Federal Ministry for the
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Renewable energy sources in figures – national and international development

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Dear Reader,

It is vital that we increase our use of renewable energies if we are to have any chance of successfully tackling the twin challenges of climate change and resource scarcity. Only a few years ago, the concept was still in its infancy, and activists were often ridiculed. However, renewable energies in Germany have expanded far more rapidly than many could have anticipated. Last year alone, renewable energies grew by almost 23 percent, thanks in part to the efforts of many dedicated individuals nationwide.

Collector panels for heat generation, solar or wind power plants for electricity generation, biogas plants and hydropower plants have since become a familiar part of the German landscape. Renewable energies have developed into a major pillar of our energy supply, and over the next few years their expansion will continue apace. The Federal Government has set itself targets outlining the next expansion stages, and the required framework conditions will be modified in line with development. In 2007, Germany will have already exceeded its 2010 target of generating 12.5 % of electricity from renewables. The Renewable Energy Sources Act has proven particularly useful in this regard, and will remain the main tool for increasing the use of renewable energies in the electricity sector over the next few years.

In March 2007, the European Council adopted ambitious targets for the European Union: By the year 2020, renewable energies must account for 20 % of total energy consumption. This will require renewed effort throughout all Member States; Germany is committed to making a commensurate contribution.

Renewable energies are not only important from a climate protection viewpoint, but are also becoming an increasingly significant economic factor in Germany. Overall, turnover from renewable energies increased by around 4.8 billion Euros from 18.1 billion Euros in 2005 to around 22.9 billion Euros in 2006. Renewable energies provided jobs for over 210,000 people in 2006, around one third more as in 2004. No other sector has experienced such a boom in recent years.

Against the backdrop of climate change, the future belongs to renewable energies. I will continue to campaign for this to remain a top priority.

Sigmar Gabriel
Federal Minister for the Environment, Nature Conservation and Nuclear Safety

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

In collaboration with the Federal Ministry of Economics and the Federal Agricultural Ministry, the German Environment Ministry has set up the Working Group on Renewable Energies – Statistics (AGEE-Stat) to ensure that all statistics and data relating to renewable energies are part of a comprehensive, up-to-date and coordinated system. The results of AGEE-Stat's work have been incorporated into this brochure.

AGEE-Stat is an independent specialist body, which began operation in February 2004. Its members include experts from

- the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
- the Federal Ministry of Economics and Technology (BMWi)
- the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)
- the Federal Environmental Agency (UBA)
- the Federal Statistical Office (StBA)
- Fachagentur Nachwachsende Rohstoffe e.V. (Agency of Renewable Resources, FNR),
- Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research, ZSW), and
- Arbeitsgemeinschaft Energiebilanzen (Working Group on Energy Balances, AGEB).

Prof. Dr. Staiß (ZSW Stuttgart) has been appointed Head of the Working Group on Renewable Energies – Statistics.

AGEE-Stat's work focuses primarily on renewable energy statistics. It has also been charged with

- creating a basis for the Federal Government's various national, EU-wide and international reporting obligations in the field of renewable energies, and
- carrying out general information and PR work on renewable energy data and development.

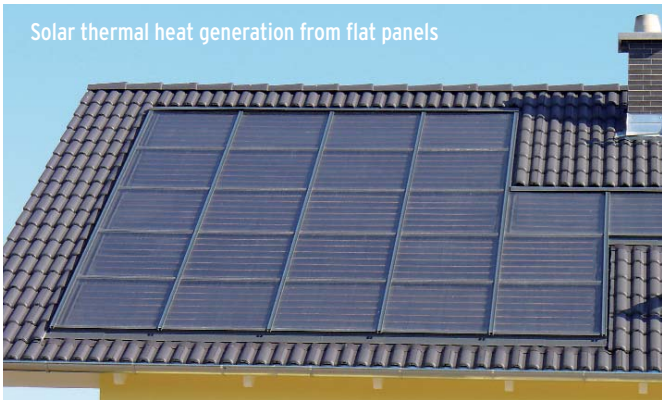
In order to improve the database and scientific calculation methods, AGEE-Stat is also involved in a range of research work. Its work is supported by workshops and consultations on selected topics.

Further information on AGEE-Stat and renewable energies may be found on the BMU website: www.erneuerbare-energien.de.


Residential unit with solar power plant


Wind power plant


Construction of the hydropower plant Kehl / Upper Rhine at weir Kehl/Strasbourg


Solar thermal heat generation from flat panels


Rape seed cultivation in the Ore Mountains


Leonberg fermentation plant – Fermenter and gas tank


Offshore wind power plant at Rostock international seaport


Fire wood supply

Contents

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

How to achieve an intelligent energy supply and ensure that it is used efficiently is one of the central challenges facing us in the 21st century. In many regions of the world energy demands are increasing at a rapid pace as industrialisation catches up. At the same time, industrialised countries are facing the need to dramatically reduce their energy consumption, because only then can they succeed in ameliorating the consequences of the greenhouse effect and become less dependent on oil, coal and uranium imports.

In addition to the important strategy of ensuring the economical use and efficient conversion of energy raw materials, the German Environment Ministry is also firmly committed to the use of renewable energy sources. In recent years, renewable energies have gained considerably in significance, particularly in the electricity market, but also in the transport and heat sectors. With a share of 12 % of Germany's electricity supply in 2006, renewable energies have become an essential pillar of the energy industry. Renewable energies contribute to a sustainable energy supply in a number of ways:

- They make a substantial contribution to climate protection, because their plants do not burn any fossil fuels – in 2006 they helped to avoid the emission of around 100 million tonnes of the climate gas CO_2. Without renewable energies, Germany's climate protection target under the Kyoto Protocol would still be a long way off.
- They diversify the range of raw materials, make us less dependent on fossil fuels, and hence contribute to supply security and the avoidance of raw material conflicts.
- In the medium term, renewables also protect us against the cost increases which inevitably occur with fossil and nuclear resources.
- At the end of their useful life, renewable energy plants are easily dismantled and recycled. They do not cause residual radiation like nuclear power stations, and do not leave a legacy of disused mines.
- Renewable energies are often domestic energy carriers which contribute to regional value-added and help to safeguard jobs. In 2006, a total turnover of around 23 billion Euros was generated in Germany; over 210,000 people were employed in this sector in 2006.
- In poor countries, renewable energies can offer a way out of poverty, and furthermore, in many cases, they also make it easier for large sections of the population to access energy, e.g. via rural electrification.

Objectives

To date, the expansion of renewable energies has been a success story. However, the Federal Government has set itself even more ambitious targets: By the year 2010, the share of renewable energies in energy supply is to be at least doubled compared with 2000 levels: in the case of electricity, to at least 12.5 %. By 2020, they will account for at least 10 % of primary energy consumption, and at least 20 % of electricity supply. By 2050, at least half of German energy consumption is to originate from regenerative sources. The BMU believes it is feasible to cover at least 25 – 30 % of the electricity supply with renewables by 2020, provided we can significantly improve the efficiency of the conversion and use of energy in all sectors. The use of renewable energies in the heat sector has been expanding for many years, and can be further significantly enhanced by means of suitable measures. The BMU has set itself a target of a 14 % renewables' share in heat from renewables by 2020.

Wind energy

With an installed capacity of 20,622 megawatts in 2006, Germany remains the world leader in windpower use. These wind power plants produced 30.5 TWh of electricity, accounting for 5.0 % of total electricity consumption. Compared with the previous year, the number of newly installed plants has increased by 15 %, while the newly installed capacity has increased by 24 %. The modernisation of existing wind farms ("repowering") is also slowly taking shape. In 2006, just under 140 MW was created by repowering, the same as in 2004 and 2005 put together.

In future years, the contribution of wind energy will continue to grow, with a new focus on the development of offshore wind farms. The wind conditions in the North and Baltic Seas are excellent. As part of its sustainability strategy "Perspectives for Germany", the Federal Government, under the leadership of the German Environment Ministry, has presented a strategy for the use of offshore wind energy and designated the first suitable areas for wind farms and protected areas.

Biomass

Biomass is a climate-friendly, regional raw energy material and is available around the clock for energy supply purposes. It therefore makes an important contribution towards achieving a reliable energy supply.
With the entry into force of the Biomass Ordinance on 21 June 2001, and the improvements to fees under the new Renewable Energy Sources Act (EEG) in 2004, we have paved the way for electricity from renewable raw materials and biogenic residues and wastes. In total, over 16 TWh of electricity was supplied in this way in 2006. Wood-fired heaters and power stations, biogas plants, plants for liquid biomass as well as biofuels already contribute 5.3 % to electricity supply in Germany (excluding electricity from biogenic wastes). Since 1 January 2007, fuel suppliers have been obliged to add a certain proportion of biofuels to the fuel blend. In 2007, the quota for diesel is 4.4 % and for petrol 1.2 % (see page 32). Biodiesel outside of the quota will be subject to taxation at a rate of 9 cents per litre (since 1 August 2006). Vegetable oil will remain tax-free for the time being.

Geothermal energy

The heat from the earth's core may be used to heat buildings or local district heating networks, as well as to generate electricity. While geothermal heating plants have existed for a number of years, 2003 saw the inauguration of the first geothermal power plant in Germany. Three further power plants are due to be commissioned in the second half of 2007. In order to be able to tap into Germany's substantial potential for geothermal heat, the Federal Government is continuing to promote projects in the field of geothermal electricity generation. The Renewable Energy Sources Act (EEG) also specifies feed-in rates.

Hydropower

The electricity yield from hydropower depends not only on the installed capacity, but also on weather conditions. For example, in 2006, electricity generation, at 21.6 TWh, was barely higher than in 2005. However, for the future this figure is expected to increase when a number of plants commence operation, having become more attractive under the new EEG 2004.

Photovoltaic / solar thermal energy

The sharp upward trend in the generation of electricity from solar energy using solar cells continued in 2006. Thanks to the support received under the EEG, solar electricity has almost quadrupled within three years, to around two billion kilowatt hours. Technical innovations and growing markets will mean that electricity from photovoltaic plants becomes more cost-effective each year.

The total surface area of new solar collectors installed has increased by 50 % compared with the increase in 2005. Just under one million plants with a surface area of around 8.6 million m^2 in Germany supported the heating of service and heating water, as well as swimming pools, in 2006. High oil and gas prices and concessions under the Federal Government's Market Incentive Programme will continue to advance the installation of solar thermal facilities.

Pillars of the energy transformation

The Federal Government consistently exploits the available potential for the rational, economical use of energy and improving energy efficiency. Pivotal to this are the ecological tax reform introduced in 1999, and the measures included in the climate protection programme of October 2000. These include the Energy Saving Ordinance, the Combined Heat and Power Generating Act, as well as measures in the field of energy consumption labelling. The building modernisation programme to cut CO_2 emissions was extended considerably in 2006. Emissions trading for plants from 20 MW heat capacity for combustion will be further developed this year to allow German industry to meet its long-term 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 individual 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 had already definitively announced that the controversial nuclear power plant Müllheim-Kärlich would not be reconnected. 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 conservation of valuable resources and achieving sustainable global development – these are the important challenges facing us in the 21st century. The transformation of the energy system is a vital precondition for achieving these goals. En route to a sustainable energy supply, the Federal Government is focussing on phasing out nuclear power, energy saving, energy efficiency, and the expansion of renewable energy sources.

The most important developments in 2006 at a glance

Germany making further advances in solar energy utilisation

Photovoltaic world champion: Newly installed capacity of 950 MW_p (2005: 863 MW_p), higher than in Japan (approximately 300 MW_p) [ZSW 3; Solar Verlag 66; Focus 69]; newly installed solar thermal collector area: around 1,400,000 m² (2005: 960,000 m²), giving over 8.6 million m² in total.

Wind energy makes the greatest contribution

Net newly installed capacity of 2,233 MW, an increase of 24 % against the previous year; in total (including the replacement of facilities) 20,622 MW installed, 30.5 TWh electricity generated.

Bioenergy gaining ground

New Renewable Energy Sources Act (EEG) boosts expansion in the electricity market: over 16 TWh bio-electricity generated; the 4 million tonnes mark for biofuels has almost been met; sales of pellet heaters continue to rise (approx. 28,000 systems) [vdz 49].

Hydopower stabilised

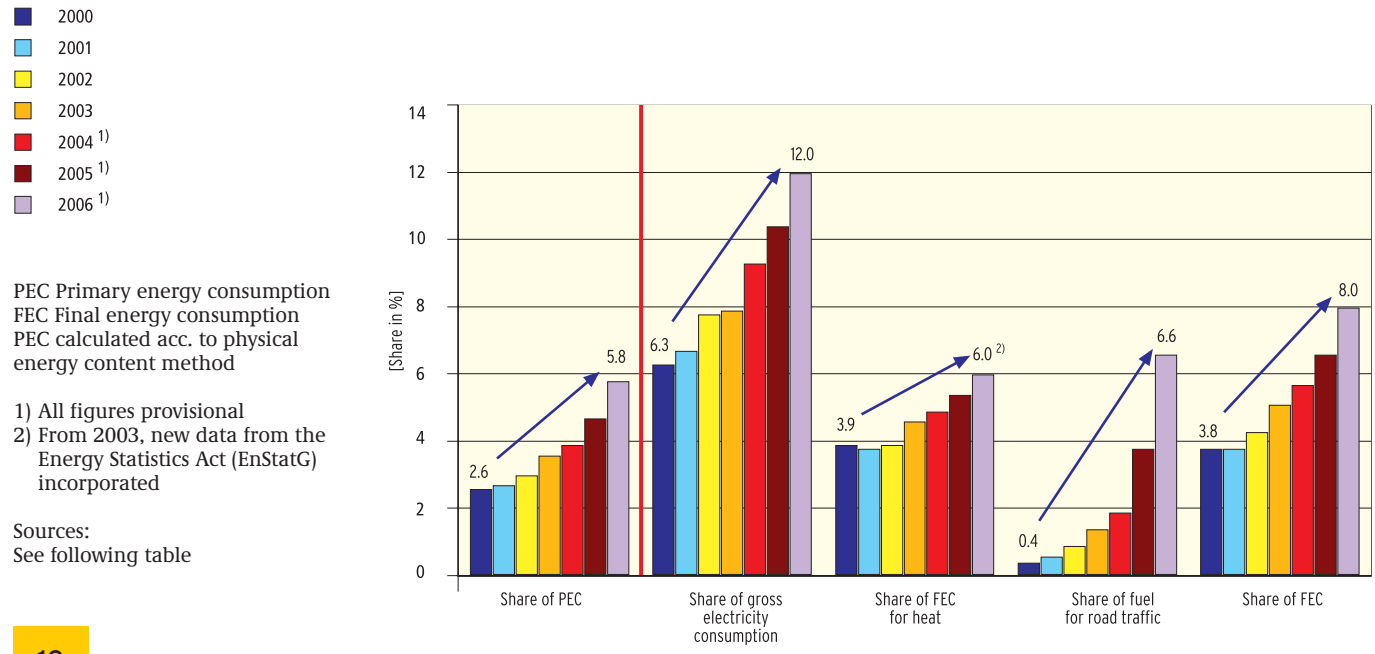
Similar weather conditions have led to roughly similar returns.

Geothermal energy in position

Deep geothermal energy: three further projects in the electricity market are due to be commissioned shortly; sales of heat pumps continue to rise (over 43,000 systems) [BWP 26].

Renewable energy sources as a share of energy supply:

- 5.8 % of primary energy consumption (2005: 4.7 %)
- 12.0 % of gross energy consumption (2005: 10.4 %)
- 6.0 % of final energy consumption for heat (2005: 5.4 %)
- 6.6 % of fuel consumption for road traffic (2005: 3.8 %)
- 8.0 % of total final energy consumption (electricity, heat, fuel; 2005: 6.6 %)



PEC Primary energy consumption
FEC Final energy consumption
PEC calculated acc. to physical energy content method

1) All figures provisional
2) From 2003, new data from the Energy Statistics Act (EnStatG) incorporated

Sources:
See following table

Contribution of renewable energy sources to energy supply in Germany, 2006

		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)	21,636	77.9	212.8	Share of electricity 8)	3.5	0.5	1.4
	Wind energy	30,500	109.8	289.4		5.0	0.8	2.0
	Photovoltaics	2,000	7.2	17.8		0.3	0.05	0.1
	Biogenic solid fuels	7,200	63.4	63.4		1.2	0.4	0.4
	Biogenic liquid fuels	1,600	14.1	14.1		0.3	0.1	0.1
	Biogas	5,400	47.5	47.5		0.9	0.3	0.3
	Sewage gas	888	7.8	7.8		0.1	0.1	0.1
	Landfill gas	1,050	9.2	9.2		0.2	0.1	0.1
	Biogenic share of waste 3)	3,600	31.7	31.7		0.6	0.2	0.2
	Geothermics 4)	0.4	0.0	0.0		0.0	0.0	0.0
	Total	**73,874**	**368.7**	**693.8**		**12.0**	**2.5**	**4.7**
Heat generation	Biogenic solid fuels (households)	61,600	221.8		Share of FEC for heat 9)	4.1	1.5	1.5
	Biogenic solid fuels (industry) 5)	11,250	40.5			0.8	0.3	0.3
	Biogenic solid fuels (CHP/HP plants) 6)	2,450	8.8			0.2	0.06	0.06
	Biogenic liquid fuels 7)	1,400	5.0			0.1	0.03	0.03
	Biogenic gaseous fuels 7)	3,000	10.8			0.2	0.1	0.1
	Biogenic share of waste 3)	4,379	15.8			0.3	0.1	0.1
	Solar thermal energy	3,273	11.8			0.2	0.1	0.1
	Deep geothermal energy	129	0.5			0.01	0.003	0.003
	Near-surface geothermal energy	1,778	6.4			0.1	0.04	0.04
	Total	**89,259**	**321.3**			**6.0**	**2.2**	**2.2**
Fuel	Biodiesel 13)	28,933	104.2		Share of FEC attributeable to road transport 10)	4.8	0.7	0.7
	Vegetable oil 13)	7,416	26.7			1.2	0.2	0.2
	Bioethanol	3,573	12.9			0.6	0.09	0.09
	Total	**39,922**	**143.7**			**6.6**	**1.0**	**1.0**
Total		**203,055**	**833.7**	**1,158.9**	**FEC 11)**	**8.0**	**5.8**	**7.8**

The current valid method for 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 used in the calculation of avoided emissions by renewable energies and the fuels provided, is also outlined below.

Deviations in the totals are due to rounding. PEC Primary energy consumption, 14,464 PJ, as at Feb. 2007; FEC Final energy consumption; RES Renewable energy sources; CHP/HP cogeneration and heating plants

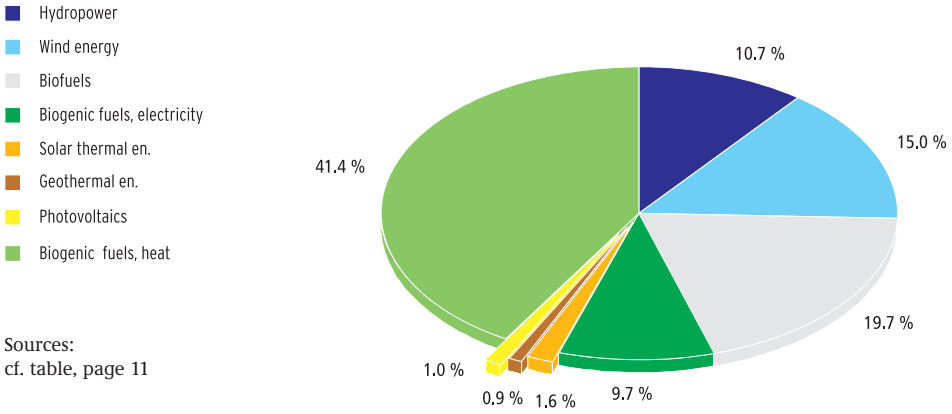
1) For an explanation of the methods used to determine primary energy equivalent refer to Appendix, para. 4; in the case of heat and fuel, final energy is equated with primary energy here
2) In the case of pumped-storage power plants, only electricity generated from natural inflow
3) Biogenic portion estimated at 50 %
4) Electricity generation from geothermal energy currently in a pilot phase
5) Industry = operations involved in mining, the extraction of stones and soil, and the manufacturing industry, § 8 of the Energy Statistics Act, 2006 figure estimated on the basis of data for 2005
6) Acc. to §§ 3 and 5 of the Energy Statistics Act, general supply only
7) Partly estimated, in the case of gases including the direct use of sewage gas
8) Based on gross electricity consumption of 615.8 TWh in 2006
9) Based on the final energy consumption for room heating, hot water and other process heat in 2005 (with due regard for the accumulation and depletion of storable fuel stocks - adjusted version) of 183.7 million tonnes of hard coal equivalent or 5,384 PJ
10) Figures provisional; based on fuel consumption in road traffic of 2,191 PJ in 2005
11) Based on final energy consumption of 9,173 PJ in 2005
12) With a substitution factor (for electricity from biomass) of 8,805 kJ/kWh, cf. Appendix, para. 4
13) Figures provisional; prior to 1 August 2006, biodiesel and vegetable oil were not recorded separately. Up until that date, vegetable oil is included under biodiesel.

On the generation of electricity from photovoltatic energy and on the supply of heat from solar thermal energy, cf. also Appendix, para. 5.

