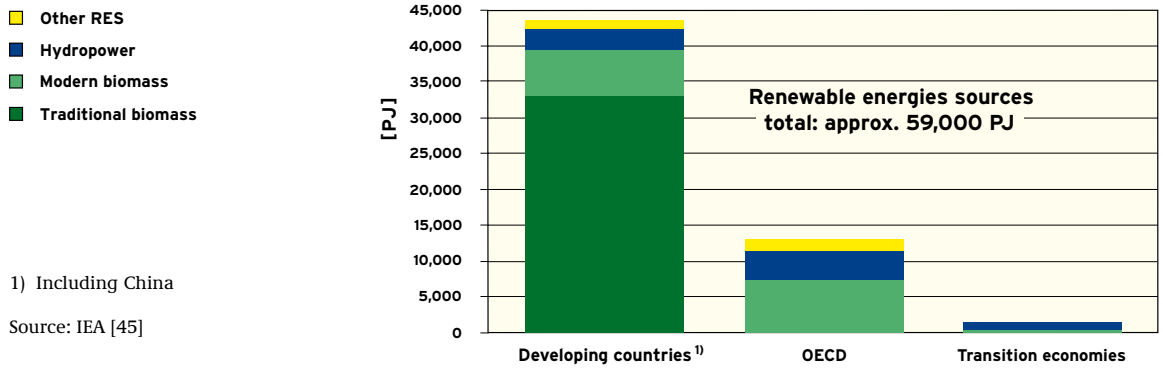
Regional distribution of renewable energy sources, 2003



1) Without China

Source: IEA [45]

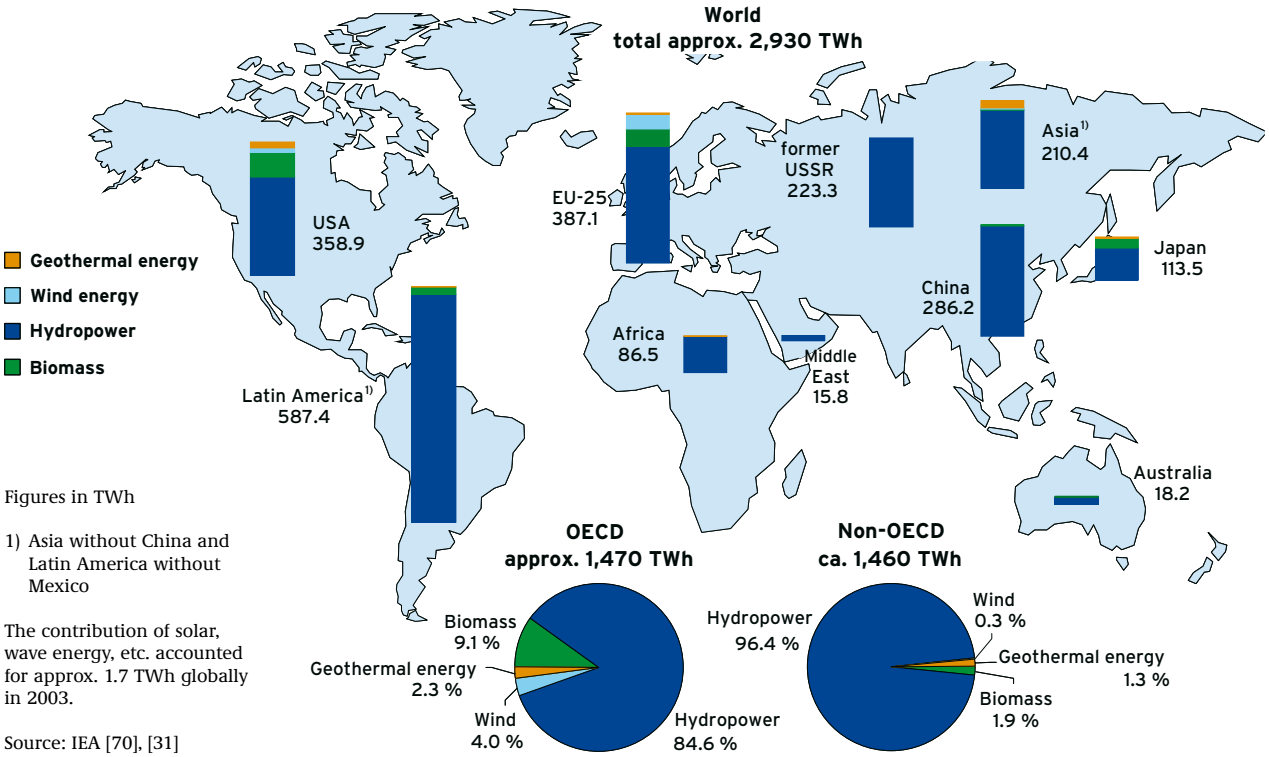
Regional structure of the use of renewable energy sources, 2003