Sources: ZSW [3]; BSW [10]; AGEB [1], [15], [18]; DIW [11]; StBA [5]; ISI [41]; VDN [9]; BMVBS [57]; IE [70]; VDEW [71], [74]; Erdwärme-Kraft [79]; BMF [67]

Structure of energy supply from renewable energy sources, 2006

Structure of final energy supply

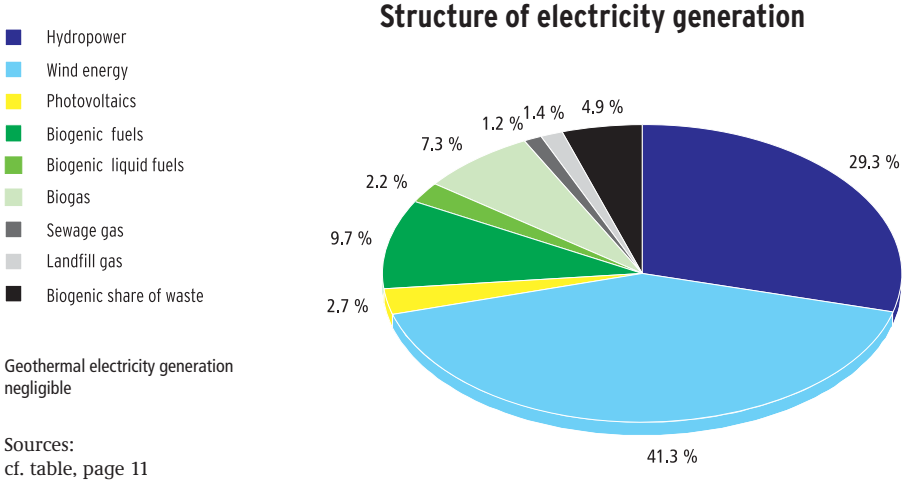


Sources:
cf. table, page 11

Final energy: 203 TWh
(8 % share of total final energy consumption)

Around 71 % of all final energy from renewable energy sources is provided by biomass.
In relation to heat generation from renewable energy sources, biomass (primarily wood) accounts for a share of 94 %.
By contrast, hydropower (41 %) and wind energy (29 %) are particularly significant for electricity generated from renewable energy sources.

Structure of electricity generation

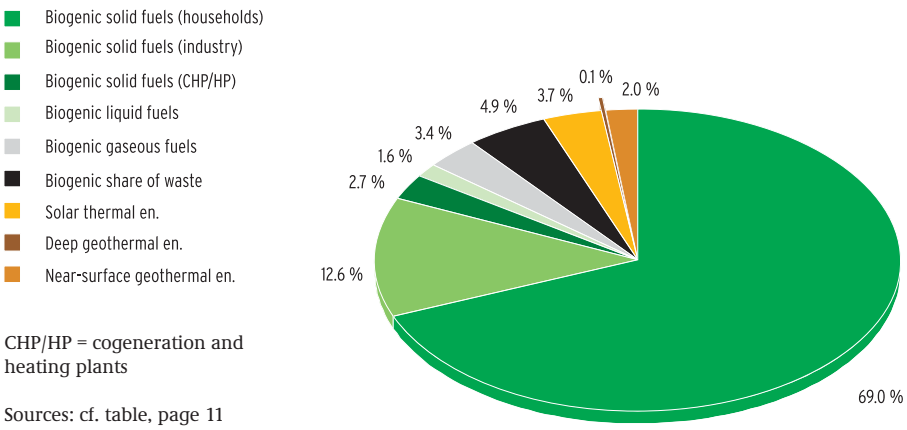


Geothermal electricity generation negligible

Sources:
cf. table, page 11

Electricity generation: approx. 74 TWh (12 % share of electricity consumption)

Structure of heat supply



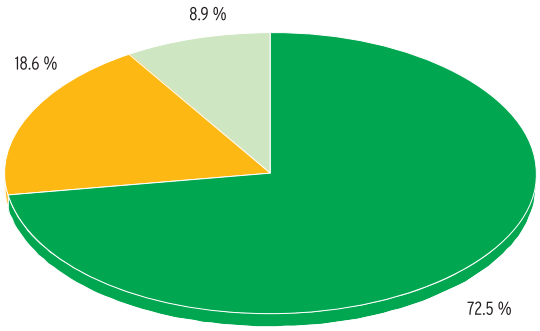
CHP/HP = cogeneration and heating plants

Sources: cf. table, page 11

Heat supply: approx. 89 TWh
(6 % share of final energy consumption for heat)

Structure of biofuels supply

Biogenic fuels: approx. 40 TWh (6.6 % share of total fuel consumption for road traffic)



Prior to 1 August 2006, vegetable oil and biodiesel were not listed separately, i.e. until that date, vegetable oil is included under biodiesel.

Sources: cf. table, page 11

Share of renewable energy sources in energy supply

	1998	1999	2000	2001	2002	2003	2004	2005 1)	2006 1)
Final energy consumption (FEC)	[%]								
Electricity generation (based on total gross electricity consumption)	4.8	5.5	6.3	6.7	7.8	7.9	9.3	10.4	12.0
Heat supply (based on total heat supply)	3.5	3.5	3.9	3.8	3.9	4.6	4.9	5.4	6.0
Fuel consumption (based on fuel consumption in road traffic)	0.2	0.2	0.4	0.6	0.9	1.4	1.9	3.8	6.6
RES share of total FEC	**3.1**	**3.3**	**3.8**	**3.8**	**4.3**	**4.9**	**5.5**	**6.6**	**8.0**
Primary energy consumption (PEC)									
Electricity generation (based on PEC)	0.8	0.9	1.1	1.1	1.4	1.5	1.6	2.1	2.5
Heat supply (based on PEC)	1.3	1.3	1.4	1.4	1.5	1.8	1.9	2.0	2.2
Fuel consumption (based on PEC)	0.03	0.03	0.06	0.1	0.1	0.2	0.3	0.6	1.0
Share of PEC 2)	**2.1**	**2.2**	**2.6**	**2.7**	**3.0**	**3.5**	**3.9**	**4.7**	**5.8**

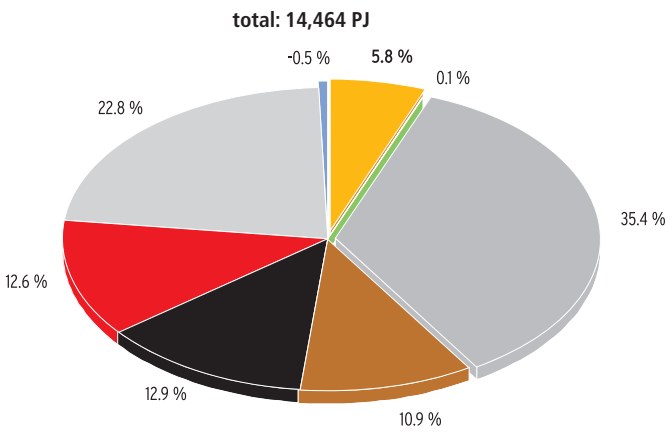
Generally speaking, all figures from 2004 onwards in the German part of this brochure are provisional.

RES = Renewable energy sources

1) Reference year for heat and fuel consumption 2005
2) Acc. to the physical energy content method, cf. Appendix, para. 4

Sources:
Acc. to previous and subsequent tables, and acc. to VDEW [17], [47]

Structure of primary energy consumption, 2006



Provisional figures, primary energy consumption as at February 2007

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

Development of energy supply from renewable energy sources, 1990 to the end of 2006

Electricity generation (final energy)

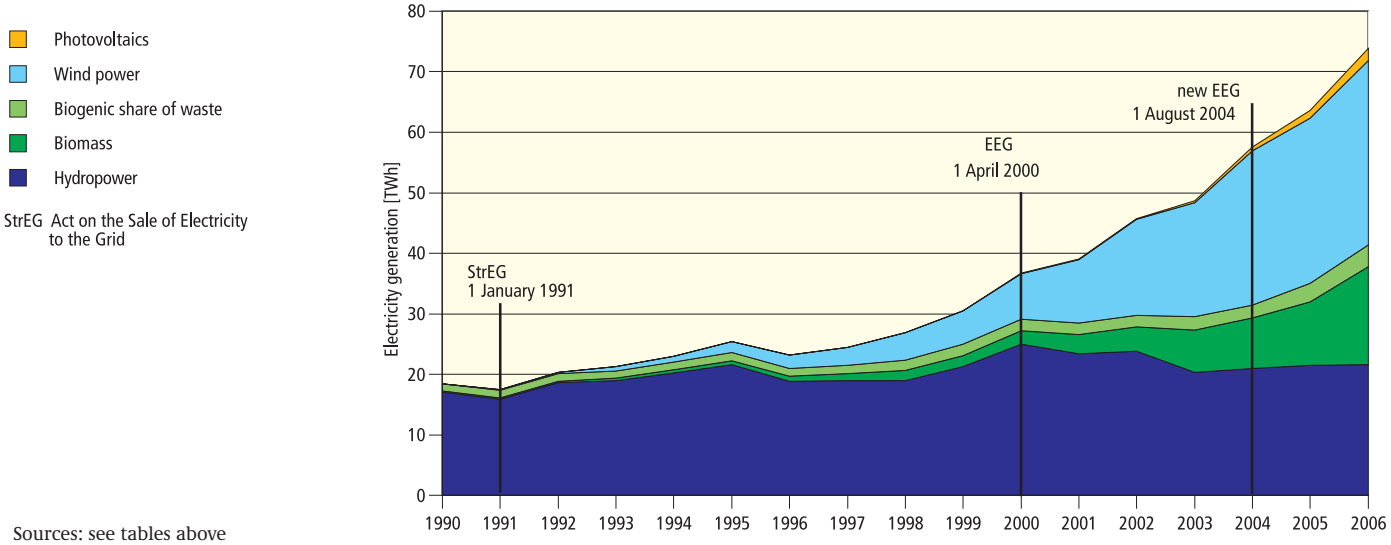
The energy supply from hydropower, wind energy and solar energy is subject to natural fluctuations which can affect the total annual energy yield on both a seasonal and short-term basis.

1) In the case of pump storage power plants, electricity generated from natural inflow only
2) Until 1998 only feed-in to the general supply grid
3) Share of biogenic waste in waste incineration plants estimated at 50 %

Sources: ZSW [3]; EnBW [12]; BWE [16]; StBA [5]; BMELV [75]; IE [8], [13], [20], [70]; VDN [9]; AGEB [2], [18]; FNR [7]; SFV [28]; BSW [10]; ZfS [19]; Erdwärme-Kraft [79]; DEWI [62], [76], [77], [78]; Solar-Verlag [66]; BMF [67]

	Hydro-power 1)	Wind power	Biomass 2)	Biogenic share of waste 3)	Photo-voltaics	Geothermal	Total electricity generation
	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]
1990	17,000	40	222	1,200	1	0	**18,463**
1991	15,900	140	250	1,200	2	0	**17,492**
1992	18,600	230	295	1,250	3	0	**20,378**
1993	19,000	670	370	1,200	6	0	**21,246**
1994	20,200	940	570	1,300	8	0	**23,018**
1995	21,600	1,800	670	1,350	11	0	**25,431**
1996	18,800	2,200	853	1,350	16	0	**23,219**
1997	19,000	3,000	1,079	1,400	26	0	**24,505**
1998	19,000	4,489	1,642	1,750	32	0	**26,913**
1999	21,300	5,528	1,791	1,850	42	0	**30,511**
2000	24,936	7,550	2,279	1,850	64	0	**36,679**
2001	23,383	10,509	3,206	1,859	116	0	**39,073**
2002	23,824	15,786	4,017	1,945	188	0	**45,760**
2003	20,350	18,859	6,970	2,162	313	0	**48,654**
2004	21,000	25,509	8,347	2,116	557	0.2	**57,529**
2005	21,524	27,229	10,495	3,039	1,282	0.2	**63,569**
2006	21,636	30,500	16,138	3,600	2,000	0.4	**73,874**

Development of electricity generation from renewable energies, 1990 to 2006



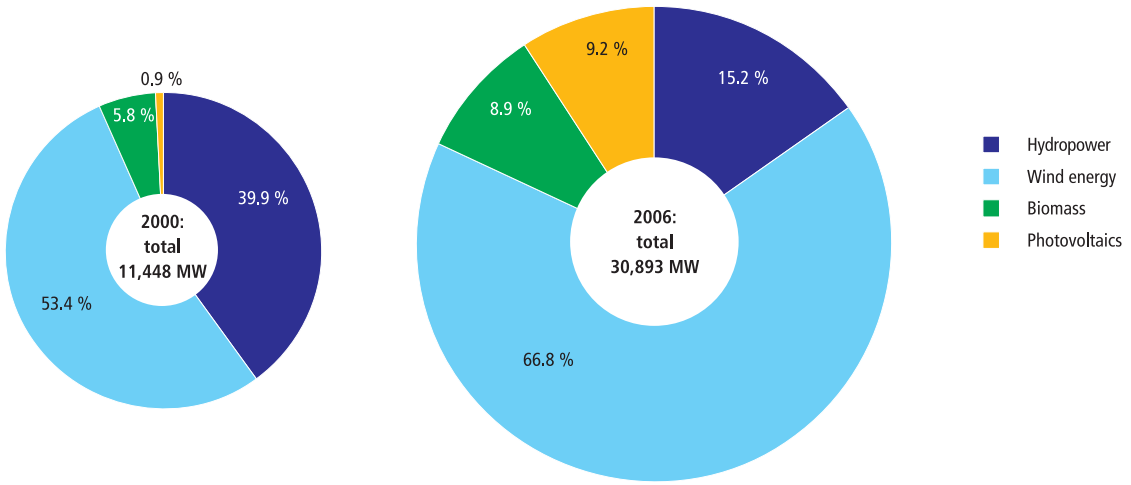
Sources: see tables above

Installed capacity for electricity generation

	Hydro-power	Wind-energy	Biomass	Photovoltaics	Geothermal	Total installed capacity
	[MW]	[MW]	[MW]	[MW_p]	[MW]	[MW]
1990	4,403	56	190	2	0	**4,651**
1991	4,403	98	N/A	3	0	**4,504**
1992	4,374	167	227	6	0	**4,774**
1993	4,520	310	N/A	9	0	**4,839**
1994	4,529	605	276	12	0	**5,422**
1995	4,521	1,094	N/A	16	0	**5,631**
1996	4,563	1,547	358	24	0	**6,492**
1997	4,578	2,082	400	36	0	**7,096**
1998	4,601	2,875	409	45	0	**7,930**
1999	4,547	4,444	604	58	0	**9,653**
2000	4,572	6,112	664	100	0	**11,448**
2001	4,600	8,754	790	178	0	**14,322**
2002	4,620	11,965	952	258	0	**17,795**
2003	4,640	14,609	1,137	408	0	**20,794**
2004	4,660	16,629	1,550	1,018	0.2	**23,857**
2005	4,680	18,428	2,192	1,881	0.2	**27,181**
2006	4,700	20,622	2,740	2,831	0.2	**30,893**

The figures on installed capacity refer to the year-end status in each case.
N/A = not available

Shares of total installed capacity of renewable energy sources, 2000 and 2006



Since the EEG entered into force in 2000, the total installed capacity for the generation of electricity from renewable energy sources has almost tripled.

Sources: cf. table, page 14

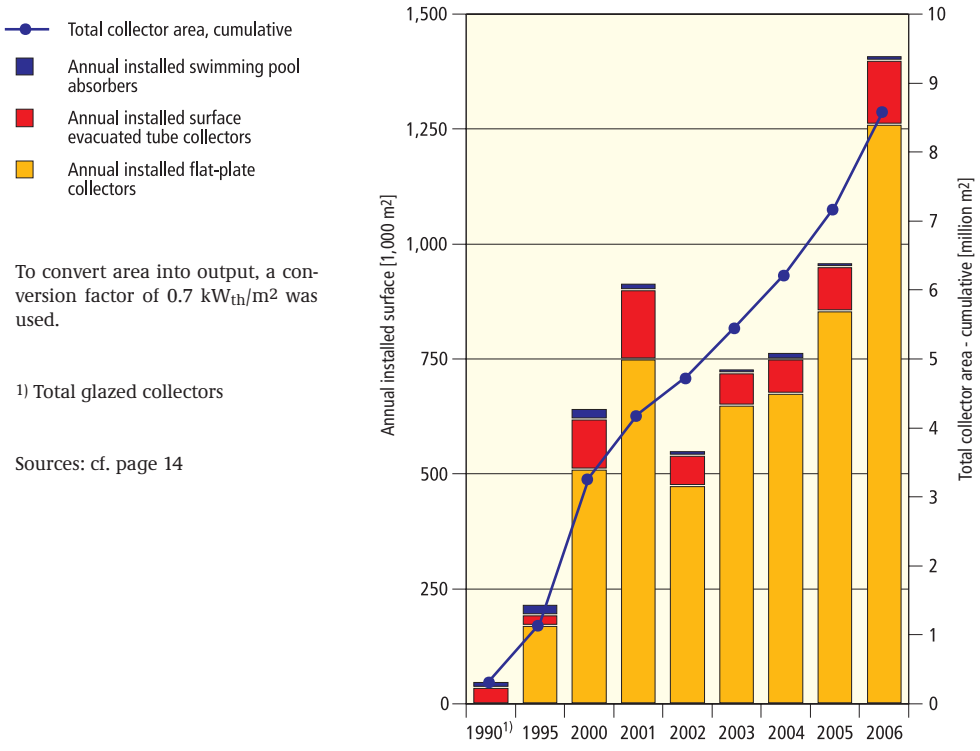
Heat supply (final energy)

1) In contrast to previous years, from 2003 onwards figures acc. to §§ 3, 5 (cogeneration and heating plants) and § 8 (industry) of the Energy Statistics Act of 2003 and direct use of sewage gas
2) Biogenic waste share in waste incineration plants estimated at 50 %

Sources: cf. page 14

	Biomass 1)	Biogenic share of waste 2)	Solar thermal energy	Geothermal	Total heat generation
	[GWh]	[GWh]	[GWh]	[GWh]	[GWh]
1990	N/A	N/A	130	N/A	N/A
1991	N/A	N/A	166	N/A	N/A
1992	N/A	N/A	218	N/A	N/A
1993	N/A	N/A	279	N/A	N/A
1994	N/A	N/A	351	N/A	N/A
1995	N/A	N/A	440	1,425	N/A
1996	N/A	N/A	550	1,383	N/A
1997	45,646	2,900	695	1,335	50,576
1998	48,625	2,988	857	1,384	53,854
1999	47,811	3,140	1,037	1,429	53,417
2000	51,036	3,278	1,279	1,433	57,026
2001	52,043	3,283	1,612	1,447	58,385
2002	51,302	3,324	1,919	1,483	58,028
2003	62,555	3,806	2,183	1,532	70,076
2004	66,251	3,694	2,487	1,558	73,990
2005	72,190	4,692	2,828	1,601	81,311
2006	79,700	4,379	3,273	1,907	89,259

Development in the installation of new solar collectors



To convert area into output, a conversion factor of 0.7 kW_{th}/m^2 was used.

1) Total glazed collectors

Sources: cf. page 14

	Solar thermal en.	
	Cumulative surface	Cumulative capacity
	[1,000 m²]	[MW]
1990	340	238
1991	468	328
1992	590	413
1993	749	524
1994	946	662
1995	1,159	811
1996	1,457	1,020
1997	1,821	1,275
1998	2,194	1,536
1999	2,641	1,849
2000	3,284	2,299
2001	4,199	2,939
2002	4,749	3,324
2003	5,478	3,835
2004	6,235	4,365
2005	7,197	5,038
2006	8,610	6,027

Fuel supply (final energy)

	Biodiesel 1)	Vegetable oil 1)	Bioethanol 1)	Total biofuels
	[GWh]	[GWh]	[GWh]	[GWh]
1990	N/A	0	0	N/A
1991	2	0	0	2
1992	52	0	0	52
1993	103	0	0	103
1994	258	0	0	258
1995	310	0	0	310
1996	517	0	0	517
1997	827	0	0	827
1998	1,033	0	0	1,033
1999	1,343	0	0	1,343
2000	2,583	0	0	2,583
2001	3,617	0	0	3,617
2002	5,683	0	0	5,683
2003	8,267	52	0	8,319
2004	10,850	52	484	11,386
2005	18,600	2,047	1,936	22,583
2006	28,933	7,416	3,573	39,922

1) For 2006 this corresponds to: biodiesel: 2,800,000 tonnes, approx. 3,200 million litres; vegetable oil: 710,000 tonnes, approx. 770 million litres; bioethanol: 480,000 tonnes, approx. 600 million litres

Sources: cf. page 11

Total energy supply and shares of renewable energies

	Total final energy supply	Share of gross electricity consumption	Share of final energy consumption	Share of primary energy consumption
	[GWh]	[%]	[%]	[%]
1990	N/A	3.4	N/A	N/A
1991	N/A	3.2	N/A	N/A
1992	N/A	3.8	N/A	N/A
1993	N/A	4.0	N/A	N/A
1994	N/A	4.3	N/A	N/A
1995	N/A	4.7	N/A	N/A
1996	N/A	4.2	N/A	N/A
1997	75,908	4.5	2.9	2.0
1998	81,800	4.8	3.1	2.1
1999	85,271	5.5	3.3	2.2
2000	96,288	6.3	3.8	2.6
2001	101,075	6.7	3.8	2.7
2002	109,471	7.8	4.3	3.0
2003	127,049	7.9	4.9	3.5
2004	142,905	9.3	5.5	3.9
2005	167,463	10.4	6.6	4.7
2006	203,055	12.0	8.0	5.8

Sources: cf. page 14

Emissions avoided via the use of renewable energy sources, 2006

		RE Electricity generation: total: 73,874 GWh		RE Heat supply: total 89,259 GWh	
Greenhouse gas/ air pollutant		Savings factor	Avoided emissions	Savings factor 1) 2)	Avoided emissions
		[kg/GWh]	[1,000 t]	[kg/GWh]	[1,000 t]
Greenhouse effect 3)	CO_2	922,105	68,120	231,652	20,677
	CH_4	-4.2	-0.3	-267.3	-23.9
	N_2O	20.8	1.5	-2.7	-0.2
	CO_2 equivalent	**928,170**	**68,568**	**224,710**	**20,057**
Acidification 4)	SO_2	528.2	39.0	92.9	8.3
	NO_X	151.3	11.2	-17.6	-1.6
	SO_2 equivalent	**633.5**	**46.8**	**80.6**	**7.2**
Ozone 5)	CO	85.9	6.3	-8,265.4	-737.8
	NMVOC	-36.7	-2.7	-667.0	-59.5
	Dust	2.3	0.2	-276.0	-24.6

The savings factor is the quotient of avoided emissions from energy supplied from renewables (in kg) and electricity, heat or fuel generation from renewables (in GWh); this corresponds to an average saving of greenhouse gases/air pollutants per GWh generated from renewables.