1) Including China

Source: IEA [45]

Electricity generation from renewable energy sources in various regions, 2003



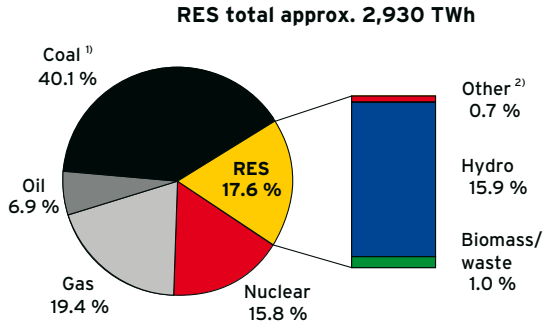
Figures in TWh

1) Asia without China and Latin America without Mexico

The contribution of solar, wave energy, etc. accounted for approx. 1.7 TWh globally in 2003.

Source: IEA [70], [31]

Share of renewable energy sources in global electricity generation, 2003



RES renewable energy sources

1) Includes non-renewable share of waste
2) Geothermal, biomass/waste, solar, wind, etc.

Sources:
IEA [31], [70]

Worldwide, renewable energy sources account for 17.6 % of total electricity generation, a slight decline against the 1990 figure (19.3 %). The reason for this is the relatively low growth in the use of hydropower in western industrialised countries (OECD), which fell short of the increase in electricity generation as a whole. This was not compensated by the use of other resources such as biomass or wind energy.
Worldwide, hydropower dominates electricity generation from renewable energy sources. It accounts for around 90 % (corresponding to 15.9 % of total electricity generation), while biomass accounts for 6 % and the remaining renewable energies for almost 4 %.

International Conference for Renewable Energies – *renewables2004* – and the follow-up process

The International Conference for Renewable Energies in Bonn, *renewables2004*, was the global beginning of a new energy age. The successful implementation of almost 200 activities of the Bonn International Action Programme (IAP) will have a major impact on the global climate and social development: from 2015, 1.2 billion t CO_2 p. a. should be avoided, which is equivalent to approximately 5 % of global emissions in 2015. The implementation would trigger investment of over 300 billion euros and up to 300 million people would get their first access to electricity.

China has considerably contributed to this: it is planning to increase the renewables' share of the total installed electrical capacity to 10 % by 2010. China has since even raised this target. To achieve this goal, China has passed a regulation comparable to the German Renewable Energy Sources Act with fixed feed-in tariffs that came into effect at the beginning of 2006. In cooperation with other participants the government will raise more than 50 billion euros.

The Federal Government is working intensively on the implementation of Germany's contribution to the IAP. Important contributions such as a new financing facility for energy efficiency and renewable energies have already been implemented. A further conference result that has been implemented is the founding of a global policy network (Renewable Energy Policy Network - REN 21). In REN 21 governments, international organisations and representatives of civil societies will work in cooperation and engage in further high-level political dialogue. The REN 21 Network published a 2005 global status report on renewables at the follow-up conference in Beijing in November 2005. According to this report already 17 % of global energy consumption comes from renewable sources. The report gives a comprehensive overview of the established support policies, markets and investment and associated employment (the report is available at www.ren21.net). The official closing document which summarises the main conference documents and the analysis of the IAP are available under www.renewables2004.de.

From 7 to 8 November 2005, the Chinese government held the first follow-up conference - the Beijing International Renewable Energy Conference (BIREC 2005), with the support of the German Government. With 1,300 participants from 100 countries, including 30 government representative at ministerial level, the conference successfully made clear that renewable energy sources do not apply exclusively to industrialised countries. The Chinese government strengthened the commitment it made at the Bonn conference. The share of electricity from renewable energy sources should climb to 30 % by 2020. BIREC 2005 sent a clear message to the meeting of the Commission for Sustainable Development in 2006/07: renewable energies and the question of how their expansion will be regularly reviewed are on the agenda. The results of the conference are available under www.birec2005.cn.