1) In the case of heat, based on room heating, hot water consumption and process heat; heat supply mix excluding renewable energies in 2004
2) In the case of CHP heat, for simplification purposes we have assumed that the emissions incurred in the combustion of biomass have already been allocated to electricity generation
3) Other greenhouse gases (SF_6, PFC, HFC) have been disregarded
4) Other air pollutants with acidification potential (NH_3, HCl, HF) have been disregarded
5) Precursor substances for ground-level ozone

On the calculation of savings factors and avoided emissions, cf. Appendix, paras. 1. and 2.

Sources: ZSW [3]; Öko-Institut/IZES [22]; ISI [41]; UBA [14], [24]; Stat. Bundesamt [44]; VDEW [47]

When combusted, biomass only emits into the atmosphere the same quantity of CO_2 as it absorbed during plant growth, and is therefore CO_2-neutral.

In the case of older combustion plants or when wood is burned in tile stoves or fireplaces, the quantity of pollutants generated is sometimes significantly higher than in the fossil heat supply mix. This is especially true of carbon monoxide and dust. However, modern wood-fired heaters and wood heating plants, which are gaining in significance, substantially reduce emissions.

Basis of the calculation [kg/GWh]			
	Biodiesel	Vegetable oil	Bioethanol
CO_2	352,362	273,062	147,749
CH_4	44	-43	-250
N_2O	-387	-393	-236
CO_2 eq.	238,789	155,645	72,253

		Biofuels1): total: 39,922 GWh	
Greenhouse gas/ air pollutant		Savings factor	Avoided emissions
		[kg/GWh]	[1,000 t]
Greenhouse effect 2)	CO_2	319,318	12,748
	CH_4	1.6	0.1
	N_2O	-374.7	-15.0
	CO_2 equivalent	**208,439**	**8,321**
Acidification 3)	SO_2	278.4	11.1
	NO_X	643.9	25.7
	SO_2 equivalent	**726.6**	**29.0**
Ozone 4)	CO	567.0	22.6
	NMVOC	140.8	5.6
	Dust	50.3	2.0

1) All figures provisional [BMF 67]; 2,800,000 t biodiesel, 710,000 t vegetable oil, 480,000 t bioethanol
2) Other greenhouse gases (SF_6, PFC, HFC) have been disregarded here
3) Other air pollutants with acidification potential (NH_3, HCl, HF) have been disregarded here
4) Precursor substances for ground-level ozone

Sources: Calculation ZSW [3]; Öko-Institut/IZES [22]

The greenhouse gas balance is dependent on various parameters, amongst others on the biomass used, the process requirements, the reference system and possible by-products. Hence, the figures given here are only estimates. At present, an average greenhouse gas balance of biofuels used in Germany is not statistically recorded.

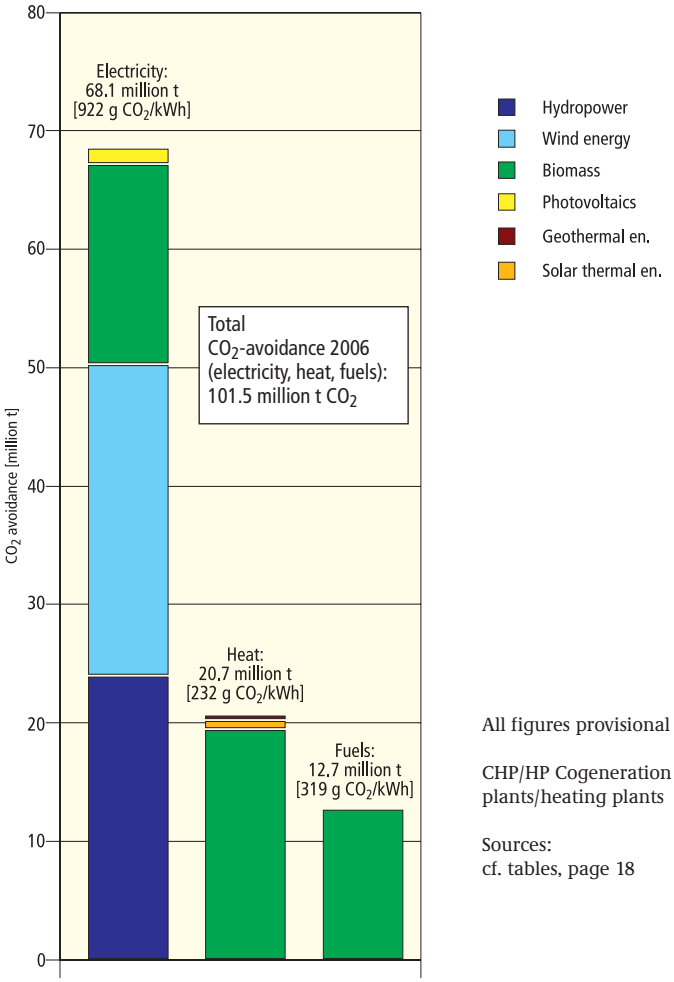
Savings factors incl. prechains and biodiesel including credits for by-products (rapeseed cake, glycerine) in the prechains. For emissions purposes, vegetable oil is equated here with rapeseed oil.

The most widely used biofuels at present – biodiesel – is not classed as CO_2-neutral because methanol of fossil origin is used in its manufacture. However, these negative effects 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 in biogenic fuels that arise mainly from the fertilisation of crops. In the calculation of the CO_2-equivalent savings factor given in the table, it is assumed that approximately 80 % of the equivalent climate gas emissions of diesel fuel are currently avoided via the use of biodiesel which constitutes the largest part of biofuels supply. The calculation of SO_2 equivalent is based on the SO_2 and NO_x emissions described here. If NH_3 emissions from the upstream biogenic chains (particularly as a result of crop fertilisation) were to be included, the SO_2 equivalent would be negative; therefore, pollution would occur. However, as this quantity of emissions only amounts to a few percent of NH_3 emissions from other emissions sources, and there is also a relatively high level of data uncertainty, this share is excluded here, as in the emissions balance for electricity and heat.

Total CO_2 avoidance through the use of renewable energy sources 2006

	Savings factor	Avoided emissions	Share
	[g/kWh]	[1,000 t]	[%]
Electricity			
Hydropower	1,088	23,547	34.6
Wind power	862	26,289	38.6
Photovoltaics	683	1,367	2.0
Biogenic solid fuels	886	6,380	9.4
Biogenic liquid fuels	748	1,197	1.8
Biogas	748	4,041	5.9
Sewage gas	1,088	966	1.4
Landfill gas	1,088	1,143	1.7
Biogenic share of waste	886	3,190	4.7
Geothermal energy	1,088	0	0.0
Total electricity		**68,120**	**100**
Heat			
Biog. solid fuels (households)	232	14,270	69.0
Biog. solid fuels (industry)	232	2,606	12.6
Biog. solid fuels (CHP/HP)	232	568	2.7
Biogenic liquid fuels	232	324	1.6
Biogenic gaseous fuels	232	695	3.4
Biogenic share of waste	232	1,014	4.9
Solar thermal en.	232	758	3.7
Deep geothermal en.	232	30	0.1
Near-surface geothermal en.	232	412	2.0
Total heat		**20,677**	**100**
Biofuels			
Biodiesel	352	10,195	80.0
Vegetable oil	273	2,025	15.9
Bioethanol	148	528	4.1
Total biofuels		**12,748**	**100**
Total (electricity, heat, fuels)		**101,545**	



All figures provisional

CHP/HP Cogeneration plants/heating plants

Sources:
cf. tables, page 18

The contribution of renewable energy sources to climate protection is clearly greater than its contribution to energy supply. In 2006, around 100 million tonnes of CO_2 were avoided through the use of renewable energies. This means that without their use, total CO_2 emissions (approx. 796 million tonnes) would be around 13 % higher. By contrast, the contribution of renewables to primary energy consumption accounts for just 5.8 %.

Development of energy-related emissions, 1990 to 2006

As at spring 2007; figures including diffuse emissions from the extraction, 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

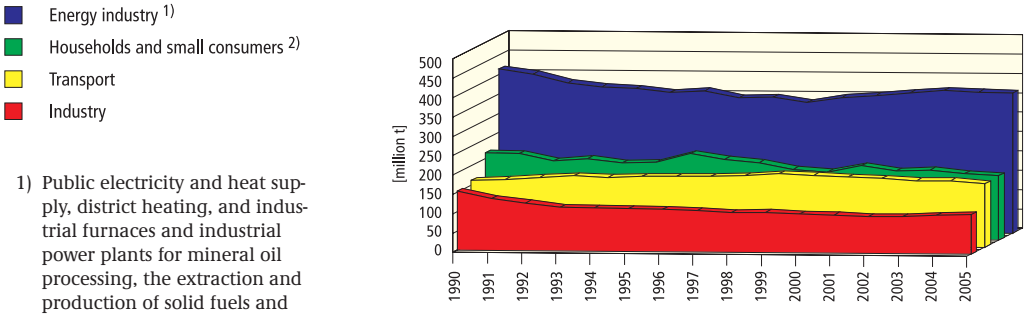
On the significance and calculation of CO_2 and SO_2 equivalents, cf. Appendix, para. 3.

The Federal Environmental Agency has made retrospective methodological changes to the determination of CO_2 emissions. For example, emission factors have been updated on the basis of new research findings, and the classification into process- and energy-related emissions reconciled with emissions trading data. For this reason, the figures here deviate from the results of previous years.

Sources: UBA [4], [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	948	1,514	25	991	5,258	2,728	15	7,215	11,443	2,183	2,177
1991	915	1,425	25	955	3,844	2,516	17	5,658	9,271	1,691	1,187
1992	871	1,288	24	907	3,130	2,367	17	4,843	7,994	1,468	723
1993	863	1,326	24	900	2,789	2,264	18	4,434	7,227	1,212	413
1994	843	1,191	23	878	2,322	2,129	19	3,874	6,252	940	171
1995	841	1,147	23	874	1,654	2,056	19	3,157	5,911	842	118
1996	867	1,121	23	899	1,384	1,945	20	2,812	5,571	754	110
1997	831	1,105	23	863	1,144	1,872	20	2,523	5,413	695	108
1998	824	991	22	854	896	1,786	20	2,216	5,047	630	97
1999	801	1,062	21	832	711	1,762	20	2,012	4,712	559	93
2000	800	1,003	22	830	522	1,615	19	1,718	4,401	468	85
2001	823	927	22	850	530	1,584	19	1,705	4,196	449	86
2002	808	887	22	835	500	1,501	19	1,615	3,928	406	82
2003	822	799	22	847	506	1,443	19	1,581	3,829	374	81
2004	816	709	22	839	478	1,394	18	1,517	3,709	352	80
2005	795	663	22	817	448	1,263	18	1,394	3,464	319	74
2006	796	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 2005

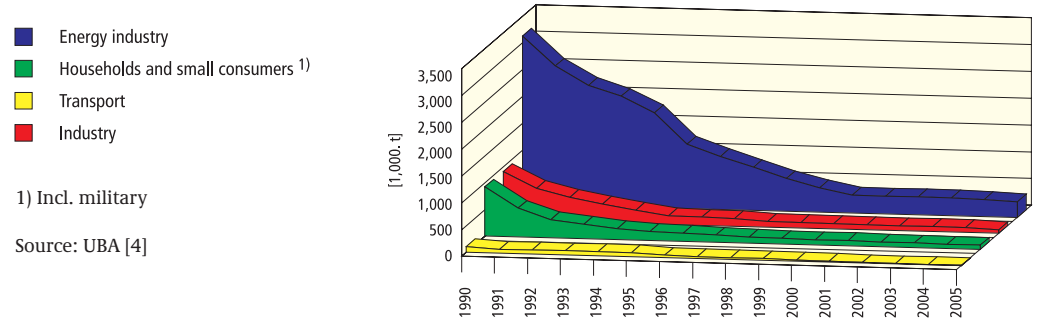


1) Public electricity and heat supply, district heating, and industrial furnaces and industrial power plants for mineral oil processing, the extraction and production of solid fuels and other energy industries
2) Incl. military

Source: UBA [4]

Energy-related CO_2 emissions were reduced by around 16 % between 1990 and 2006; total emissions of greenhouse gases were reduced by around 18 % by the year 2005.

Development of energy-related SO_2 emissions, 1990 to 2005



1) Incl. military

Source: UBA [4]

Between 1990 and 2005, energy-related emissions of sulphur dioxide were reduced by more than 90 %.

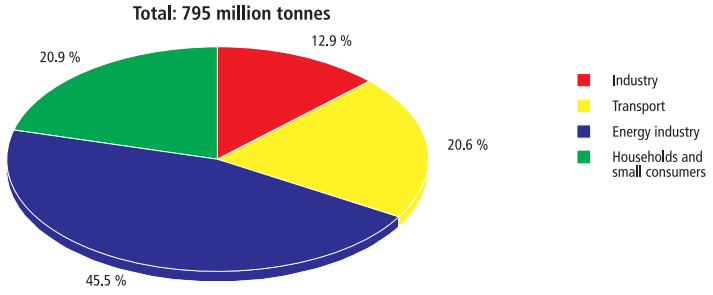
Energy-related emissions according to source groups, 2005

		Energy industry [1]	Households and small consumers [2]	Transport [3]	Industry [4]	Total [5]	Savings from RE [6] (2006)
CO_2	[million t]	362.0	166.3	164.2	102.8	795.2	101.5
CH_4	[1,000 t]	6.1	35.3	8.9	6.0	56.3	-24.1
N_2O	[1,000 t]	12.5	1.9	4.2	2.9	21.5	-13.7
CO_2 equivalent [7]	[million t]	365.8	167.6	165.7	103.8	802.9	96.9
SO_2	[1,000 t]	289.9	78.3	1.5	62.8	432.5	58.4
NO_X [8]	[1,000 t]	285.5	162.0	747.8	68.1	1,263.4	35.3
SO_2 equivalent [9]	[1,000 t]	499.9	202.3	561.8	115.1	1,379.2	83.0
CO	[1,000 t]	133.0	1,125.9	1,574.9	622.0	3,455.8	-708.8
NMVOC	[1,000 t]	8.4	101.5	159.4	3.1	272.4	-56.6
Dust	[1,000 t]	12.5	31.4	25.6	2.1	71.6	-22.5

Emissions as at spring 2007

1) Public electricity and heat supply, district heating plants, industrial furnaces and industrial power plants for mineral oil processing, the extraction and manufacture of solid fuels, and other energy industries
2) Private households, commerce, trade, services and military, plus agricultural and forestry traffic and military land and air traffic
3) Including rail traffic, national aviation, coastal and inland shipping
4) Manufacturing industry; excluding process-related emissions
5) Figures excluding diffuse emissions from the extraction, conversion and distribution of fuels
6) Electricity and heat generation and fuels from renewable energies
7) Includes CO_2, CH_4 and N_2O
8) Calculated as NO_2
9) for NH_3 emissions with renewable energies cf. page 19

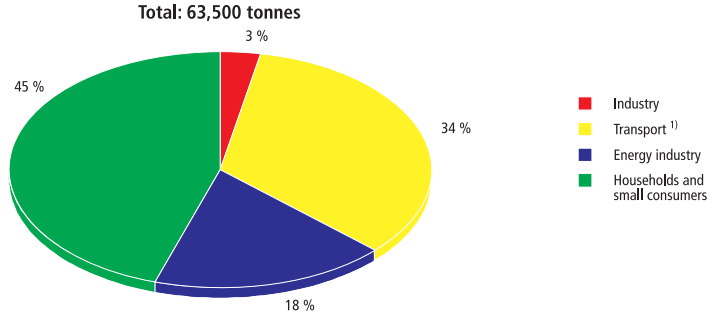
Source group shares of energy-related CO_2 emissions, 2005



Sources: UBA [4]; ZSW [3]

Source: UBA [4]

Source group shares of energy-related particulate matter emissions, 2005



1) Excluding abrasion from tyres and brake pads.

Only includes fine dust emissions for particle sizes up to 10 micrometres (PM10) in accordance with the European Air Quality Directive (1999/30/EC), which has been in force in Germany since 1 January 2005.

Source: UBA [4]

Fossil fuels saved via the use of renewable energy sources, 2006

On the calculation of fossil fuel savings, cf. also Appendix, para. 6. Electric heaters have been disregarded here.

1) Substitution acc. to the ISI expert report on CO_2 reductions in the electricity sector via the use of renewable energies
2) Fuel use calculated as final energy

Sources: ZSW [3]; Öko-Institut/ IZES [22]; according to ISI [41]

	Lignite	Hard coal	Natural gas	Heavy oil / light fuel oil	Diesel fuel	Petrol	Total
	Primary energy [TWh]						
Electricity [1]	91.2	89.3	15.7	-	-	-	**196.3**
Heat	3.3	0.8	54.7	40.1	-	-	**99.0**
Fuel [2]	-	-	-	-	43.8	2.6	**46.4**
Total	**94.6**	**90.1**	**70.5**	**40.1**	**43.8**	**2.6**	**341.7**
	Primary energy [PJ]						
Total	**340.4**	**324.4**	**253.7**	**144.5**	**157.7**	**9.3**	**1,230.0**
Corresponding to	**37.1 mill. t**	**11.2 mill. t**	**6,900 mill. m³**	**4,037 mill. litres**	**3,915 mill. litres**	**291 mill. litres**	

The table above gives a detailed insight into the saving of fossil fuels via the use of renewable energies in 2006. As a large proportion of the fossil, i.e. non-renewable, fuels in Germany is imported, these savings also lead to a direct reduction in German energy imports.

Development in the saving of fossil fuels via the use of renewable energies, 2004 to 2006

	Electricity	Heat	Fuels	Total
	[TWh]			
2004	150.8	67.6	14.0	232.4
2005	169.4	88.4	26.9	284.7
2006	193.2	97.3	31.9	322.4

Growing levels of primary energy savings, in conjunction with rising import prices for primary energy carriers, mean a disproportionately high increase in financial savings. Between 2004 and 2006, this amount increased 2.6-fold, while the substituted quantity of primary energy only increased 1.4-fold (Calculation according to so-called physical energy content method, cf. appendix, para. 4).

Development in the costs saved on energy imports, 2004 to 2006 [1)]

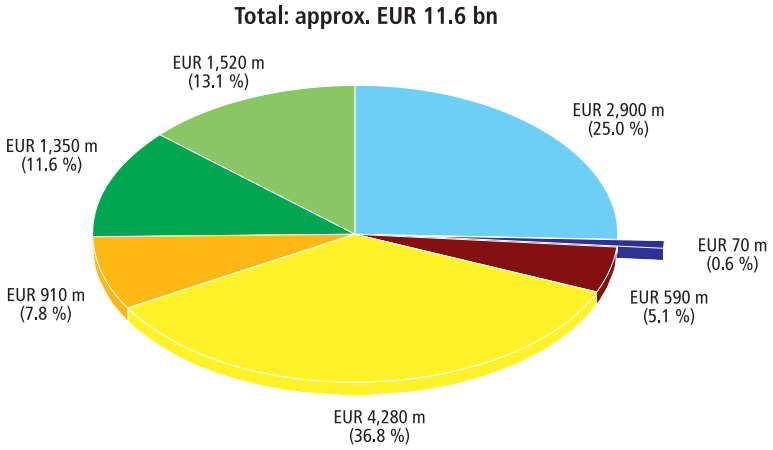
	Electricity	Heat	Fuels	Total
	[bn EUR]			
2004	0.5	1.2	0.4	2.0
2005	0.7	2.1	1.1	3.9
2006	1.0	2.7	2.0	5.7

1) Excluding imported lignite for heating purposes (briquettes). Import shares of petroleum and natural gas acc. to [BMWi]. Import share for steam coal 100 %, because fixed purchase agreements for German hard coal do not permit any reductions. Consequently, steam coal savings lead to a reduction of hard coal imports. The overall import share of hard coal is more than 60 %. Import prices acc. to [Bafa].

Biomass imports e.g. for the manufacture of biofuels cannot be offset, due to the insufficient data available.

Sources: BAFA [83], BMWi [84], IfnE [85]

Turnover from the construction of plants for the use of renewable energy sources in Germany, 2006



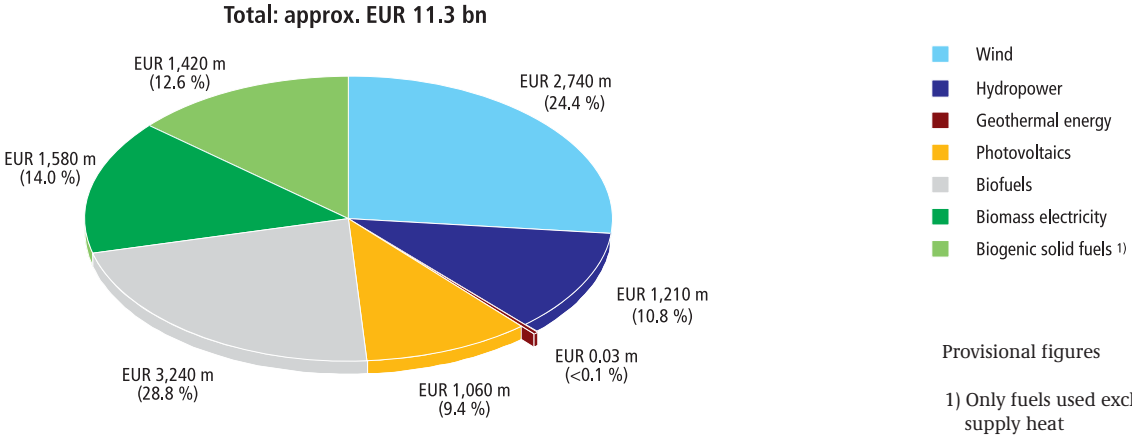
Provisional figures

1) Large plants 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 in Germany, 2006



Provisional figures

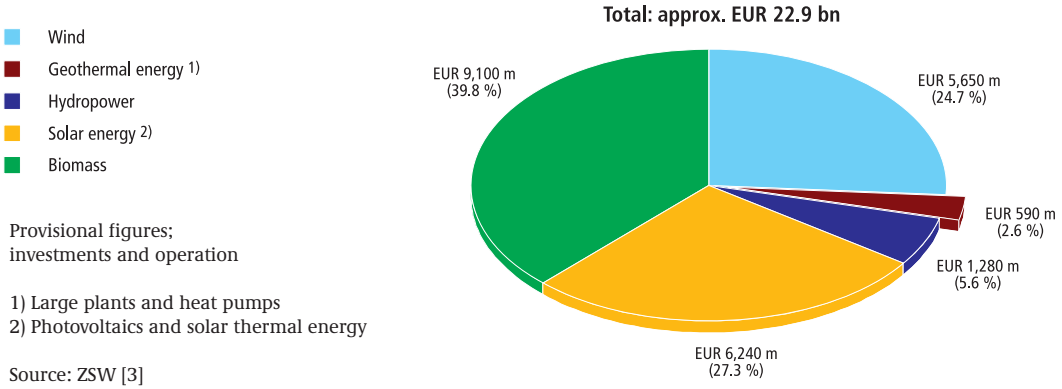
1) Only fuels used exclusively to supply heat

For explanations, refer to Appendix, para. 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. In the case of heat generation, turnover only refers to the sale of fuels, i.e. generally speaking wood, since in the majority of cases the heat produced is not sold, but used internally.

Total turnover with renewable energy sources in Germany, 2006



Provisional figures;
investments and operation

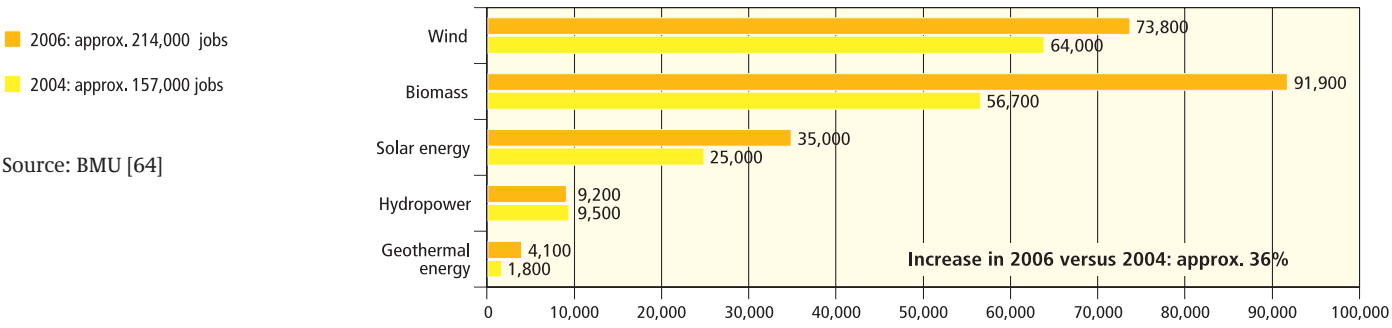
1) Large plants and heat pumps
2) Photovoltaics and solar thermal energy

Source: ZSW [3]

Jobs in the renewable energies sector in Germany

Renewable energies are a job creator for Germany. Their continuous expansion in Germany has led to a noticeable growth in employment.
According to the interim results of a research project by the BMU [64], preliminary at least 214,000 domestic jobs were attributable to the renewable energies sector in 2006. Compared with 2004, this means that around 57,000 new jobs have been created, an increase of approximately 36 % in just two years. The main contributory factors include the high demand for heat generation plants, increasing production of systems and components, specifically in the areas of biogas and photovoltaics, the export successes of the German wind industry, and the significant increase in the supply of biogenic fuels and biofuels.

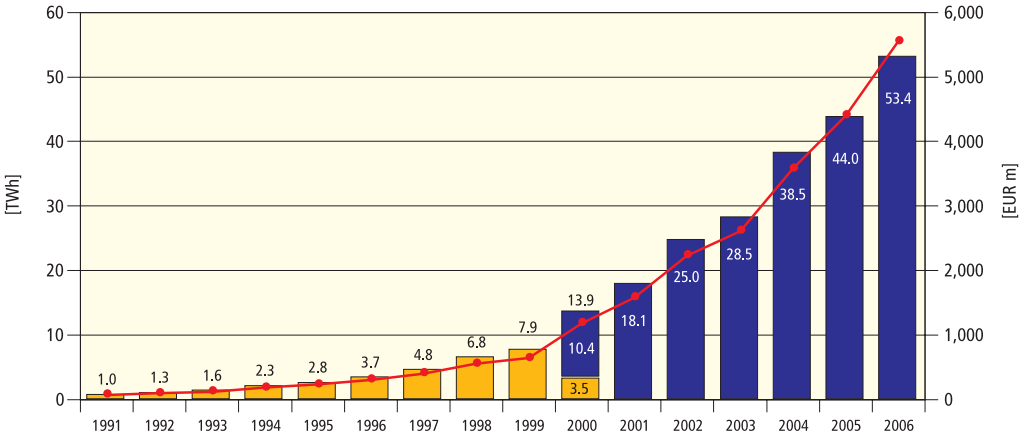
Consequently, in the overview of all application areas of renewable energies, in 2006 biomass, with around 92,000 jobs (increase of 35,000 compared with 2004) has replaced the previously dominant wind energy sector (2006: around 74,000 jobs; increase of 10,000 against 2004) as the sector with the greatest number of jobs. Both the solar industry (increase of 10,000 jobs since 2004) and the geothermal energy sector, whose employment contribution almost doubled between 2004 and 2006 to more than 4,000 jobs, have also seen significant increases. Employment in the area of hydropower remained approximately on a par with previous years, with around 9,000 jobs.



Source: BMU [64]

Over the next few years, the aforementioned research project anticipates a further significant increase in employment levels in the renewable energies sector. With due regard for all potential negative employment effects in the next decades, the net employment contribution is expected to be very positive. The extent to which German companies are able to secure export shares in the world market for renewable energies, which is expected to see sharp growth, will play a key role in this respect.

Feed-in and fees under the Act on the Sale of Electricity to the Grid (StrEG) and the Renewable Energy Sources Act (EEG)



In 2004 for the first time, fees paid with regard for avoided grid utilisation fees

1) Private and public feed-in

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

On 1 April 2000, the Act on the Sale of Electricity to the Grid was replaced by the Renewable Energy Sources Act, with improved terms. Over 54 % of all fees currently apply to electricity from wind energy, and around 15 % to photovoltaic electricity. Since 2004, following the commissioning of Germany's first electricity-generating geothermal plant, fees have also been payable for geothermal electricity. Around 80 % of electricity from hydropower originates from older plants with an output of more than 5 MW. This electricity is not remunerated under the EEG. The contribution of private generators to the electricity supply through renewable energies is very high. About 45 TWh of electricity were provided in 2006 [VDEW 21].

Structure of electricity volumes remunerated under the EEG

		2000 1)	2001	2002	2003	2004	2005	2006 2)
Total end consumption	**[GWh]**	**344,663**	**464,286**	**465,346**	**478,101**	**487,627**	**491,177**	**495,000**
Privileged end consumption 3)	[GWh]	-	-	-	5,847	36,865	63,474	70,100
EEG electricity volume Total 4)	**[GWh]**	**10,391.0**	**18,145.4**	**24,969.9**	**28,417.1**	**38,511.2**	**43,966.6**	**53,374.4**
Hydropower, gases 5)	[GWh]		6,088.3	6,579.3	5,907.7	4,616.1	4,952.6	4,739.0
Gases 5)	[GWh]					2,588.6	3,135.6	3,035.0
Biomass	[GWh]		1,471.7	2,442.0	3,483.6	5,241.0	7,366.5	13,100.0
Geothermal energy	[GWh]		-	-	-	0.2	0.2	0.4
Wind energy	[GWh]		10,509.2	15,786.2	18,712.5	25,508.8	27,229.4	30,500.0
Solar irradiation energy	[GWh]		76.2	162.4	313.3	556.5	1,282.3	2,000.0
EEG quota 6)	**[%]**	**3.01**	**3.91**	**5.37**	**6.02**	**8.48**	**10.0**	**12.5**
Average fee	**[ct/kWh]**	**8.50**	**8.69**	**8.91**	**9.161**	**9.29**	**9.995**	**10.4**
Total fee 7)	**[bn EUR]**	**0.88**	**1.58**	**2.23**	**2.61**	**3.58**	**4.40**	**5.55**

1) Short year: 01/04 – 31/12/2000
2) Figures for 2006 preliminary; adjusted by [ZSW 3] compared with VDN medium-term forecast.
3) On the basis of the special compensation provision (§ 11 and 16 of the EEG), privileged end user (since July 2003)
4) Does not include post-corrections by the VDN (2002 to 2005) because the additional feed-ins for previous years according to auditors' certificates cannot be allocated to energy carriers
5) Landfill, sewage and pit gas listed separately for the first time in 2004
6) Quota of non-privileged end use
7) Overall fees until 2006 including avoided grid utilisation fees, includes post-corrections by the VDN for previous years. Fees differ clearly from the differential costs (see the following pages).

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

Cost to electricity consumers

From a business viewpoint[1], electricity from renewable sources which is remunerated under the EEG is still more expensive than that from conventional energy sources. To date, the total costs have generally been calculated according to the following basic formula:

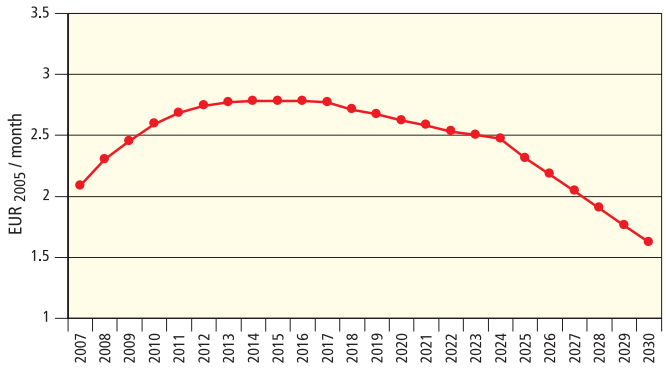
EEG apportionment = EEG quota x (EEG average fee – avoided electricity purchase price)

The EEG fees paid to plant operators are published by the Verband der Netzbetreiber (Association of German Network Operators, VDN e.V.) on 31 October of the following year, in an audited annual account. Until that date, only forecasts are available. The electricity purchase costs avoided as a result of EEG feed-in must also be roughly calculated according to the annual account, because no reliable database exists as yet. As the assumptions made may vary, published figures on EEG cost levels can differ significantly.

Based on a current BMU research project [73], it would seem plausible to estimate the (business) value of conventional electricity that is substituted by the EEG feed-in at 4.4 cents per kWh in 2006. With an EEG electricity volume of just over 53 TWh and an average fee of around 10.4 cents per kWh (provisional figures), this leads to costs of approximately 3.2 billion Euros. These costs are significantly lower than the EEG fees payable to the operators of EEG electricity generation plants in 2006 of around 5.6 billion Euros (provisional figures).

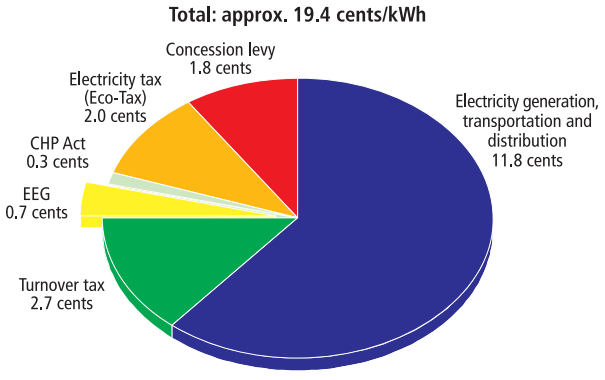
With due regard for a special provision in the EEG for particularly electricity-intensive companies[2], this produces an average nationwide EEG apportionment of 0.72 cents per kWh (provisional) for all electricity consumers without privileges, which includes private households. This equates to just 3.7 % (approx.) of the costs for a kilowatt hour of household electricity in 2006 (an average of 19.4 cents/kWh). Depending on the market situation and the market behaviour of electricity suppliers, however, the actual EEG apportionment invoiced may vary. Despite the further increase in the feed-in of electricity from renewable sources, the EEG cost share will not increase significantly over the next few years. In 2006, the cost of the EEG to the average household with an electricity consumption of 3,500 kWh per annum was around 2.10 Euros per month.

Anticipated development in the monthly EEG apportionment of an average household



Average household: Annual consumption of 3,500 kWh/a
Source: BMU [43]

Breakdown of costs for one kWh of electricity for household customers, 2006



Average electricity price of an average household with an annual consumption of 3,500 kWh/a in cents/kWh
CHP Act = Combined Heat and Power Act
Source: BMU [43]

According to a publication by the BMU [73], provided renewables continue to expand at a rapid rate, EEG costs in the household sector will have peaked at approximately 2.80 Euros/month (monetary value 2005) by the middle of the next decade, and will subsequently fall again. Un update is under way.

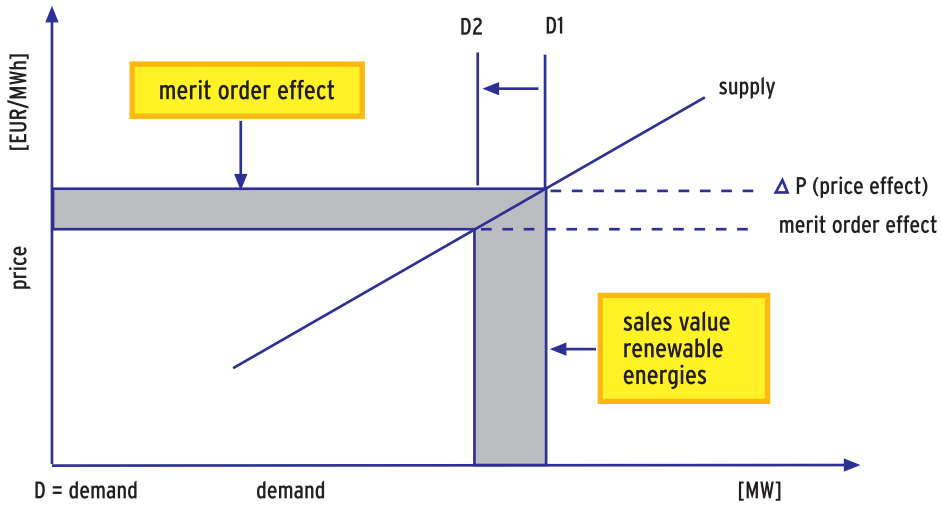
1) A macro-economic analysis gives a different picture; cf. in this respect page 28.
2) § 16 of the EEG currently allows around 380 particularly electricity-intensive companies in the manufacturing industry and railways to purchase EEG electricity at significantly reduced prices, based on an EEG levy (differential costs) of just 0.05 ct/kWh. As a result, the EEG costs of all other electricity customers are increased. The retrospective implementation of an amendment to § 16 for the year 2006 is likely to further increase the concessionary effect in 2008.

Effects of renewable energies on electricity prices

When assessing the economic effects of the promotion of renewable energy sources by the EEG, as well as considering the market value of EEG electricity, it is also necessary to take into account the impacts of electricity generation from renewable energies on wholesale prices on the electricity market. The fact that priority is given to the feed-in of renewables will in the short term lead to a lowering of electricity prices on the wholesale market. An on-going scientific study commissioned by the BMU [88] analyses the impacts of EEG electricity generation on wholesale prices.

The market price of electricity is determined by the most expensive power station still needed to satisfy the demand for electricity (merit order). Because priority is given to EEG feed-in, demand for conventional electricity is reduced. In accordance with the merit order, therefore, the most expensive power plants are no longer needed to meet demand, and the market price falls accordingly. This effect is also known as the merit order effect. As the market price is also the most important price indicator for the electricity market as a whole, the EEG therefore not only leads to considerable price reductions on the market, but should also lead to savings for all customers. This effect has been quantified on the basis of a detailed electricity market model (PowerACE). A diagrammatic representation of this effect is shown below.

Diagrammatic representation of the merit order effect



Note: The model is calculated against the market prices for the respective year, which means that the results for different years are only comparable to a limited extent. With the time series given below, it is important to bear in mind that in 2006, the feed-in prices of CO_2 for lignite power plants were reduced, while fuel prices followed with a time lag.

The results of the model show that the calculated merit order effect for the year 2006 is in the region of 5 billion Euros. The detailed results for 2005 and 2006 are depicted in the table below. This substantial figure is determined in part by the very high gas prices in 2006. Overall, the rising price trend for renewable energies continued in 2006. The outlined effect is also confirmed by the statistical analysis of current market data [80], [42].

	Simulated EEG electricity generation	Average price reduction	Volume merit order effect	Specific effect	Average feed-in fee
Year	[TWh]	[EUR/MWh]	[bn. EUR]	[EUR/MWh$_{EEG}$]	[EUR/MWh$_{EEG}$]
2005	47.70	5.25	3.38	71	99.50
2006	52.20	7.83	4.98	95	103.00

Macroeconomic external costs

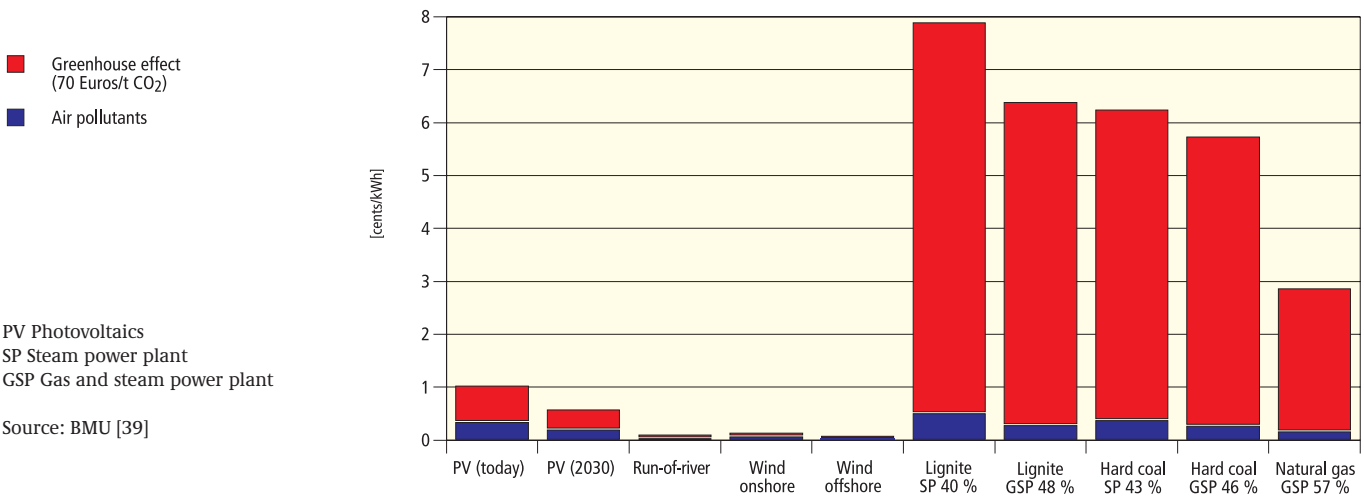
The costs of the EEG derived from the figures on the previous page are not sufficient for a comprehensive economic evaluation of renewable energy sources, because as microeconomic dimensions, they do not reflect the fact that conventional electricity generation still causes significantly more environmental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

According to a scientific study carried out on behalf of the BMU [39], greenhouse gas emissions play a key role: The current best estimate of the cost of climate damage arising from this is around 70 Euros/t CO_2. In addition, health and material damage caused by air pollutants are important, together with, to a lesser extent, agricultural revenue losses. External costs for electricity generated from hard coal and lignite – even allowing for modern technology – 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)].

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

1) Further external effects of electricity generation from fossil fuels (impairment of biodiversity, ecosystems and supply reliability as well as geopolitical risks) cannot be quantified, due to the lack of reliable data. As such, the aforementioned variables are only a sub-total of the actual external costs currently anticipated.

External costs of electricity generation for various options



PV Photovoltaics
SP Steam power plant
GSP Gas and steam power plant

Source: BMU [39]

Given the – scientifically proven – assumption that electricity remunerated under the EEG at present fully displaces electricity generated from fossil fuels, on the basis of the aforementioned study, the external costs avoided in the electricity sector thanks to renewables can be estimated at 3.4 billion Euros minimum. This is considerably higher than EEG expenditure to promote renewables over the same period (3.2 billion Euros – cf. page 26), indicating that the promotion of renewable energy sources via the EEG is worthwhile purely in terms of the avoided external costs alone. Renewable energy sources can also boast a host of other strategic and economic advantages.

Overview of the cost and benefit effects of the EEG

The previous pages explain in detail how the EEG creates costs on the one hand but has considerable macroeconomic benefits on the other. The following overview gives a brief summary of the variables mentioned.

From a business viewpoint, electricity generation from renewables is still more expensive than electricity from non-renewable sources. Due to the obligation to purchase laid down in the EEG, the electricity suppliers incur higher procurement costs. In 2006, these amounted to around 3.2 billion Euros in 2006 (see p. 26). For the additional expenses caused by renewable energies for balancing energy and the running of the EEG apportionment mechanism, a further 0.1 billion Euros can be added in the same year[1] as a – conservatively estimated – upper limit. Hence total costs of about 3.3 billion Euros arise.

1) Possible EEG-related grid expansion costs have been disregarded; these would probably arise primarily only in the future.