Appendix: Methodological notes

The data published here in part reflects only provisional results. This is also true of individual time series which are currently being reviewed by the Working Group on Renewable Energies/Statistics (AGEE-Stat) (cf. also www.erneuerbare-energien.de). Changes may still arise compared with earlier publications until finalised data is published. Differences between the figures in the tables and the corresponding column or line totals are due to rounding up or down.
The standard terminology in energy statistics includes the term (primary) energy consumption, although this is not strictly accurate in a physical sense, because energy is neither extracted nor consumed, but can merely be transformed into different forms of energy (such as heat, electricity, mechanical energy). Admittedly, this process is not completely reversible, so that a certain proportion of energy's useful work potential is lost.

1. Calculation of emission factors for electricity generation

The figures regarding the avoidance of emissions are based on the "Report on CO_2 Reduction through the Use of Renewable Energy Sources" of the Fraunhofer Institute for System and Innovation Research [41]. The paper examines in detail to what extent renewable energies can replace conventional energy sources in light of the current power plant park.

For the most part, the feed-in of wind power replaces electricity from hard coal-fired medium load power plants, and to a lesser extent electricity from natural gas power stations; in times of strong winds and low load it can replace lignite power plants. Hydropower on the other hand, substitutes for lignite in the base load because of its feed-in characteristics. The same applies to electricity generation from geothermal energy, landfill and sewage gas. In contrast, biogas power plants follow the grid load daily and seasonally, whether they are heat or power directed. Therefore they predominantly replace medium (hard coal) and peak load power stations (natural gas). Liquid and solid biogenic fuels, which are flexible because they can be stored, mostly substitute hard coal and to a lesser extent lignite and natural gas. Electricity generation from photovoltaics follows the power demand with its generation profile. For the most part it substitutes for natural gas and to some extent hard coal.

Due to the currently available base load supply a substitution of renewable energy sources for nuclear energy is not anticipated because of its lower marginal costs compared to lignite power plants that are also used in base load.

	Substitution			
	Nuclear power	Lignite	Hard coal	Gas
Wind energy	0 %	20 %	70 %	10 %
Geothermal en. and hydropower	0 %	100 %	0 %	0 %
Biomass/Waste[1)]	0 %	30 %	60 %	10 %
Photovoltaics	0 %	0 %	50 %	50 %
Biogas	0 %	0 %	70 %	30 %
Landfill and sewage gas	0 %	100 %	0 %	0 %

The emission factors were calculated according to the fuel substitution listed here.

1) Only biogenic share

Source: ISI [41]

2. Calculation of emission factors and avoided emissions for heat generation

The calculation only considers direct emissions (including auxiliary power and heat distribution), i.e. no upstream or downstream processes such as the manufacture or disposal of plants. The calculation assumes the following structure of the heat supply mix which is substituted by renewable energy:

Sources:
acc. to VDEW [17];
acc. to Statistisches Bundesamt [44]

Natural gas	Heating oil	Coal	Electricity
52.9 %	41.5 %	1.5 %	4.1 %

3. CO_2 and SO_2 equivalent

CO_2 equivalent

Key greenhouse gases are the so-called Kyoto gases CO_2, CH_4, N_2O, SF_6, PFC and HFC, which must be reduced under the Kyoto Protocol. They contribute in different degrees to the greenhouse effect. In order to be able to compare the greenhouse effect of the individual gases, they are allocated a factor known as relative greenhouse potential (GHP), which represents a measure of their greenhouse effect compared with the reference substance CO_2.
The CO_2 equivalent of the Kyoto gases is calculated by multiplying the relative greenhouse potential by the mass of the respective gas, and indicates the quantity of CO_2 which would account for the same greenhouse effect over an observation period of 100 years.

The figures reflect the current scientific status according to IPCC [65]. For the Kyoto Protocol the italic printed figures are relevant according to IPCC [51]. This brochure was calculated with the new data.