	Estimated costs EEG (2006)	Comments
Additional procurement costs	€ 3.2 billion	Additional costs compared to conventional electricity generation
Additional costs balancing energy/administration of EEG apportionment mechanism	€ 0.1 billion	Estimated upper limit, as no plausible details on transmission grid operators available
Total	**€ 3.3 billion**	

On page 27 it was described how the additional electricity arising from the EEG significantly reduces the wholesale price for electricity, as the supply has increased while demand remains the same. Thus in 2006, procurement costs for the electricity suppliers fell by around 5 billion Euros. Further benefits arise from the avoidance of external costs amounting to 3.4 billion Euros (see page 28) and savings on fossil energy imports such as hard coal and natural gas for use in power plants (see page 22).

	Estimated benefit EEG (2006)	Comments
Lowering of wholesale price for electricity	€ 5.0 billion	Price reductions via so-called merit order effect, i.e. the displacement of conventional electricity production by the EEG
Savings on energy imports	€ 1.0 billion	Saving of hard coal and gas imports for electricity generation
Avoidance of external costs of electricity generation	€ 3.4 billion	External costs arising from climate change and air pollutants
Total	**€ 9.4 billion**	

This overview of the possible cost-benefit effects of the EEG does not claim to be complete. Due to the various levels and interrelations of the effects, these figures cannot be balanced out. Nevertheless, the comparison indicates that when viewed as a whole the EEG already generates significantly more benefits than costs.

Support programmes for renewable energy sources

The Federal Government supports renewable energies through research and development and with a range of measures to encourage market development.
The **Renewable Energy Sources** Act has been of pivotal importance to the electricity market, while biofuels benefit from the blending obligation under the Biofuels Quota Act (Biokraftstoffquotengesetz) and the mineral oil tax concessions in selected application areas.

The **Market Incentive Programme** to support measures for the utilisation of renewable energy sources, which is financed through the eco-tax reform, is primarily aimed at expanding heat generation from biomass, solar power and geothermal energy. Smaller plants from private investors receive support in the form of subsidies, while larger plants receive interest-reduced loans and partial debt relief. Details of the support available may be found in the relevant guidelines.

In the **buildings sector**, the Reconstruction Loan Corporation (KfW) also offers a range of attractive financing programmes. These also include the use of renewable energy sources and the conversion of heating systems. It also grants investment loans for photovoltaic systems ("solar power generation"), for the new construction of energy-saving houses ("ecological construction") and for the modernisation of homes ("home modernisation"); further information is available from: www.kfw-foerderbank.de.

In addition, those wishing to obtain a comprehensive energy consultation for older residential buildings are eligible for a grant towards the cost of the advice (programme "local consultations to save energy", www.bafa.de).

Support at federal level is supplemented by a host of measures in various Federal states and local authorities. The nationwide campaign "Climate Seeks Protection" ("Klima sucht Schutz") at www.klimasuchtschutz.de provides an overview of the measures available, together with information on saving energy in the home.
In cooperation with the BINE information service (www.bine.info), the Federal Environment Ministry has published a detailed brochure outlining all the support available at EU, national, state and local level, as well as from the power utilities (www.bmu.de/klimaschutz/).
A comprehensive support database (http://db.bmwi.de) is also provided by the Federal Ministry of Economics and Technology.

The Market Incentive Programme

The Market Incentive Programme to promote measures for the utilisation of renewable energies, which is financed by revenues from the ecological tax reform, supports the construction of plants for generating heat from renewable energy sources.

From the beginning of the programme up to the end of 2006, over 523,600 solar collectors with an area of around 4.6 million square metres and over 95,300 small biomass boilers were installed with financial grants from this programme.

Within the framework of the Market Incentive Programme, the Reconstruction Loan Corporation (KfW Programme Renewable Energies) has agreed to provide over 3,095 loans totalling more than 887 million Euros for large installations for the combustion of solid biomass, installations for the utilisation of deep geothermal energy, and biogas plants, over the period 2000 to 2006.

Since this programme's launch, in total more than 623,900 investment projects for the use of renewable energies had been funded by the end of 2006 with the available funds of over 827 million Euros, triggering an investment volume of more than 6.5 billion Euros.

As of 2007, the programme is being continued with new support guidelines and a simplified procedure for investment grants. In 2007, 213 million Euros will be made available for this purpose.

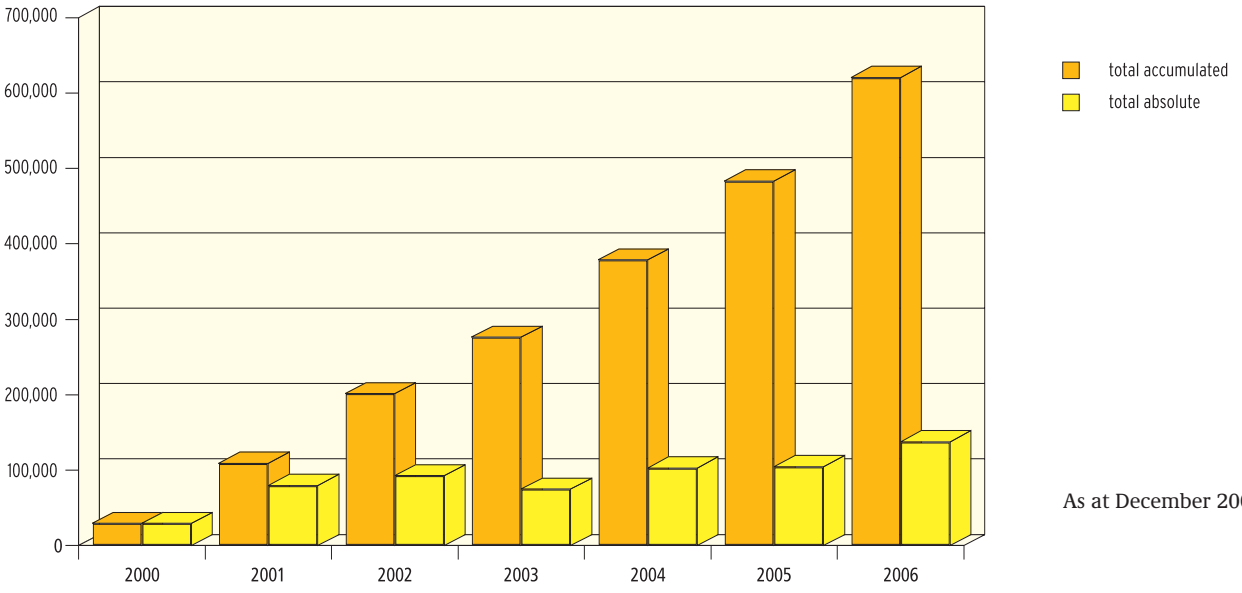
In the residential sector, the main emphasis is on supporting solar collectors and biomass heating systems with grants. A recent addition to the scheme is an innovation bonus for large solar collector systems, solar systems for process heating or solar cooling, as well as secondary measures for reducing emissions and increasing efficiency in biomass plants. In addition, support is given to installations for the use of solid biomass with a capacity of 100 kW or more, deep geothermal energy, large solar installations, and local heating systems. Details of the support available are set out in the relevant guidelines.

During the course of the programme, the support guidelines have been modified several times in line with market developments. The high demand for support, as well as the improved cost-efficiency of the supported installations, have made it possible to lower the funding rates while still maintaining the attractiveness of the support programme. In future, the guidelines will continue to respond promptly to market developments in order to ensure the efficient use of funds from the federal budget.

Information on the grants available under the Market Incentive Programme is issued by the Federal Office of Economics and Export Control (BAFA), telephone +49 (0)6196 908625 (www.bafa.de).

The Reconstruction Loan Corporation (KfW) information centre, telephone +49 (0)1801 335577 (www.kfw-foerderbank.de) answers questions about reduced-rate loans for commercial or municipal applicants within the context of the Market Incentive Programme.

Number of installations supported with investment grants



As at December 2006

Biofuels

On the basis of the Biofuel Quotas Act (Biokraftstoffquotengesetz) adopted by the Bundestag in October 2006, from 2007 onwards companies that market fuels are required to sell a legally specified minimum share (quota) in the form of biofuels. From 2007, there is a 4.4 % quota for diesel and a 1.2 % quota for petrol; the latter will increase continuously over subsequent years, rising to 3.6 % in 2010. In addition to the minimum quotas, as of 2009 a total quota of 6.25 % will be introduced for both fuel types, which will be gradually raised to 8 % by 2015. All quotas are based on the energy content of the fuels.

	Overall quota	Diesel quota	Petrol quota
2007	-	4.40 %	1.20 %
2008	-		2.00 %
2009	6.25 %	Minimum quota	2.80 %
2010	6.75 %	also applies to	3.60 %
2011	7.00 %	subsequent years	
2012	7.25 %		Minimum quota
2013	7.50 %		also applies to
2014	7.75 %		subsequent years
2015	8.00 %		

For pure biofuels not included in the quota, a degressively structured tax concession has been specified in the Energy Taxation Act (Energiesteuergesetz) for a transitional period up to the end of 2011. Biogas, bioethanol in the form of E85 and second generation biofuels (e.g. BTL Biomass-To-Liquid and bioethanol from lignocellulose) are granted tax concessions under the Energy Taxation Act until 2015, with due regard for the over-compensation provision.

In 2006, the share of biofuels in road traffic was already 6.6 %, and the indicative EU target of a biofuel share of 5.75 % by 2010 has therefore already been met.

Overview of biofuels

First generation biofuels		
Biofuel type	**Biomass feedstock**	**Production process**
Vegetable oil	Oil crops 1)	Cold pressing/extraction
Biodiesel		
from energy crops	Oil crops 1)	Cold pressing/extraction and transesterification
from biogenic waste	Biogenic waste/fat	Transesterification
Bioethanol 2)	Sugar beet, grains	Fermentation and hydrolysis
Second generation biofuels		
Biofuel type	**Biomass feedstock**	**Production process**
Bioethanol 2)	Lignocellulose	Advanced hydrolysis and fermentation
SNG		
from biogas	(wet) Biomass	Anaerobic fermentation
from synthesis gas	Lignocellulose	Gasification and synthesis
Synthetic biofuels (BTL)	Lignocellulose	Gasification and synthesis
Biohydrogen	Lignocellulose	Gasification and synthesis or biological processes

Biofuels are usually referred to as second-generation if the manufacturing process facilitates the use of the entire plant. Compared with the production of first-generation biofuels, this leads to increased efficiencies and yields.

SNG Substitute Natural Gas
BTL Biomass-To-Liquids

1) Generally rapeseed
2) Bioethanol can either be added directly to petrol or processed into ETBE (ethyl tertiary butyl ether)

Source: ZSW [3], Bohlmann [87]

Research and development of technologies for the use of renewable energies

Research and development projects for the use of renewable energy sources are eligible for support under the Federal Government's Energy Research Programme. We are investing in renewable energies in order to save resources, to reduce our dependency on energy imports and to relieve the burden on the environment and the climate. Cost reductions are achieved via technical innovations.

Research support is also significant with regard to job market policy. The leading position of German companies and research institutions is strengthened and new jobs are created in a growing worldwide market.

Main focus of research support

The aims and main focus of research support are:

- to lower the cost of renewable energy systems
- to ensure ecologically sound and nature-friendly advancement
- to promote resource-conserving production methods
- to optimise integration into the electricity grid
- to ensure the rapid transfer of technology from research to market
- to promote system-based integrated solutions, such as combinations of thermal insulation, household technology, and renewable energies in the buildings sector.
- to encourage transboundary projects and technologies for use primarily in other countries
- to promote cross-sectoral research (economic issues, jobs, system studies etc.) [68].

In 2006, a total of 118 new projects with a total volume of more than 98.8 million Euros were approved in the fields of photovoltaics, geothermal energy, low-temperature solar thermal energy, solar thermal power plants, as well as overall strategy and overarching issues.

The main focus of research support in 2006 was on photovoltaics and geothermal energy. In the case of photovoltaics, there is a particularly pressing need for research and development work, because the EEG fee rates show the highest degression in these areas and it is vital that suitable cost reductions are achieved. In addition, these areas also offer the greatest innovation potential. Ultimately, it is a matter of safeguarding Germany's leading international position in photovoltaic research and improving the competitiveness of German companies in a rapidly expanding global market.

In 2007, the share of wind energy research will see a further increase, primarily because there are major technical challenges to be overcome, especially in the offshore sector; research is also needed into eco-friendly ways of maximising potential. The anticipated integration of large volumes of electricity into the national grid also plays a decisive role in this respect.

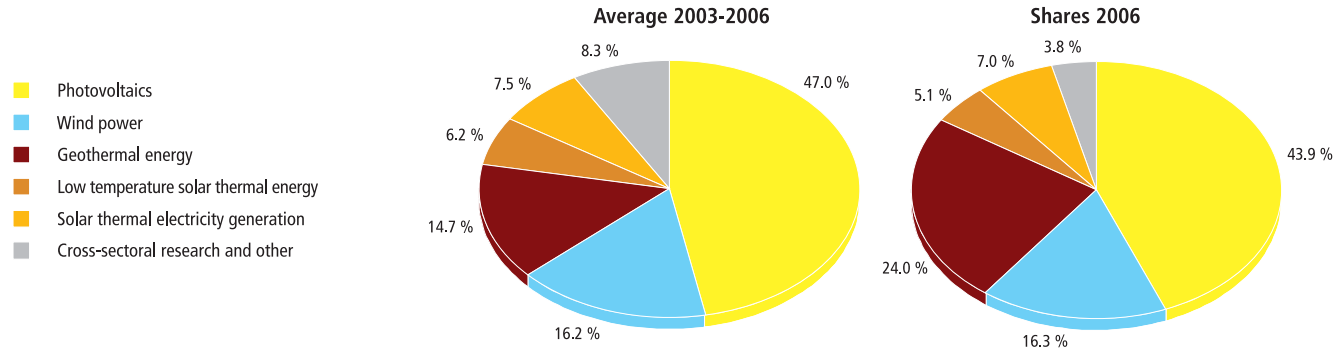
Research in other areas also continues to receive high-level support. All renewable energy sources are needed if we are to meet the Federal Government's ambitious expansion targets. For geothermal energy the emphasis is on demonstrating the economic feasibility of geothermal electricity generation in a variety of geological formations – the Upper Rhine Graben, the South German Molasse Basin, and the North German Basin. An overview of on-going research projects may be found at www.erneuerbare-energien.de/inhalt/36049/.

Approved, on-going and completed projects, 2006

	newly approved projects		current projects		completed projects	
	[number]	[1,000 EUR]	[number]	[1,000 EUR]	[number]	[1,000 EUR]
Photovoltaics	39	43,367	118	135,393	34	24,502
Wind	29	16,083	122 1)	55,518	48 2)	7,925
Geothermal en.	11	23,718	36	51,724	5	995
Low termperature solar thermal energy	13	5,058	45	24,125	10	6,298
Solar thermal electricity generation	16	6,875	53	23,111	28	9,726
Cross-sectoral research and other	10	3,716	28	20,295	4	1,052
Total	**118**	**98,818**	**402**	**310,166**	**129**	**50,498**

1) Including 49 individual projects within the context of the 250 MW wind programme
2) Including 39 individual projects within the context of the 250 MW wind programme

Shares of expenditure in 2003 – 2006 and of newly approved funding in 2006



Expenditure [1,000 EUR]						
	2003	2004	2005	2006	Average 2003 - 2006	Average Share [%]
Photovoltaics	29,654	24,417	41,961	37,609	33,410	47.0
Wind	12,160	7,354	16,885	9,765	11,541	16.2
Geothermal en.	11,361	5,883	10,667	13,985	10,474	14.7
Low temperature solar thermal energy	2,682	3,532	4,920	6,612	4,437	6.2
Solar thermal electricity generation	4,710	5,552	5,154	5,906	5,331	7.5
Cross-sectoral research and other	7,486	3,504	6,229	6,490	5,927	8.3
Total	**68,053**	**50,242**	**85,816**	**80,367**	**71,120**	**100.0**

Source: BMU [81]

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

	Utilitsation	Potential		Comments
	2006	Yield	Capacity	
Electricity generation	[TWh]	[TWh/a]	[MW]	
Hydropower 1)	21.6	25	5,200	Run-of-river plants and natural inflow to reservoirs
Wind energy				
onshore	30.5	68	35,000	
offshore	-	135	35,000	
Biomass 2)	19.7	50	10,000	Generation partly in combined heat/power generation
Photovoltaics	2.0	105	115,000 3)	Only suitable roof, facade and human settlement areas
Geothermal energy	0.0004	150	25,000	Bandwidth 66 - 290 TWh depending on
				heat utilisation requirements (combined heat/power)
Total	**73.9**	**533**		
Share in relation to gross electricity consumption, 2006	**12.0 %**	**87 %**		
Heat generation	[TWh]	[TWh/a]		
Biomass	84.1	150		Including useful heat from combined heat/power generation
Geothermal energy	1.9	330		Only energy supply from hydrothermal sources
Solar thermal energy	3.3	300		Only suitable roof and human settlement areas
Total	**89.3**	**780**		
Share in relation to final energy consumption for heat 4) 2005	**6.0 %**	**51 %**		
Fuels	[TWh]	[TWh/a]		
Biomass	39.9	155		
Total	**39.9**	**155**		
Share in relation to fuel consumption of road traffic, 2005	**6.6 %**	**26 %**		
Share in relation to final energy consumption, 2005	**8.0 %**	**58 %**		

As there are varying assumptions regarding the availability of suitable locations, the technical characteristics of the utilising technologies and a number of other factors, the results of potential estimates can differ considerably.

The guideline values given here make particular allowance for the requirements of nature and landscape conservation, and hence represent the lower limit of the technically feasible potential.

The energetic use of biomass shows a high level of flexibility. Depending on requirements, therefore, the percentages allocated to the areas of electricity, heat and fuel supply may vary. This is particularly true of the cultivation of energy crops (based here on a cultivation area of 4.5 million hectares).

Imports of energy carriers on the basis of renewable energy sources are not included in the figures.

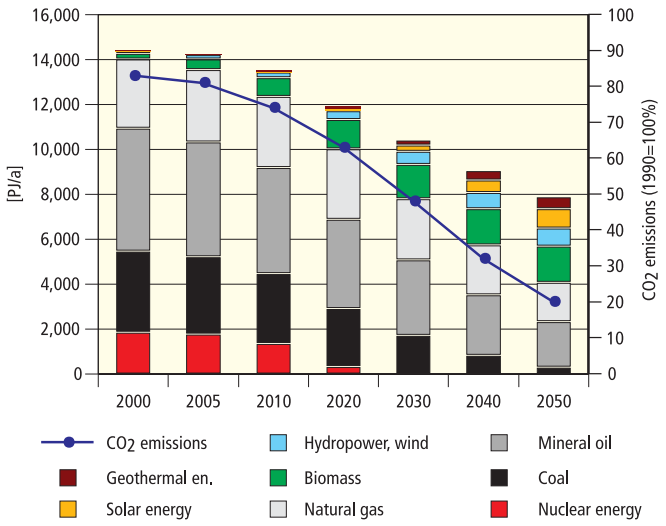
1) Excluding marine energy
2) Including biogenic share of waste
3) Output figure relates to the modular output (MWp); the corresponding AC output is 106,000 MW
4) Room heat, hot water and other process heat

Sources: BMU [27]; Arbeitsgemeinschaft WI, DLR, IFEU [38]; ZSW [3]

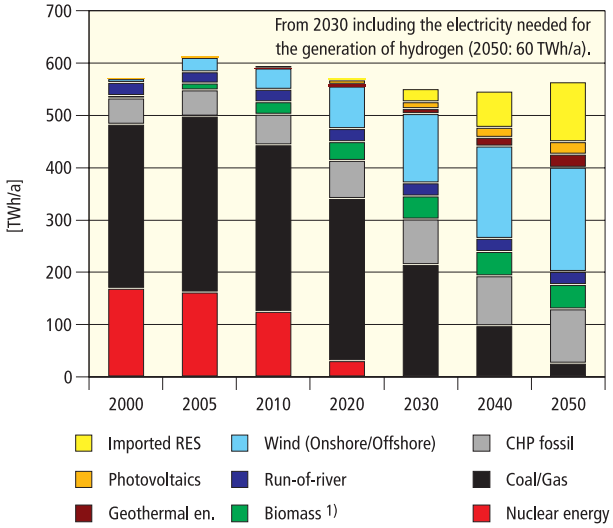
Scenario for an intensified expansion of renewable energies

The 2007 lead study represents the potential development of energy supply until the year 2050, facilitating an 80 % reduction in CO_2 emissions compared with 1990 levels through the intensified expansion of renewable energy sources and the more efficient use of energy. It is hoped that as early as 2020, just under 16 % of primary energy consumption and around 27 % of gross electricity generation can be met from renewable energy sources. By the year 2050, renewable energies can account for around half of total primary energy consumption. By that date, the renewable share of electricity consumption can be around 80 %, and of heat consumption around 48 %. Renewables can contribute 42 % to fuel consumption.