1) based on a time horizon of 100 years
2) Reference substance

Gas		relative greenhouse potential [1]	
CO_2	Carbon dioxide	[2] 1	[2] 1
CH_4	Methane	23	*21*
N_2O	Dinitrogen oxide (Laughing gas)	296	*310*
SF_6	Sulphur hexafluoride	22,200	*23,900*
HFC	Hydrofluorocarbons	12 - 12,000	*140 - 11,700*
PFC	Perfluorinated carbons	8,600 - 11,900	*6,500 - 9,200*

SO_2 equivalent

Gas		relative acidification potential
SO_2	Sulphur dioxide	1
NO_x	Nitrogen oxide	0.696
HF	Hydro fluoride	1.601
HCl	Hydro chloride	0.878
H_2S	Hydrogen sulphide	0.983
NH_3	Ammonia	3.762

Source: GEMIS, Öko-Institut [2]

The acidification potential of SO_2, NO_X, HF, HCl, H_2S and NH_3 is determined analogously to the CO_2 equivalent. The SO_2 equivalent of these air pollutants indicates the quantity of SO_2 which would produce the same acidifying effect.

4. Calculation of the primary energy equivalent for electricity, heat and fuels from renewable energy sources

In the physical energy content method, the primary energy for electricity is deduced from final energy using an efficiency factor of 100 % for energy sources which cannot be assigned a calorific value, such as hydropower, wind power and photovoltaics. Thus e.g. 1 kWh of electricity from hydropower corresponds to a primary equivalent of 1 kWh.

With the substitution method, the primary energy equivalent for electricity from hydropower, wind power and photovoltaics is stated as the fuel substituted through the electricity generation of the respective energy source in conventional power plants. For the calculation of fuel savings, the survey quoted under point 1 is used.

For calculating the primary energy equivalent for electricity from biomass, a so-called average substitution factor is applied for both methods. It is calculated from the ratio of fossil fuel used for electricity generation in public power stations to the gross electricity generation from these energy sources, and for 2004 amounts to 8,309 kJ/kWh (status 2004, provisional) AGEB [1]. Primary energy use for the different technologies will not be evaluated here.

For calculating the primary energy equivalent for the supply of heat and fuels from renewable energies, final energy and primary energy are equated.

5. Supply of energy from photovoltaics and solar thermal energy

Photovoltaics

Electricity generation for 2005 is equivalent to the medium-term prognosis of VDN [9] of November 2005. The information for 2004 corresponds to the annual statement of October of the same year. Up to and including 2003, electricity generation was calculated using the installed capacity at the beginning of the year and half of the capacity increase of the respective year multiplied by a specific electricity output. The specific electricity output for Germany was provided by the Solar Promotion Association of Germany [28] as an average value. Taking half the capacity increase allows for the fact that newly installed capacity of the respective year only proportionally contributes to the electricity generation.

Solar thermal energy

The specified heat supply is calculated from the installed collector area and an average annual yield of 450 kWh/m^2 for glazed collectors, and 300 kWh/m^2 for swimming pool absorbers. Because the collector area available during the course of the year is lower than the specified installed area at the end of the year due to the construction of new plants, only half of the area increase in any given year is used when calculating heat supply for that year.

6. Saving fossil fuels through renewable energy sources

The saving of fossil fuels in electricity generation is calculated with a typical level of utilisation of lignite, hard coal and natural gas power plants.

	Lignite power plants	Hard coal power plants	Natural gas power plants
Average efficiency factor	36.6 %	37.6 %	43.9 %

Source: ISI [41]

It must be borne in mind that the different renewable energy sources save different fossil fuels. Therefore, hydropower reduces the energy generation of base load power plants (lignite), while wind power primarily reduces electricity generation in medium load power plants (hard coal, natural gas). The systematics are described in detail in ISI [41] (see also 1.).
In contrast to electricity generation, for calculating the saving of fossil fuels through heat generation from renewables the preliminary processes of energy supply are taken into account.

It is assumed that for the utilisation of renewable energies mainly wood heaters are used. Therefore, for each used kilowatt-hour of energy from renewable sources there is a saving of 1.11 kWh (primary energy) compared with oil heaters and 1.08 kWh compared with natural gas. For the various coal heaters, the figures are 1.59 (hard coal briquettes), 1.80 (lignite briquettes) and 2.03 (hard coal coke). The extent to which fossil fuels are substituted is specified according to the structure of the heat supply mix described under point 2. For coal heaters, it is assumed that 79.6 % lignite briquettes, 12.9 % hard coal briquettes and 7.5 % hard coal coke are substituted. In the calculation electric heaters were not taken into account.

Energy source	Consumption of primary energy (fossil) kWh_{prim}/kWh_{input}
Oil heating	1.20
Gas heating	1.17
Hard coal briquette heating	1.68
Hard coal coke heating	2.12
Lingnite briquette heating	1.89
Wood heating	0.09

Source: Öko-Institut [24]

With the saving of fossil fuels through biofuels, the preliminary processes of energy supply are also taken into account.
Thus, every used kilowatt-hour of biodiesel results in a saving of 1.26 kilowatt-hours (primary energy) compared with diesel fuel. For biodiesel, the credits for by-products are included. For bioethanol the figure compared to petrol is 0.72, for rape seed oil compared to diesel 0.99. Vegetable oil is here equated with rape seed oil.

	Consumption of primary energy (fossil) kWh_{prim}/kWh_{input}
Petrol	1.23
Diesel	1.16
Bioethanol	0.51
Rape seed oil	0.17
Biodiesel	-0.10

7. Sales proceeds from the use of renewable energy sources

Turnover from the generation of electricity may be estimated based on the quantity of electricity fed into the grid and the payment rates according to the Renewable Energy Sources Act. The revenues from facilities that do not fall under the scope of the Act must be added, especially hydropower plants over 5 MW capacity and electricity generation from thermal waste handling (only biogenic share). An average value of 4.6 cents/kWh can be determined according to the stock market price for base load electricity. With an electricity generation of just under 19 TWh in 2005, a value of approximately 0.9 billion euros can be assigned.

For the fuel sector the revenues can be calculated directly from the sale of biofuels. This must take into account the different types of fuel as well as the distribution channels. An average price of 82 cents/l net (95 cents/l gross), for example, was estimated for the sale of biodiesel to public petrol stations. Lower prices were assumed for sales to vehicle fleets and the blending of diesel fuel.

The value of heat supply from renewable energies is disregarded, since the heat is mainly used internally. One conceivable valuation in such cases, however, would be the avoided costs for fuel oil or natural gas. Taking a substituted heat volume of approximately 73 TWh and an average fuel oil price of 55 cents per litre, this would correspond to approximately 4 billion euros for the private household sector. The costs of maintenance and repair of heat-generating plants as well as the revenues from the sale of heat in district heating systems are also not taken into account. This leaves the valuation of biogenic input materials such as logging residues and industrial wood residues, wood pellets etc. as well as a proportion of the used firewood, that is estimated at a total of 0.5 billion euros.

8. Calculation of the primary energy equivalent of renewable energy sources for the EU

When calculating the primary energy equivalent for electricity generation from hydropower, wind energy and photovoltaic energy, primary energy is here equated with the generation of electricity according to the physical energy content method, in conformity with Eurostat. Biomass and biofuels for electricity and heat generation are evaluated in accordance with their calorific value (in conformity with Eurostat, but deviating from the methodology used in this brochure for Germany; cf. Appendix, No.4). For geothermal electricity generation, an efficiency factor of 10 % is assumed, i.e. 1 GWh of electricity from geothermal energy is valued at 36 TJ primary energy. For heat generation from geothermal and solar thermal energy, final energy and primary energy are considered equal.

The deviations arising from the different methodologies are minimal and can be disregarded when calculating the overall contribution of renewable energy sources to primary energy consumption.

9. Share of renewable energy sources in global primary energy consumption

Different sources give different figures for the share of global primary energy consumption that is attributable to renewable energies. The reasons for this include the accounting of thermal recovery of domestic and industrial waste and the generation of electricity in pumped-storage power stations. However, the greatest influence is the so-called traditional use of firewood and coal, which can only be estimated with considerable uncertainties, and for which figures can vary by more than 50 %. For this reason, traditional biomass use is not always included in energy statistics. With due regard for the current status of knowledge in this field, it can be said that renewables account for around 13.3 % of primary energy consumption.

10. OECD

The Organization for Economic Cooperation and Development was founded on 30 September 1961. Its main tasks include the coordination of economic policy, particularly trade cycle and currency policy, and the coordination and intensification of development aid from the Member States: Australia, Belgium, Germany, Denmark, Finland, France, Greece, United Kingdom, Ireland, Iceland, Italy, Japan, Canada, Korea, Luxembourg, Mexico, New Zealand, Netherlands, Norway, Austria, Portugal, Poland, Sweden, Switzerland, Slovak Republic, Spain, Czech Republic, Turkey, Hungary and USA. OECD headquarters is in Paris. The International Energy Agency (IEA) is a sub-organisation of the OECD; it is also located in Paris.