Development of primary energy consumption and CO_2 emissions

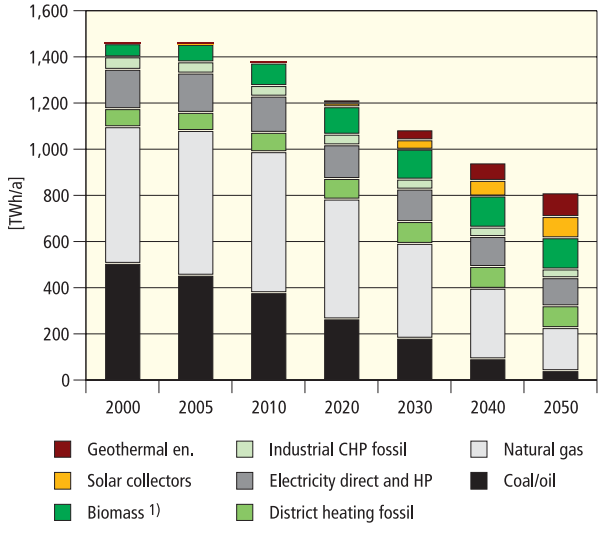


Development of electricity generation



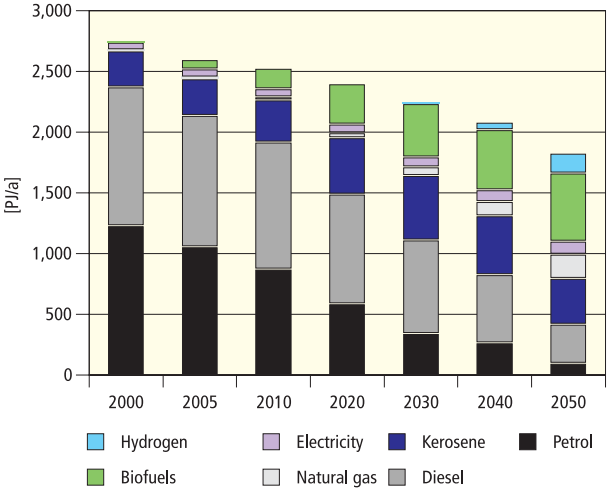
1) Including the biogenic portion of waste

Development of heat supply



CHP Cogeneration
HP Heat pumps
1) CHP and direct heat supply

Development of fuel supply



Calculations based on physical energy content method
Source: BMU [27]

Renewable energies in Europe

On 10 January 2007, the European Commission presented its comprehensive "climate and energy package". Pivotal elements include the communication from the Commission to the European Council and the European Parliament entitled "Energy Policy for Europe" (Strategic Energy Review), which provides a summary of the 12 individual initiatives in the "energy package" and draws conclusions for further measures, and the COM communication on climate protection ("Limiting Global Climate Change to 2 Degrees Celsius – The Way Forward Until 2020 and Beyond"). Numerous legislative proposals for 2007 are announced in these two communications.
On 9 March 2007, the spring summit of heads of state and government (European Council) adopted a road map which set a binding target for renewables of 20 % of total energy consumption by 2020, based on the present level of 6.6 %. This goal is to be supported with binding national targets for the share of renewables in energy consumption and implemented within the framework of national action plans detailing the distribution among the relevant sectors. For biofuels, a binding minimum target of 10 % of total petrol and diesel consumption for all Member States by the year 2020 has been adopted, together with the introduction of sustainability standards.

These pioneering decisions by the European Council will lend fresh impetus to the expansion of renewables. They represent a major leap forwards compared with the existing targets for 2010, and help to create investment security. For the second half of 2007, the European Commission has announced its proposal of a comprehensive Directive on renewable energy sources. One of the aims of this Directive is to set binding national overall targets on renewables for the Member States.

Current instruments at EU level include the Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market and the Biofuels Directive. A key element of the EU Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market, which entered into force in 2001, is to increase the share of electricity generated from renewable sources from 14 % in 1997 to 21 % by 2010 in the EU-25 (cf. also Appendix, para. 8).

Share of renewable energy sources in primary energy consumption in the EU

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 [1]
	[%]											
Belgium	1.4	1.4	1.3	1.2	1.3	1.3	1.3	1.5	1.5	1.9	2.1	3.5
Denmark	6.7	7.6	7.2	8.3	8.7	9.6	10.8	11.4	12.4	13.5	15.1	16.2
Germany	1.6	1.9	1.9	2.2	2.4	2.6	2.8	3.0	3.4	3.6	4.0	4.8
Finland	19.0	21.2	19.9	20.6	21.8	22.1	23.9	22.4	21.9	20.9	23.0	23.2
France	7.0	7.5	7.0	6.8	6.7	6.9	7.0	7.1	6.4	6.4	6.3	6.0
Greece	5.0	5.3	5.4	5.2	4.9	5.3	5.0	4.5	4.7	5.1	5.1	5.2
Ireland	1.6	1.5	1.6	1.6	1.9	1.8	1.8	1.7	1.9	1.8	2.1	2.7
Italy	4.2	4.8	5.2	5.3	5.5	5.8	5.2	5.5	5.3	5.9	6.8	6.5
Luxembourg	1.3	1.4	1.2	1.4	1.5	1.3	1.6	1.3	1.4	1.4	1.6	1.6
Netherlands	1.4	1.2	1.6	1.8	1.9	2.1	2.1	2.1	2.2	2.6	2.9	3.5
Austria	20.2	22.0	20.6	21.1	20.8	22.5	23.2	21.8	22.1	19.5	20.8	20.5
Portugal	15.9	13.3	16.1	14.7	13.6	11.1	12.9	15.7	14.0	17.1	14.9	13.4
Sweden	24.9	26.1	23.6	27.5	28.1	27.0	31.4	28.3	26.3	25.3	25.8	29.8
Spain	7.0	5.5	7.0	6.4	6.1	5.2	5.7	6.6	5.5	7.0	6.5	6.1
United Kingdom	0.5	0.9	0.8	0.9	1.0	1.1	1.1	1.1	1.2	1.3	1.5	1.7
EU-15	**4.9**	**5.3**	**5.3**	**5.5**	**5.5**	**5.6**	**5.8**	**5.9**	**5.8**	**6.0**	**6.4**	**6.7**
Estonia	4.5	8.8	10.1	10.3	9.5	10.2	10.8	10.4	10.3	9.5	10.6	11.2
Latvia	13.1	27.5	27.3	30.5	34.5	34.4	34.3	34.1	34.5	33.1	36.0	36.3
Lithuania	2.0	5.7	5.7	6.1	6.5	7.9	9.2	8.4	8.1	7.9	8.1	8.8
Poland	1.6	3.9	3.7	3.8	4.1	4.0	4.2	4.5	4.6	4.5	4.7	4.8
Slovakia	1.6	2.8	2.5	2.5	2.5	2.7	2.8	3.9	3.7	3.3	3.9	4.3
Slovenia	4.6	9.4	9.8	8.1	8.7	8.7	12.3	11.5	10.9	10.3	11.6	10.6
Czech Republic	0.2	1.5	1.4	1.6	1.6	1.9	1.5	1.7	2.1	3.5	4.0	4.1
Hungary	1.8	2.4	1.9	2.0	1.9	1.9	2.1	1.9	3.4	3.4	3.7	4.2
Cyprus	0.4	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	2.0	2.0
EU-25 [2]	**4.4**	**5.1**	**5.1**	**5.3**	**5.4**	**5.4**	**5.7**	**5.8**	**5.7**	**5.9**	**6.3**	**6.5**
Bulgaria	0.6	1.6	2.0	2.4	3.4	3.5	4.2	3.6	4.4	4.9	5.2	5.6
Romania	4.2	5.9	8.0	10.7	11.2	11.9	10.9	9.3	9.8	10.0	11.7	12.8
EU-27	**4.4**	**5.1**	**5.1**	**5.4**	**5.5**	**5.6**	**5.8**	**5.8**	**5.8**	**6.0**	**6.4**	**6.7**

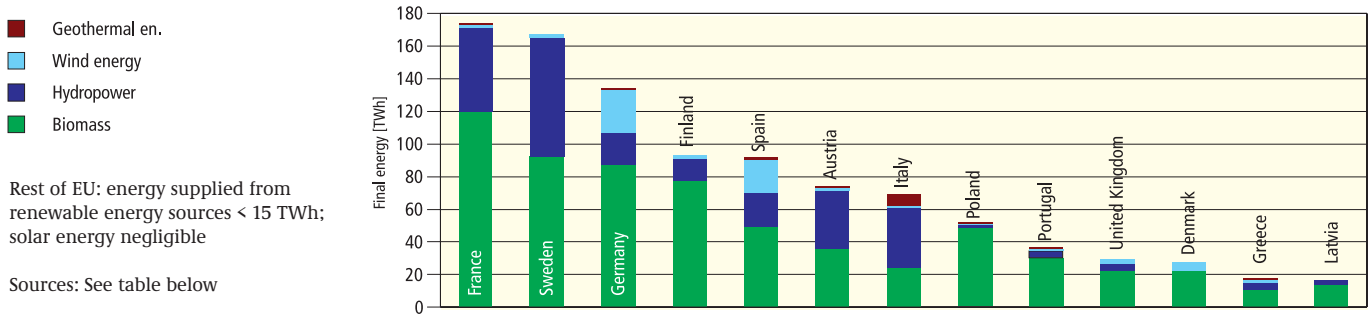
The figures on the supply and use of renewable energies in Germany given in European and international statistics sometimes deviate from the figures derived from German sources. As well as different data origins, this is also attributable in part to different accounting methods (calculations according to physical energy content method; cf. also Appendix, para. 9).

In the section on "Europe", for reasons of consistency, the figures for Germany were taken from the international statistics. However, the detailed information from the national sources on the preceding pages is generally more reliable.

1) Provisional figures
2) No figures on the use of renewable energies are available for Malta

Sources: Acc. to Eurostat [34]

Use of renewable energy sources in selected EU countries, 2005



Rest of EU: energy supplied from renewable energy sources < 15 TWh; solar energy negligible

Sources: See table below

Use of renewable energy sources in the EU, 2005

	Bio-mass [1]	Hydro-power [2]	Wind energy	Geothermal energy [3]	Total	Solar thermal energy [4]		Photo-voltaics [5]
	Final energy [TWh]					[1,000 m²]	[MW_{th}]	[kW_p]
Belgium	7.0	0.3	0.18	0.03	7.5	80	56	2,058
Denmark	22.2	0.0	6.61	-	28.9	348	243	2,650
Germany	88.0	19.6	26.50	0.20	134.2	7,109	4,976	1,910,000
Finland	78.3	13.8	0.17	-	92.2	14	10	4,002
France	120.0	51.7	0.99	1.51	174.2	914	640	26,273
Greece	10.9	5.0	1.34	0.15	17.4	3,047	2,133	5,444
Ireland	2.3	0.6	1.12	0.01	4.1	11	8	300
Italy	24.6	36.1	2.34	6.98	70.0	530	371	46,300
Luxembourg	0.3	0.1	0.05	-	0.4	13	9	23,561
Netherlands	11.1	0.1	2.07	-	13.3	536	375	50,776
Austria	36.0	35.9	1.33	0.22	73.4	2,599	1,819	24,021
Portugal	30.5	4.7	1.73	0.18	37.2	125	88	2,989
Sweden	92.8	72.8	0.87	-	166.5	258	181	4,237
Spain	50.2	20.1	20.71	0.10	91.1	547	383	57,600
United Kingdom	22.4	5.0	2.91	0.02	30.3	201	141	10,877
EU-15	**596.5**	**265.7**	**68.89**	**9.39**	**940.5**	**16,332**	**11,432**	**2,171,088**
Estonia	6.8	0.02	0.02	-	6.8	1	1	3
Latvia	13.6	3.3	0.05	-	17.0	3	2	5
Lithuania	8.1	0.5	0.002	-	8.6	2	2	17
Malta	-	-	-	-	-	19	14	15
Poland	48.9	2.2	0.14	0.10	51.3	122	86	317
Slovakia	4.9	4.6	0.01	0.84	10.4	64	45	60
Slovenia	0.4	3.5	-	0.17	4.0	106	74	180
Czech. Rep.	12.0	2.4	0.02	0.02	14.4	69	48	530
Hungary	9.1	0.2	0.01	2.20	11.5	49	34	155
Cyprus	0.1	-	-	-	0.1	500	350	456
EU-25	**700.4**	**282.4**	**69.14**	**12.72**	**1,074.0** [6]	**17,268**	**12,087**	**2,172,826**

	Final energy [PJ]				
EU-25	**2,521.4**	**1,016.6**	**248.90**	**45.80**	**3,866.5** [6]

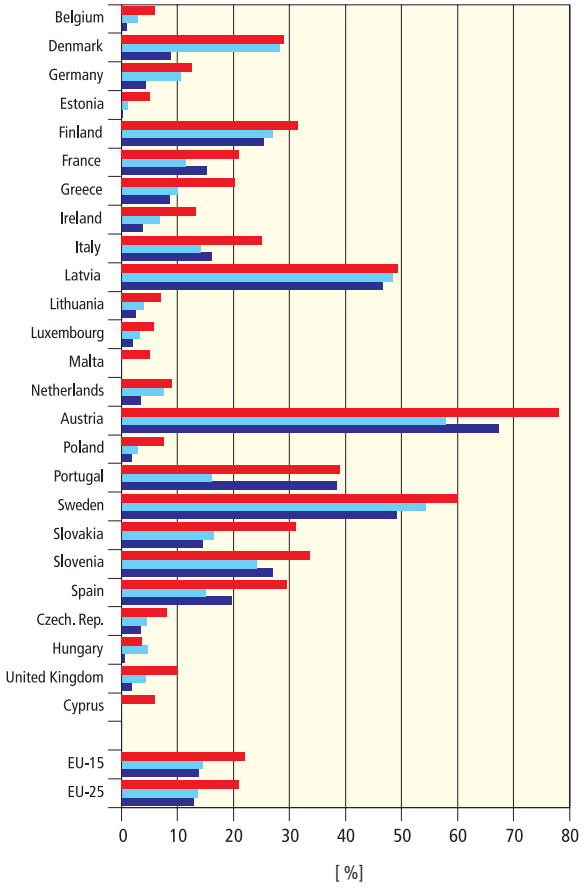
All figures provisional

1) Generation of electricity and heat from solid biomass, biogas and the biogenic portion of waste as well as biofuels; where figures are not available, these have been replaced by the previous year's figures
2) In the case of pumped- storage power plants, generation from natural inflow only
3) Heat and electricity generation; electricity generation in Italy with 5 TWh, Portugal 0.07 TWh and Austria 0.002 TWh (France 0.095 TWh in departements overseas not included). In Germany, geothermal electricity was produced for the first time in 2004.
4) Glazed and unglazed collectors; conversion factor 0.7 kWth/m²
5) Photovoltaics including installations in departements overseas
6) Total includes 7.9 TWh (28.5 PJ) from solar thermal energy and 1.5 TWh (5.4 PJ) from photovoltaics

Sources:
Biomass: Observ'ER [53], [61]; IEA [31]
Hydropower: Eurostat [34]
Wind energy: Observ'ER [46]
Geothermal and solar thermal energy: Observ'ER [37]
Photovoltaics: Observ'ER [82]

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

	RES electricity 1997	RES electricity 2005	Target value 2010
	[%]		
Belgium	1.0	2.8	6.0
Denmark	8.8	28.2	29.0
Germany	4.3	10.5	12.5
Finland	25.3	26.9	31.5
France	15.2	11.3	21.0
Greece	8.6	10.0	20.1
Ireland	3.8	6.8	13.2
Italy	16.0	14.1	25.0
Luxembourg	2.0	3.2	5.7
Netherlands	3.5	7.5	9.0
Austria	67.2	57.9	78.1
Portugal	38.3	16.0	39.0
Sweden	49.1	54.3	60.0
Spain	19.7	15.0	29.4
United Kingdom	1.9	4.3	10.0
EU-15	**13.8**	**14.5**	**22.0**
Estonia	0.1	1.1	5.1
Latvia	46.7	48.4	49.3
Lithuania	2.6	3.9	7.0
Malta	0.0	0.0	5.0
Poland	1.8	2.9	7.5
Slovakia	14.5	16.5	31.0
Slovenia	26.9	24.2	33.6
Czech. Rep.	3.5	4.5	8.0
Hungary	0.6	4.6	3.6
Cyprus	0.0	0.0	6.0
EU-25	**12.8**	**13.6**	**21.0**



RE Renewable energies; 2005 shares provisional

Renewable electricity generation as a share of gross electricity consumption

Source: Eurostat [34]

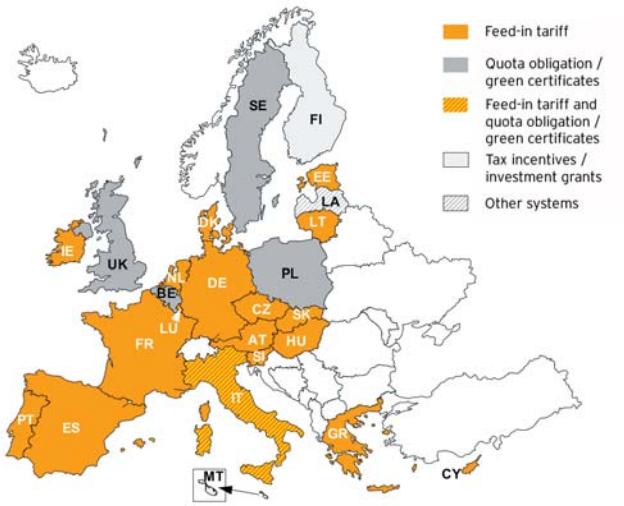
Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market entered into force in October 2001. The EU's aim is to increase the share of renewable sources in electricity generation from 14 % in 1997 to 22 % by 2010 in the EU-15 and 21 % in the EU-25. According to a Commission report dated 10 January 2007, Germany – along with Denmark, Hungary, Finland, Ireland, Luxembourg, Spain, Sweden and the Netherlands – is well on the way to achieving its contribution to the EU target for electricity from renewables. The integration of renewable energy sources in the electricity sector also requires EU-wide improvements in terms of integration into electricity grids and the expansion of offshore wind energy. As announced in the biomass action plan, further measures are also needed to promote the use of biomass, and particularly biofuels. The Federal Government will advocate setting a clearer priority for energy efficiency and renewable energy sources in the 7th Framework Research Programme.

In its green paper "A European strategy for sustainable, competitive and secure energy", published in March 2005, the EU Commission highlights the contribution to a secure electricity supply made by wind energy, solar power, biomass, hydropower and geothermal energy, as domestic energy sources, especially in the light of a growing EU-wide dependency on imports. The green paper underscores the importance of renewable energies for the economy and the technological leadership of Europe in this sector, with reference to around 300,000 jobs in the EU in the field of renewables. In order to meet the aforementioned targets, on 10 January 2007 the Commission presented a road map for the further expansion of renewable energy sources in the EU.

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

Achieving the national indicative targets for the EU Member States that were laid down by the European Commission is a prerequisite for raising the share of renewable energy sources in the electricity market in the EU-25 to 21 % by 2010. The Member States are called on to promote the expansion of renewable energy sources at national level by creating suitable framework conditions.

The example of wind energy shows that achievement levels vary significantly between individual EU states, and that the plan to expand renewables evenly throughout all EU states has not yet been met. This is primarily due to the respective framework conditions vis-à-vis energy policy, and less to natural potential. Germany's Renewable Energy Sources Act (EEG) and Spain's legislation compare particularly favourably with other international support models. In reports of December 2005 and January 2007, the European Commission determined that feed-in regulations such as the EEG are very effective in promoting wind energy. Quota systems with tradable certificates that have been implemented in some countries have thus far failed to produce comparable results. The costs are also higher than in countries with feed-in regulations. This reflects the higher risks for operators of facilities and the potential high profit-taking effects. While the EEG guarantees a legally fixed fee for 20 years, the revenues from the sale of electricity and certificates in the quotas system are extremely insecure and depend on a multitude of factors that are difficult to assess. Thanks to the EEG, Germany will in all likelihood achieve its national expansion target as formulated by the European Union as early as 2007, ahead of the set time limit. Thanks to the success achieved with national feed-in regulations – and the lack of success for other support regulations – the European Union has concluded that it is still too early for European harmonisation, and plans instead to encourage greater coordination between Member States.



Source: Ragwitz [52]

International Feed-In Cooperation

At the 2004 International Conference for Renewable Energies in Bonn, Spain and Germany decided to share their experience of feed-in regulations for electricity from renewables and to intensify their cooperation (International Feed-In Cooperation). By signing a joint declaration in October 2005, this cooperation was placed on a formal footing. In January 2007 Slovenia also signed the joint declaration. In this way, these countries are complying with the Commission's recommendation to cooperate more closely. Other states have expressed an interest and are very welcome to join.

The aims of cooperation are to promote the exchange of experience with and optimise feed-in systems, to support other countries in improving and developing feed-in systems, and to incorporate the experience acquired into international forums, particularly into the political debates of the European Union. In total, 18 EU Member States now have priority and fee regulations which are comparable with the German, Slovenian and Spanish systems.

Further information on German-Spanish cooperation may be found on the Internet at www.feed-in-cooperation.org.

Generation of electricity from renewable energy sources in the EU, 1990 to 2006

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 1)	2005 1)	2006 1)
	[TWh]												
Biomass 2)	16.6	23.6	24.4	28.0	31.5	35.0	39.3	39.5	48.4	57.1	67.8	70.4	N/A
Hydropower 3)	260.3	290.2	289.0	297.8	305.5	304.6	321.5	339.7	280.8	277.7	304.0	282.4	N/A
Wind energy	0.8	4.1	4.8	7.3	11.3	14.2	22.2	27.0	35.6	44.2	57.1	69.1	81.4
Geothermal en.	3.2	3.5	3.8	4.0	4.3	4.5	4.8	4.6	4.8	5.4	5.5	5.1	N/A
Photovoltaics	0.01	0.03	0.03	0.04	0.06	0.08	0.11	0.17	0.26	0.44	0.74	1.49	2.19
Total	281.0	321.4	322.1	337.1	352.6	358.4	387.9	410.9	369.8	384.8	435.1	428.5	N/A
RE share of gross electricity consumption [%]	13.5	13.7	13.4	13.8	14.1	14.0	14.7	15.2	13.6	13.8	13.7	13.6	N/A

RE Renewable energies
From 2004 including electricity generation in the Member States of the EU enlargement of May 2004 (EU-25).