Conversion factors

Kilo	k	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

Terawatt hour:	1 TWh = 1 billion kWh
Gigawatt hour:	1 GWh = 1 million kWh
Megawatt hour:	1 MWh = 1,000 kWh

Units for energy and capacity

These units have been statutorily binding in Germany since 1978. The calory and derived units such as coal equivalent and crude oil equivalent are still used as an aid.

Joule	**J**	**for energy, work, heat quantity**
Watt	**W**	**for capacity, energy flow, heat flow**

1 Joule (J) = 1 Newton metre (Nm) = 1 Watt second (Ws)

Conversion factors

The figures refer to calorific value.

		PJ	TWh	Mio. t SKE	Mio. t RÖE
1 Petajoule	**PJ**	1	0.2778	0.0341	0.0239
1 Terawatt hour	**TWh**	3.6	1	0.123	0.0861
1 million t coal equivalent	**Mio. t ce**	29.308	8.14	1	0.7
1 million t crude oil equivalent	**Mio. t oe**	41.869	11.63	1.429	1

Greenhouse gases

CO_2	**Carbon dioxide**
CH_4	**Methane**
N_2O	**Dinitrogen oxide (Laughing gas)**
SF_6	**Sulphur hexafluoride**
HFC	**Hydrofluorocarbons**
PFC	**Perfluorinated carbons**

Other air pollutants

SO_2	**Sulphur dioxide**
NO_x	**Nitrogen oxide**
HCl	**Hydrogen chloride**
HF	**Hydrogen fluoride**
CO	**Carbon monoxide**
NMVOC	**Non-methane volatile organic compounds**

Bibliography

Personal reference:

[1] Working Group on Energy Balances (AGEB), Berlin, January 2006
[2] Working Group on Energy Balances (AGEB): Satellitenbilanz Erneuerbare Energieträger 1995-1999, Berlin
[3] Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW), Stuttgart
[7] Agency of Renewable Resources (FNR), Gülzow, 2004, 2005, 2006
[9] Association of German Network Operators (VDN), Berlin
[10] Bundesverband Solarwirtschaft (BSW), Berlin
[12] EnBW Kraftwerke AG Stuttgart, 2005
[15] Federal Ministry of Food, Agriculture and Consumer Protection, (BMELV), April 2006
[19] Rationelle Energietechnik GmbH (ZfS), Hilden
[22] Institut für Zukunfts-Energie-Systeme (IZES): Umwelteffekte der Strom- und Wärmebereitstellung sowie der Kraftstoffnutzung im Jahr 2004, Saarbrücken
[24] U. Fritsche, Öko-Institut Darmstadt, 2005
[26] Bundesverband WärmePumpe (BWP) e. V., München, April 2006
[28] Solarenergie-Förderverein Deutschland e. V. (SFV), Aachen, 2005
[42] Federal Office of Economics and Export Control (BAFA), Eschborn, February 2004

Literature:

[4] Federal Environmental Agency (UBA): Deutsches Treibhausgasinventar 1990- 2004, Nationaler Inventarbericht 2006, Dessau, 2006:
[5] Federal Statistical Office, Wiesbaden, 2004, 2005, 2006
[6] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (ed.): Ausbau Erneuerbarer Energien im Stromsektor bis zum Jahr 2020: Vergütungszahlungen und Differenzkosten durch das Erneuerbare-Energien-Gesetz, Stuttgart, Wuppertal, Dezember 2005
[8] Institute for Energy and Environment (IE): Fortschreibung der Daten zur Stromerzeugung aus Biomasse, Leipzig, 2004, 2005
[11] German Institute for Economic Research (DIW) (Ed.): Hohe Energiepreise dämpfen Primär-energieverbrauch in Deutschland, in: Wochenbericht Nr.10/2006
[13] Institute for Energy and Environment (IE): Monitoring zur Wirkung der Biomasseverordnung auf der Basis des Erneuerbare-Energien-Gesetzes, Endbericht, Leipzig, 2003
[14] Öko-Institut – Institut für angewandte Ökologie: Gesamt-Emissions-Modell integrierter Systeme (GEMIS), Version 4, Darmstadt 2001
[16] German WindEnergy Association (BWE), Osnabrück 2005
[17] Verband der Elektrizitätswirtschaft e. V. (VDEW): Endenergieverbrauch in Deutschland, VDEW-Materialien, Frankfurt a. M., 1998/1999/2000/2001/2002/2003
[18] Working Group on Energy Balances (AGEB): Auswertungstabellen zur Energiebilanz für Deutschland von 1990 bis 2005, Berlin
[20] Institute for Energy and Environment (IE): Erfahrungen mit dem novellierten EEG hinsichtlich der Stromerzeugung aus Biomasse, Leipzig, Februar 2006
[21] Verband der Elektrizitätswirtschaft e. V. (VDEW): Pressemitteilung vom 18.04.2005
[23] International Energy Agency: World Energy Outlook 2002, IEA/OECD, Paris 2002
[25] Erfahrungsbericht der Bundesregierung: Bericht über den Stand der Markteinführung und der Kostenentwicklung von Anlagen zur Erzeugung von Strom aus erneuerbaren Energien (Erfahrungsbericht zum EEG) vom 28. Juni 2002, Berlin

[27] German Aerospace Center (DLR), Institute for Energy and Environmental Research Heidelberg (Ifeu), Wuppertal Institute for Climate, Environment and Energy (WI): Ökologisch optimierter Ausbau der Nutzung der erneuerbaren Energien in Deutschland, 2004, im Auftrag des Bundesumweltministeriums

[29] Verband der Industriellen Energie- und Kraftwirtschaft (VIK): Statistik der Energiewirtschaft, Essen, 2000/2001

[30] International Energy Agency (IEA): World Energy Outlook 2004, OECD/IEA, 2004

[31] International Energy Agency (IEA), Paris: Renewables Information, Edition 2002, Edition 2003, Edition 2004, Edition 2005, IEA/OECD

[32] European Commission: Eurostat Online Database: Table es_105a.tab, http://epp.eurostat.cec.eu.int/

[33] Energy Information Administration (EIA): International Energy Annual, Edition 2003, http://www.eia.doe.gov/iea/elec.html, released May - July 2005, Washington DC

[34] European Commission : Eurostat Online Database: Tables es_100a, es_1071a, es_1072a, es_113a, http://epp.eurostat.cec.eu.int/

[35] Observatoire des énergies renouvelables (Observ'ER): European Barometer 2002, Le bilan 2002 des énergies renouvelables, in: Systèmes Solaires, n°148, 04/2002

[36] Observatoire des énergies renouvelables (Observ'ER): Solar Thermal Barometer, in: Systèmes Solaires, n°168, August 2005

[37] Observatoire des énergies renouvelables (Observ'ER): Photovoltaic Energy Barometer, in: Systèmes Solaires, n°166, April 2005

[38] Öko-Institut, Frauenhofer Institut Umwelt-, Sicherheits- Energietechnik (UMSICHT), Institut für Energetik und Umwelt, Institut für Energie- und Umweltforschung Heidelberg (ifeu), Institut für ZukunftsEnergieSysteme (izes), TU Berlin, TU Braunschweig, TU München: Stoffstromanalyse zur nachhaltigen energetischen Nutzung von Biomasse, 2004, im Auftrag des Bundesumweltministeriums

[39] Systèmes Solaires: La production d'électricité d'origine renouvelable dans le monde, Paris, September 2000

[40] German Institute for Economic Research (DIW): DIW-Wochenberichte Nr. 9/2005,12/2006, Berlin

[41] Fraunhofer Institute for Systems and Innovation Research (FhG-ISI): Gutachten zur CO_2-Minderung im Stromsektor durch den Einsatz erneuerbarer Energien, Karlsruhe, 2005

[43] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): Was Strom aus erneuerbaren Energien wirklich kostet, February 2006

[44] Federal Statistical Office: Mikrozensus-Zusatzerhebung 2003

[45] International Energy Agency (IEA): Renewables in Global Energy Supply – An IEA Fact Sheet, IEA/OECD, Paris

[46] Observatoire des énergies renouvelables (Observ'ER): Wind Energy Barometer, in: Systèmes Solaires n° 171, February 2006

[47] European Commission: Energy - Monthly Statistics, 2-2006

[48] German Advisory Council on Climate Change (WBGU): World in Transition: Towards Sustainable Energy Systems, Berlin 2003

[49] Institute for Energy and Environmental Research Heidelberg (Ifeu): Gutachten zur Erweiterung der Ökobilanz für RME, May 2003