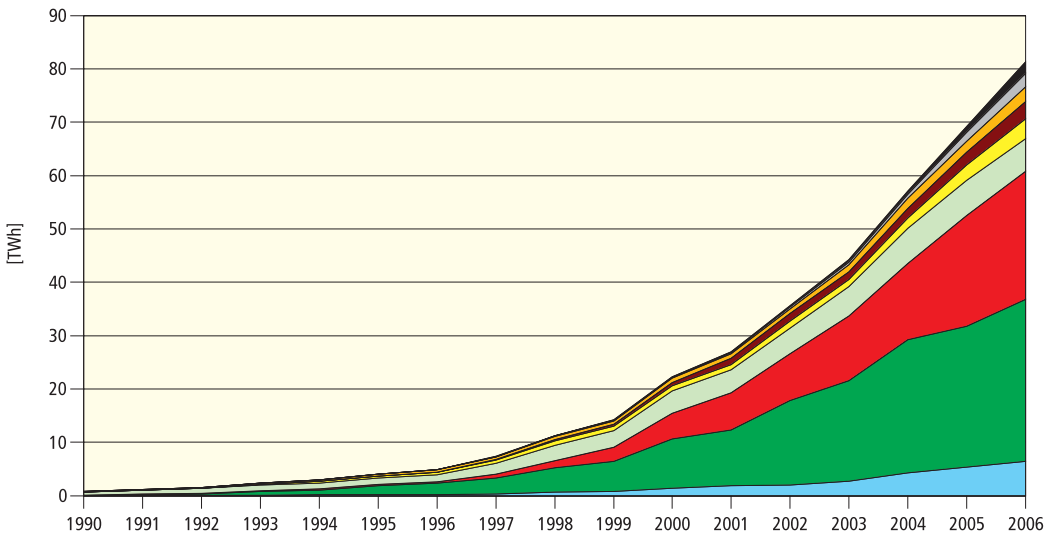
1) Provisional figures
2) Including municipal waste and biogas
3) In the case of pumped- storage power plants, generation from natural inflow only

Sources: Eurostat [34], [72]; IEA [31], Observ'ER [53], [46], [61], [37]; DGEMP [36]; EIA [33]; ZSW [3]

Since 1997 electricity generation from renewables in the EU-15[1)] has increased by an average of 2.5 % p. a. to an estimated 407 TWh (EU-25 approx. 428 TWh) in 2005, and contributes 14.4 % (EU-25 13.6 %) to the electricity supply. The increase to date is primarily attributable to developments in two renewable energy sectors: wind energy, with an average growth of around 32 % p.a.; and the use of biomass for electricity generation, with around 11 % p.a. Equivalent growth rates are needed in the other sectors if the EU-25 is to supply the aspired 21 % of its entire gross electricity consumption from renewables by 2010. An optimum combination of all renewable energy sources is needed in order to meet these targets.

1) In 2005, the new Member States from the 2004 EU enlargement accounted for 5 % of the total electricity supplied from renewable energies, i.e. at present, developments in the renewable electricity market of the EU-15 countries is decisive for the development of this share.

Generation of electricity from wind energy in the EU, 1990 to 2006



From 2004, including installations in the Member States of the EU enlargement of May 2004 (EU-25).

1) Generation < 2 TWh/a in each case

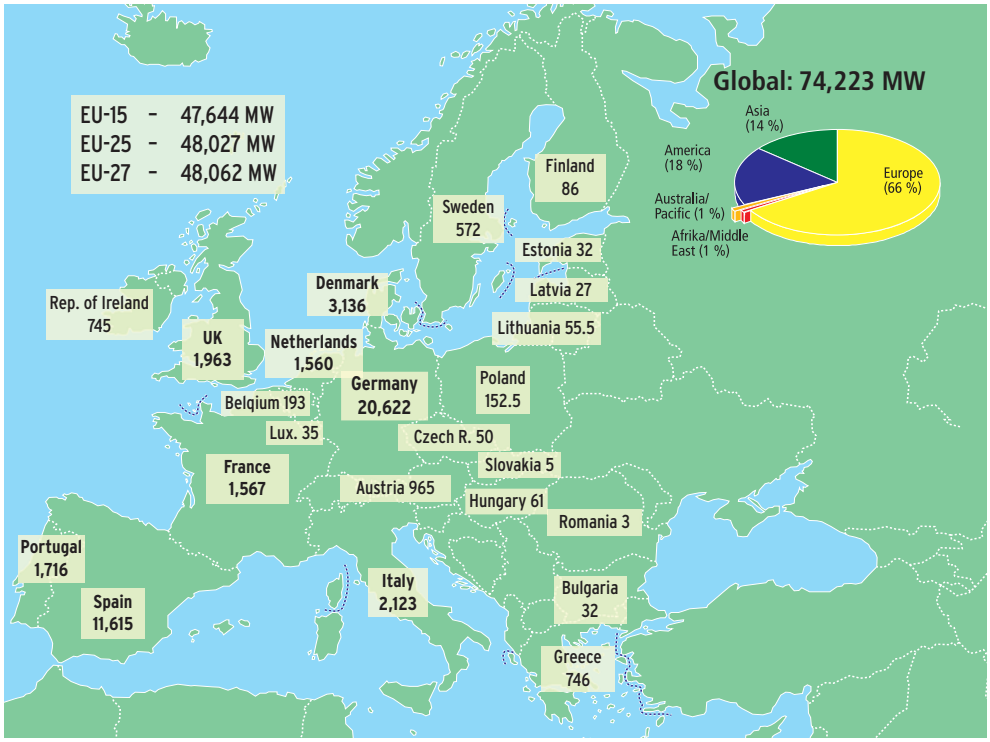
Sources: Eurostat [34]; Observ'ER [46]

Total installed wind energy capacity in the EU, end of 2006

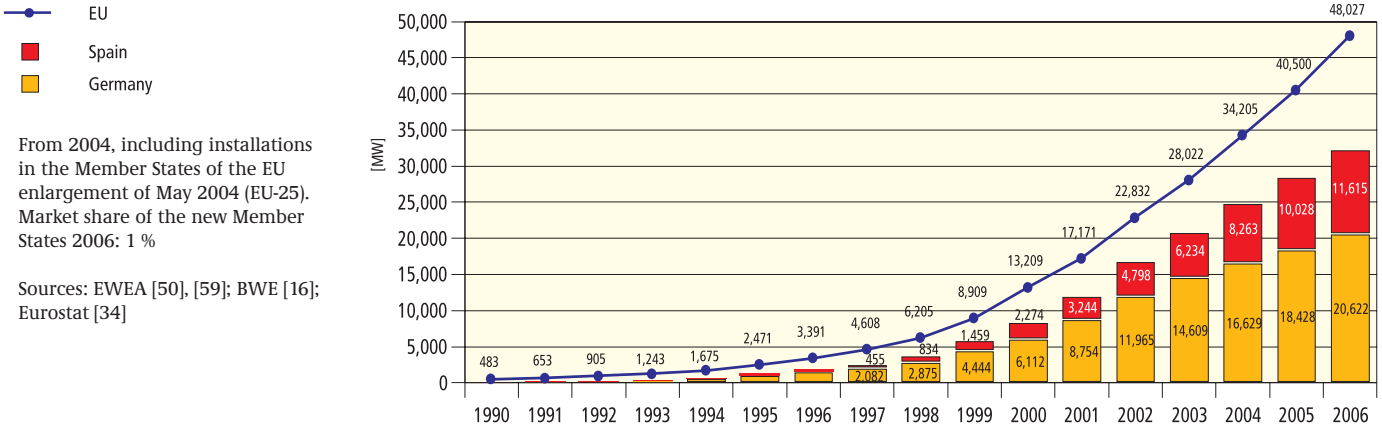
Figures in MW

No wind energy use in Malta, Slovenia and Cyprus

Sources:
EWEA [50]; GWEC [60]



Development of installed wind energy capacity in the EU, 1990 to 2006



From 2004, including installations in the Member States of the EU enlargement of May 2004 (EU-25). Market share of the new Member States 2006: 1 %

Sources: EWEA [50], [59]; BWE [16]; Eurostat [34]

In recent years, the use of wind energy has experienced a very dynamic upturn, particularly in the countries of the EU. In the past five years alone, the installed capacity has more than doubled, to around 48,000 MW. As in the previous year, the increase in 2006 was driven primarily by developments in the wind energy market in Germany and Spain. At the end of 2006 Germany broke through the 20,000 MW barrier, having added an additional 2,233 MW (net) of new capacity over the course of the year. The Spanish wind market likewise further consolidated its lead over the other EU states last year by installing 1,587 MW; by the end of 2006, the total installed capacity was around 11,600 MW. Together, these two countries account for almost two-thirds of the total installed capacity in the EU, or around 40 % of the global installed capacity, which totalled around 75,000 MW at the end of 2006. Germany heads the worldwide league table for wind farms, with a global market share of 28 %, followed by Spain (15.6 %) and the USA (15.6 %).

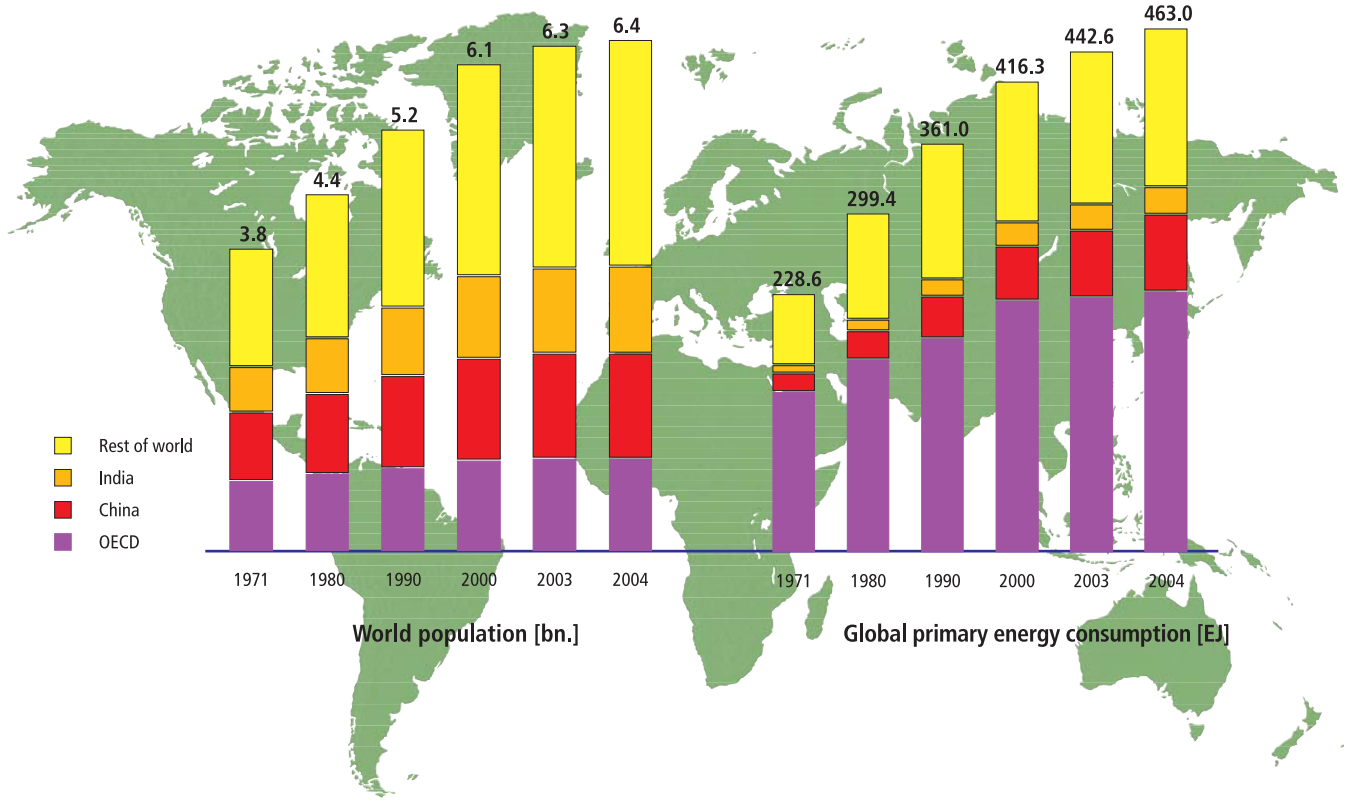
Global use of renewable energy sources

The importance of renewable energy sources for sustainable development is widely recognised. Since 1995, the supply of primary energy from renewables has increased by 15 % to around 60,600 PJ in 2004.

Comparing renewable energy supply with total primary energy consumption, the share of renewables is declining, standing at 13.1 % in 2004 (see also Appendix, para. 10), 0.7 % less than in 1995. This trend is primarily attributable to the increase in total global primary energy consumption, which cannot be compensated by the increased energy supply from renewables. Developing and newly industrialising countries play a key role in this scenario, especially China, which accounts for a quarter of the global rise in primary energy consumption since 1995, and which consumed 15 % of the world's primary energy in 2004.

Against this background, it becomes clear that in order to meet the challenges of global energy supply and, in particular, climate protection, as well as using energy more efficiently, it is also necessary to increase the development momentum of renewable energy sources. This is particularly true of wind, solar and geothermal energy, but also of modern techniques for the use of biomass. Traditional forms of use 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 no longer represent a sustainable use of renewables (cf. also page 46).

Development of world population and global primary energy consumption



Source: JEE [86]

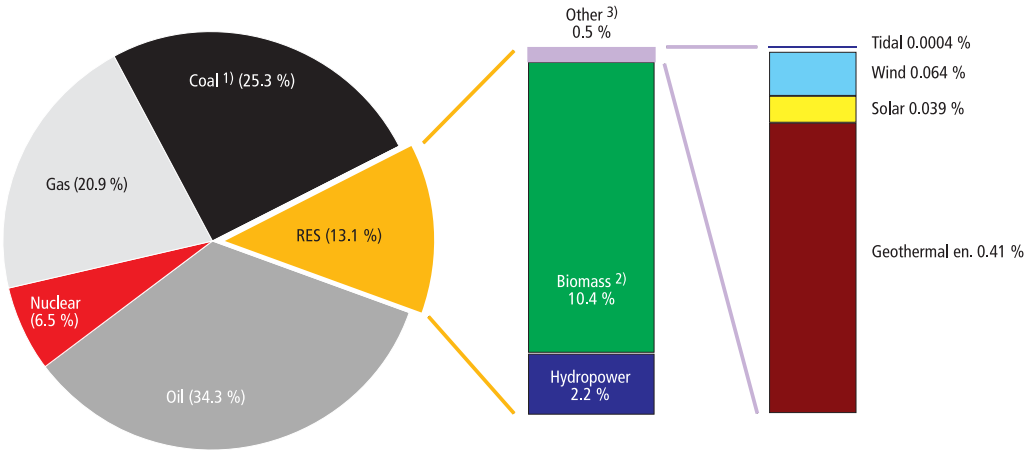
Structure of global primary energy consumption, 2004

RES Renewable energy sources
Primary energy consumption in 2004: 463,000 PJ

1) Incl. non-renewable share of waste (0.2 %)
2) Incl. renewable share of waste
3) Geothermal energy, solar energy, wind energy, tidal

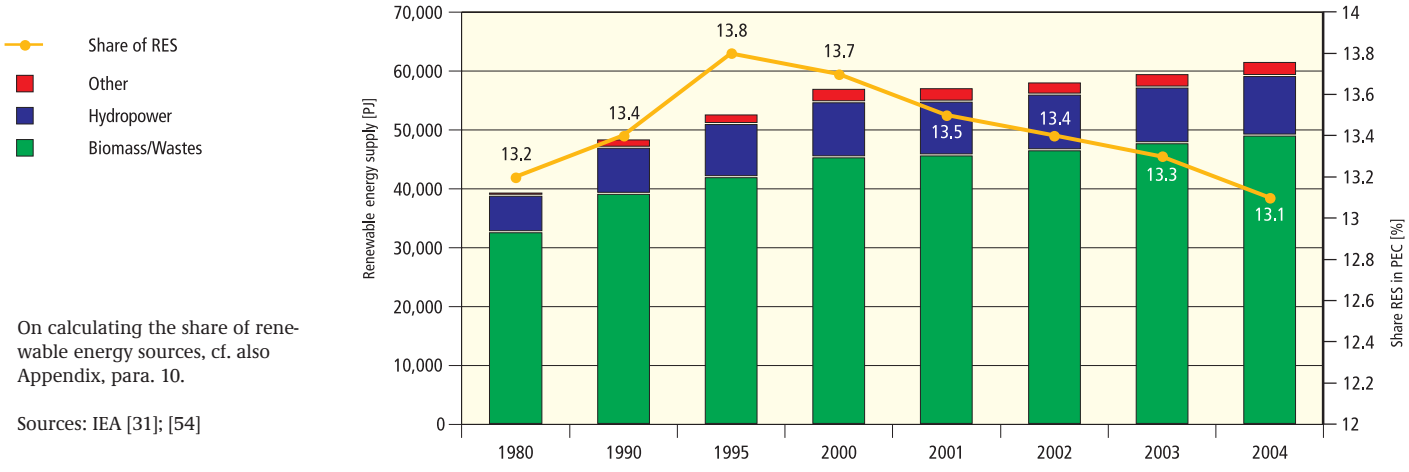
Sources: IEA [31]; [45]

In accordance with international agreements, electricity from nuclear power is rated at an average conversion efficiency of 33 % in relation to primary energy. In the case of electricity from hydropower, on the other hand, an approximation of 100 % is used. According to this calculation method (so called physical energy content method) nuclear power accounts for a share of approx. 6 % of primary energy consumption and hydropower for approx. 2.2 %, while their contribution to electricity generation almost equals; cf. page 47 and Appendix, para. 4.



Global primary energy consumption has more than doubled since 1971, rising to 463,000 PJ in 2004. In 2004, global demand for primary energy rose by around 5 %, or in absolute terms, by around 20 PJ (by way of comparison: in 2006, primary energy consumption in Germany totalled around 14,500 PJ). Renewable energies already contributed 13.1 % to the energy supply. If we break this down according to the various forms of use, it becomes clear that the lion's share (12.6 %) is provided by biomass (including waste) and hydropower. Considering the development of renewable energy sources over a five-year period, we can see that the average energy supply from hydropower was 9,600 PJ. The average growth in the area of biomass (including waste) was 2 %. The development of solar, wind and marine energy has been encouraging, with average growth rates of just under 15 %.

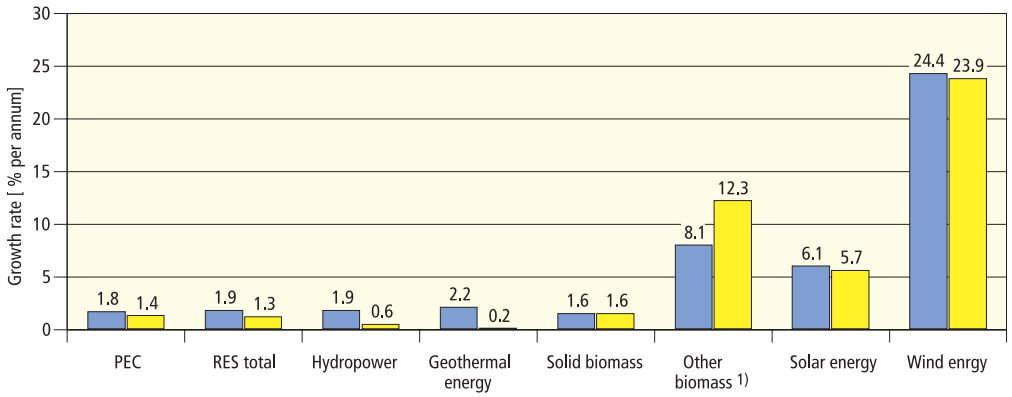
Worldwide development of renewable primary energy supply and share of renewable energies



On calculating the share of renewable energy sources, cf. also Appendix, para. 10.

Sources: IEA [31]; [54]

Average growth rates of primary energy consumption and renewable energy sources for the period 1990 to 2004



RES Renewable energy sources
PEC Primary energy consumption

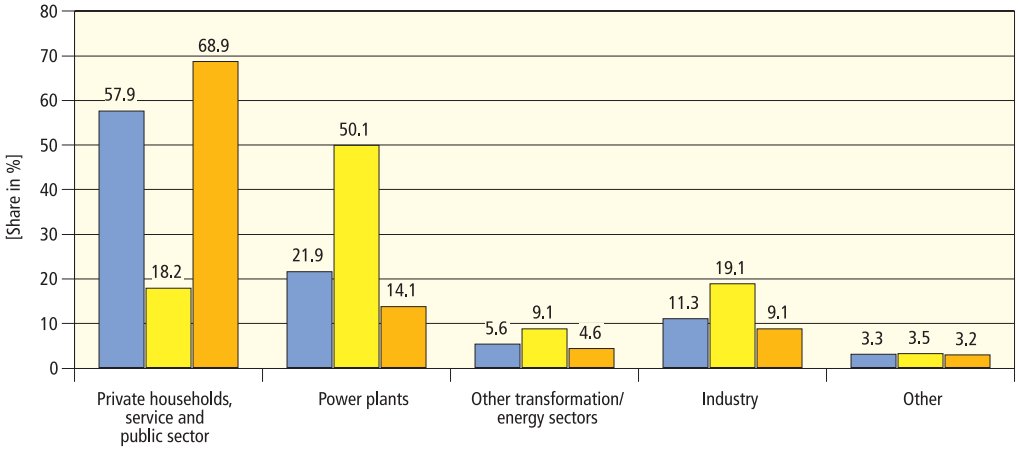
The OECD Member States are listed in the Appendix, para. 11

1) Biogenic portion of local authority waste, biogas, liquid biomass

Source: IEA [31]

Against the background of various climate protection targets, including the Kyoto Protocol, the development of renewable energy sources has been of particular interest since the year 1990. Since then, however, efforts to significantly raise their profile amongst energy supply have failed. Although energy supply increased by an average of 1.9 % up until 2004, growth was only slightly higher than that of primary energy consumption as a whole, at 1.8 % p.a. Among western industrialised countries (OECD), the contribution of renewable energy sources actually declined, from 5.8 % in 1990 to 5.7 % in 2004.

Share of renewable energies in energy demand in the OECD, Non-OECD and world according to application areas, 2004



Source: acc. to IEA [31]

Globally, today, around 60 % of renewable energies are used to supply heat in private households and in the public and services sector. Essentially, this refers to wood and charcoal. 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 14.1 %. The share attributable here to decentralised heat provision is correspondingly high, at around 70 %, compared with only 18 % or so in the OECD countries.