[50] European Wind Energy Association (EWEA): Wind Power Installed in Europe by End of 2005 (Cumulative), http://www.ewea.org/, download 08.03.2006

[51] Intergovernmental Panel on Climate Change (IPCC): Guidelines for National Greenhouse Gas Inventories, 1996

[52] Eurostat, Statistical Office of the European Communities, Luxembourg: Energy, annual statistics, 2001 Edition, 2002 Edition, 2003 Edition, 2004 Edition

[53] Observatoire des énergies renouvelables (Observ'ER): Biofuels Barometer, in: Systèmes Solaires, n° 167, June 2005
[54] Direction Générale de l'Énergie et des Matières Premières [DGEMP] : La production d'énergie renouvelable en France en 2004, Paris, Juin 2005
[55] E. Wagner: Nutzung erneuerbarer Energien durch die Elektrizitätswirtschaft, in: VDEW: Elektrizitätswirtschaft, Heft 24, 2000
[56] German Institute for Economic Research (DIW): Aktualisierung der Schätzung der Beschäftigungszahlen im Umweltschutz. Gutachten im Auftrag des Umweltbundesamtes. Berlin, 2004
[57] Faninger, G.: Der Photovoltaik-Markt in Österreich 2003, iff-Universität Klagenfurt, March 2004
[58] European Solar Thermal Industry Federation (ESTIF)/ International Energy Agency (IEA): Press Release: Worldwide capacity of solar thermal energy greatly underestimated, 10 November 2004
[59] European Wind Energy Association (EWEA): NEWS RELEASE, European record for wind power: over 6,000 MW installed in 2005. Wind energy has surpassed EC white Paper targets for 2010, Brussels, 1st February 2006
[60] Global Wind Energy Council (GWEC): Press Release: Record year for wind energy: Global wind power market increased by 43 % in 2005, Brussels, 17 February 2006
[61] European Commission, Directorate-General for Energy and Transport, Beatriz Yordi: Situation of the Renewable Electricity Directive, ECOSOC, 4 April 2005
[62] Lund, John W.: 100 Years of geothermal power production, GHC Bulletin, September 2004
[63] International Energy Agency (IEA): Energy Balances of OECD Countries, 2004 Edition
[64] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): Wirkung des Ausbaus der Erneuerbaren Energien auf den deutschen Arbeitsmarkt unter besonderer Berücksichtigung des Außenhandels, Pressemeldung 22.03.2006
[65] Intergovernmental Panel on Climate Change (IPCC): Third Assessment Report (TAR), 2001
[66] Direction Générale de l'Énergie et des Matières Premières [DGEMP] : Les énergies renouvelables en France 1970-2003, Paris, Janvier 2005
[67] Observatoire des énergies renouvelables (Observ'ER): Geothermia Barometer, in: Systèmes Solaires, n° 170, December 2005
[68] Federal Ministry of Transport, Building and Housing (BMVBW) (Ed.): Verkehr in Zahlen 2005/2006, Deutscher Verkehrs-Verlag
[69] Deutsches Windenergie-Institut (DEWI): Windnutzung in Deutschland – Stand 31.12.2005, DEWI Magazin Nr. 28, Februar 2006
[70] International Energy Agency (IEA): Energy Balances of Non-OECD Countries, 2004 Edition
[71] European Commission, Directorate general for Energy and Transport, Beatriz Yordi: Communication on the support of electricity from renewable energy sources (COM (2005) 627), 2005
[72] German Aerospace Center (DLR), Fraunhofer Institute for Systems and Innovation Research (FhG-ISI): Externe Kosten der Stromerzeugung aus erneuerbaren Energien im Vergleich zur Stromerzeugung aus fossilen Energieträgern, Gutachten im Rahmen von Beratungsleistungen für das Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 6. April 2006
[73] Bundesverband Solarwirtschaft (BSW): Aktuelle Entwicklungen im deutschen Photovoltaikmarkt, Vortrag von G. Stryi-Hipp, 21.Symposium Photovoltaische Solarenergie, 08.-10. März 2006, Kloster Banz, Bad Staffelstein
[74] Bundesverband Solarwirtschaft (BSW): www.solarwirtschaft.de, Berlin

“Mindful of its responsibility for future generations, the state shall protect the natural foundations of life ...”

Germany’s Basic Law, Article 20 A

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