Regional use of renewable energy sources, 2004

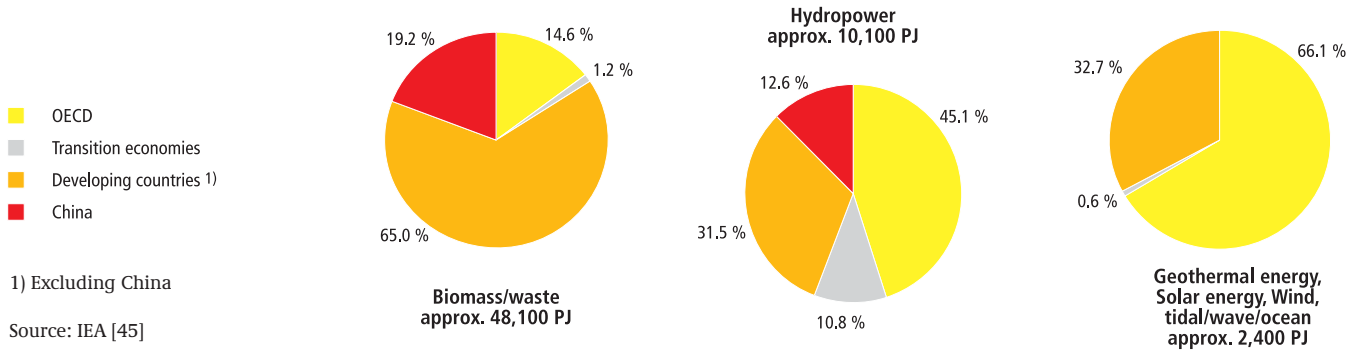
Transition economies: Countries that are in transition from a planned economy to a market economy; the IEA uses this term to refer to the countries of non-OECD Europe and the countries of the former USSR.

1) Biogenic portion of waste; in non-OECD countries it is not always possible to make a clear delimitation between biogenic and non-biogenic portions
2) Geothermal energy, solar energy, wind energy, marine energy
3) Latin America excluding Mexico and Asia excluding China

(physical energy content method)

Source: IEA [31]

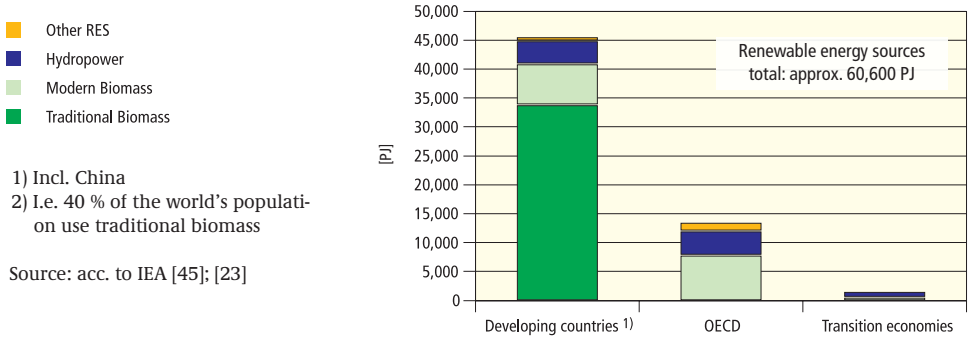
	PEC	Of which RES	RES as a share of PEC	Principal RES as a share of total RES [%]		
	[PJ]	[PJ]	[%]	Hydro-power	Biomass / waste 1)	Others 2)
Africa	24,535	12,021	49.0	2.6	97.0	0.4
Latin America 3)	20,327	5,870	28.9	36.1	62.4	1.4
Asia 3)	53,986	17,187	31.8	4.0	92.4	3.6
China	68,100	10,509	15.4	12.1	87.9	0.0
Middle East	20,089	138	0.7	43.4	32.2	24.4
Transition economies	45,369	1,712	3.8	63.7	34.6	1.6
OECD	230,610	13,189	5.7	34.6	53.4	12.0
World	**463,017**	**60,626**	**13.1**	**16.7**	**79.4**	**4.0**



1) Excluding China

Source: IEA [45]

Traditional use of biomass, 2004



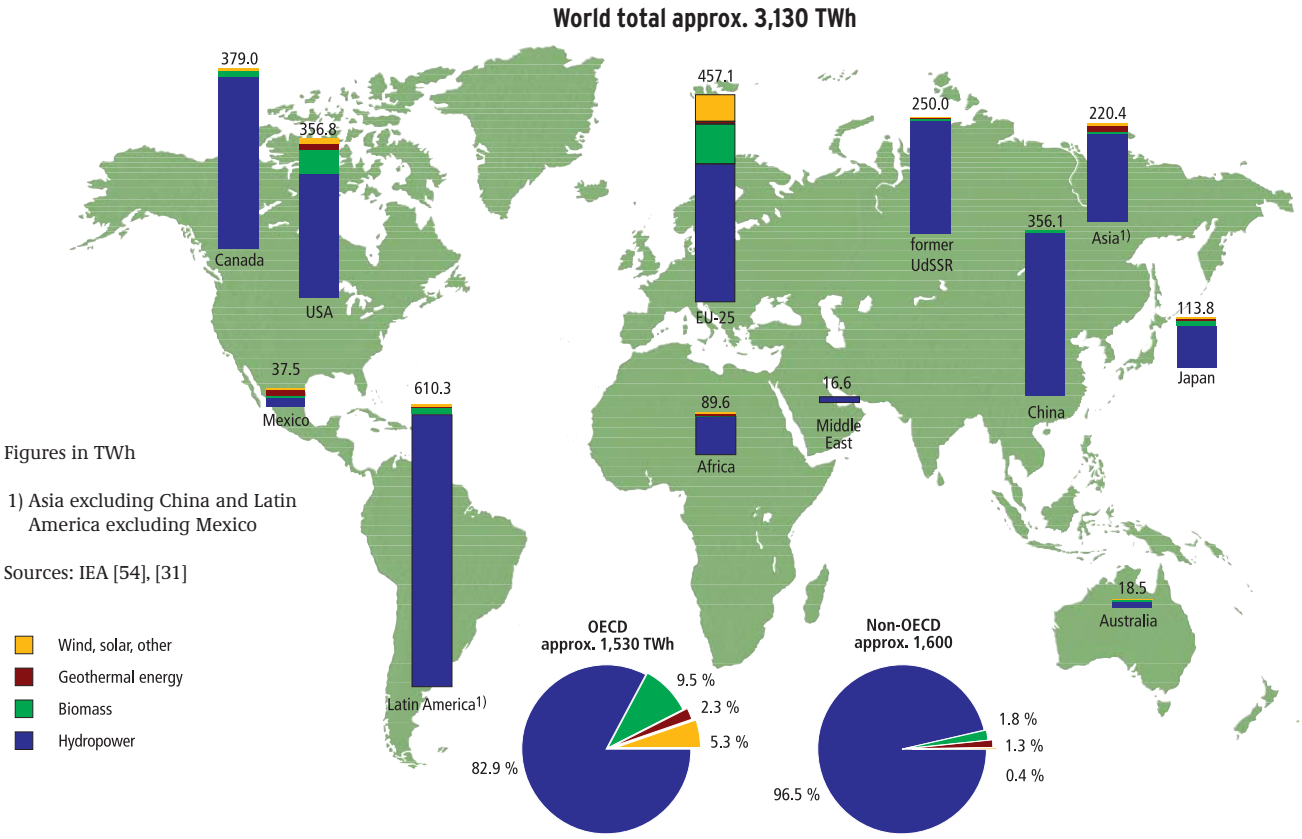
1) Incl. China
2) I.e. 40 % of the world's population use traditional biomass

Source: acc. to IEA [45]; [23]

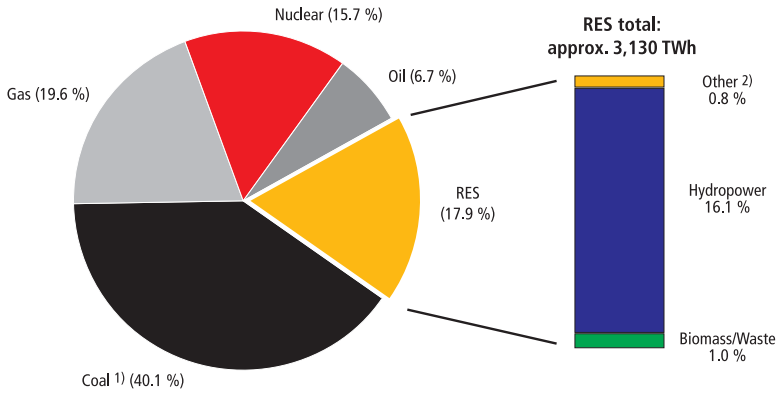
People relying on traditional biomass	2004 [Million]
Sub-Saharan Africa	575
North Africa	4
India	740
China	480
Indonesia	156
Rest of Asia	489
Brazil	23
Rest of Latin America	60
Total 2)	**2,528**

The share of energy that is generally considered renewable is particularly high in Africa. However, this primarily concerns traditional uses of biomass that are not sustainable in the long term. Basic forms of cooking and heating can impair health through the use of open fires, and lead to the often irreversible effects of deforestation. The use of hydropower from large embankment dams can also be an unsustainable use of renewable energies, since such dams can have serious social and ecological consequences.

Electricity generation from renewable energy sources in various regions, 2004



Share of renewable energy sources in global electricity generation, 2004



RES Renewable energy sources

1) Contains the non-renewable portion of waste (0.3 %)
2) Geothermal energy, solar energy, wind energy, marine energy.

Sources:
IEA [31], [54]

Worldwide, renewable energy sources account for 17.9 % of total electricity generation, and this figure has declined since 1990 (19.3 %). The reason for this is the relatively low growth in hydropower use in western industrialised countries (OECD), which remained behind the increase in electricity generation as a whole. This was not compensated via the use of other resources such as biomass or wind energy.
Worldwide, the use of hydropower dominates the generation of electricity from renewable sources, accounting for around 90 % (corresponding to 16.1 % of total electricity generation), while biomass accounts for 6 % and other renewable energy sources just under 4 %.

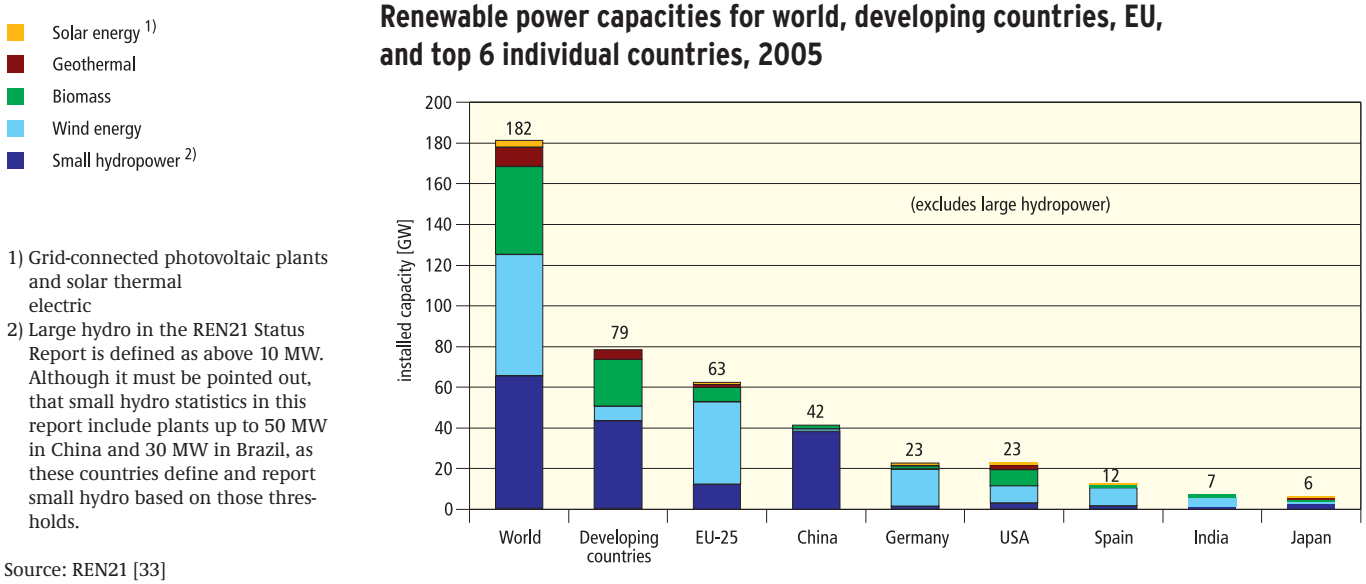
REN21 Renewable Energy Policy Network for the 21st Century

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

The International Conference for Renewable Energies in Bonn, *renewables2004*, marked the beginning of a new global energy era. The successful implementation of almost 200 activities under the Bonn International Action Programme (IAP) is already contributing to global climate protection and sustainable development: with complete implementation of the IAP, emissions could be reduced by 1.2 billion t CO_2/annum by 2015, corresponding to around 5 % of global emissions in the year 2015. Worldwide, implementation will lead to investments in excess of US$ 300 billion. Whereas in 2004 global investments in renewable energies totalled US$ 30 billion, this figure had already increased to more than US$ 38 billion by 2005. Moreover, implementation of the IAP will provide up to 300 million people with access to electricity for the first time. The official closing documentation, including the central conference documents and evaluation of the IAP, is available to download from www.renewables2004.de.

China has made a significant contribution in this respect: it is planning to increase the share of renewables in electricity generation to 16 % by 2020. In order to achieve this goal, in 2005 China introduced a regulation to promote renewable energies, significant aspects of which are based on Germany's Renewable Energy Sources Act (EEG). The Chinese Government has announced that in collaboration with other players, it will be raising more than 50 billion Euros for the expansion of renewables.

Renewable power capacities for world, developing countries, EU, and top 6 individual countries, 2005



1) Grid-connected photovoltaic plants and solar thermal electric
2) Large hydro in the REN21 Status Report is defined as above 10 MW. Although it must be pointed out, that small hydro statistics in this report include plants up to 50 MW in China and 30 MW in Brazil, as these countries define and report small hydro based on those thresholds.

Source: REN21 [33]

The Federal Government is continuing to work intensively on the implementation of Germany's contribution to the Bonn Action Programme. Key contributions such as a new financing facility for energy efficiency and renewable energies have already been implemented. By the end of 2006, more than EUR 300 million had been provided at Government level, including projects in 9 countries.

A further outcome of the conference that has since been implemented is the founding of a global policy network (Renewable Energy Policy Network – REN21). Governments, international organisations and representatives of civil society will work together in the REN21 network and engage in further high-level political dialogue. One important outcome of the REN21 network is the annual publication of a Global Status Report. The Report gives a comprehensive overview of the established support policies, markets and investment and associated employment (the report is available for downloading at www.ren21.net). The REN21 Network is also involved in implementing the IAP. It supports important events such as the renewables 2007 conference in Brussels, the European Neighbourhood Conference of 19 April 2007, and the G8 Gleneagles Dialogue. REN21 also supports the Bonn Resolutions at the United Nations, particularly at the 14th and 15th meeting of the UN Commission on Sustainable Development.

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 Federal Government. With 1,300 delegates from 100 countries, including 30 government representatives at ministerial level, the conference was very successful in highlighting the fact that renewable energy sources are not the exclusive domain of industrialised countries. The Chinese Government strengthened the commitment it had made at the Bonn conference. The results of the conference may be viewed at www.birec2005.cn.

For March 2008, the US Government has announced that it will be staging a follow-up conference, the Washington Renewable Energy Conference (WIREC). Clearly, the Bonn renewables conference is now a well-established process.

A number of regional activities are also being pursued, as well as cooperation with key developing and newly industrialising countries. For example, Germany supports the expansion of renewable energies in the Arab countries i. a. beyond the Arab initiative by the Middle East and North Africa Renewable Energy Conferences (MENAREC) in 2004 in Sana'a (Yemen), in 2005 in Amman (Jordan), in 2006 in Cairo (Egypt) and in 2007 in Damascus (Syria). The expansion of renewables is likewise promoted within the context of the German-Indian energy dialogue and the German-Brazilian energy agreement.

One important contribution to the IAP is the Implementing Agreement Renewable Energy Technology Deployment (RETD), which was set up at the initiative of the BMU. This is a cross-technology agreement designed to accelerate the market launch of technologies for the use of renewable energies by means of internationally coordinated activities within the framework of the International Energy Agency. Following the Agreement's official entry into force in September 2005, the RETD is continuing to take shape. More than ten countries are now involved, nine of them as official members (Germany plus France, Italy, the United Kingdom, Denmark, the Netherlands, Canada, Ireland and Norway). The RETD publishes up-to-date information on renewable energies and hosts expert conferences, the most recent of which was in Paris in March 2007. Further information may be found at www.iea-retd.org.

In addition, as agreed in the Coalition Agreement, the Federal Government also supports the establishment of an International Renewable Energy Agency (IRENA).

Appendix: Methodological notes

Some of the data published here reflects provisional results only. This is also true of individual time series which are currently being reviewed by the Working Group on Renewable Energy Statistics (AGEE-Stat) (cf. also www.erneuerbare-energien.de). Figures may still change in comparison 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 include the terms (primary) energy consumption, although this is not strictly true 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 part of the useful energy is lost.

1. Calculation of savings factors and of avoided emissions for electricity generation

The figures pertaining to 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 the extent to which renewable energies can replace conventional energy sources in the light of the current power plant park. For the most part, the feed-in of wind-generated power replaces electricity from hard coal-fired, medium-load power plants, and to a lesser extent electricity from natural gas power stations; during periods of strong winds and low load it can also replace lignite power plants. Hydropower, on the other hand, serves as a substitute 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 driven. As such, they predominantly replace medium (hard coal) and peak-load power plants (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 serves as a substitute for natural gas and, to some extent, hard coal.

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

The savings factors were calculated according to the fuel substitution ratios shown here.

For the CO_2 saving factor for electricity the value of 922 g/kWh is given.

	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%

1) Biogenic portion only

Source: ISI [41]

2. Calculation of savings 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 and disposal of plant. If we assume that district heating and electrical heaters are not replaced, the calculation assumes the following structure for the heat supply mix substituted by renewable energy:

Natural gas	Fuel oil	Coal
56.9 %	40.5 %	2.6 %

Sources: acc. to VDEW [47];
acc. to Federal Statistical Office [44]

For the CO_2 saving factor for heat the value of 232 g/kWh is given.

3. CO_2 and SO_2 equivalent

CO_2 equivalent

The 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 terms of the Kyoto Protocol. They contribute in varying degrees to the greenhouse effect. In order to be able to compare the greenhouse effect of individual gases, they are allocated a factor known as relative greenhouse potential (GHP), which measures their greenhouse effect in comparison with the reference substance CO_2.

The CO_2 equivalent of the Kyoto gases is derived by multiplying the relative greenhouse potential by the mass of the respective gas, and indicates the quantity of CO_2 which would develop the same greenhouse effect over an observation period of 100 years.

		Relative greenhouse potential 1)	
Gas		Values acc. to IPCC 2001 [65]	Values acc. to IPCC 1996 [51]
CO_2	Carbon dioxide	1	1
CH_4	Methane	23	21
N_2O	Nitrous 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

The figures according to IPCC [65] of the year 2001 reflect the current status of scientific knowledge. However until now, these figures have not been bindingly accepted by the contracting states. For the purposes of this brochure, however, the calculations are based on these figures. For the Kyoto Protocol, the figures according to IPCC of the year 1996 are relevant [51].

1) Based on a time scale of 100 years; CO_2 as reference substance

SO_2 equivalent

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.

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

Source: Öko-Institut/IZES [22]

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

The internationally applied method for calculating the primary energy equivalent of electricity is the physical energy-content method. In the case of electricity whose net calorific value is known (fossil fuels), the net calorific value is multiplied by the quantity used. In the case of energy carriers for which the calorific value is not known, as in the case of the renewable energy sources hydropower, wind energy and photovoltaics, primary energy is deduced from final energy using an efficiency factor of 100 %. Hence, for example, 1 kWh of electricity from hydropower is equivalent to a primary energy equivalent of 1 kWh. In the case of nuclear power, an efficiency of 33 % is assumed when determining the primary energy equivalent. This method means that in the definition of primary energy consumption, the energy carriers water, wind and photovoltaic energy are heavily under-represented compared with energy carriers with a low level of efficiency. In 2006 according to the physical energy content method, the share of renewable energies accounted for 5.8 %.

By contrast, when calculating primary energy consumption according to the substitution method, it is assumed that electricity from hydropower, wind energy and photovoltaic energy which replaces a given quantity of electricity in conventional power plants also substitutes the equivalent fuel. The quantity of substituted fuel is generally calculated by means of a substitution factor which is equivalent to the consumption of fossil fuels used to generate electricity from these fuels (only general supply power plants; fuel consumption in cogeneration plants based on the so-called Finnish method). For the purposes of this brochure, however, fuel savings have been calculated according to the expert report [41]. The primary energy equivalent of electricity from hydropower, wind energy and photovoltaic energy is slightly higher with this method than with calculation based on the substitution factor. According to the substitution method, the share of renewable energies in Germany accounted for 7.8 % in the year 2006.

In the case of electricity from biomass, in which the calorific value or quantity used is difficult to ascertain with both methods, primary energy is deduced from final energy using the aforementioned substitution factor.

5. Supply of energy from photovoltaic and solar thermal energy

Photovoltaic energy
Electricity generation for 2006, at 2 TWh, is estimated to be slightly higher than the EEG medium-term forecast 2002 – 2012 by the VDN [9] of September 2006, while the figures for 2005, 2004 and 2003 correspond to the VDN annual calculations. Up to and including 2002, electricity generation was calculated using the installed capacity at the beginning of the year and half of the capacity increase of that year multiplied by a specific electricity yield. The specific electricity yield was supplied as an average for Germany by the Solarenergie-Förderverein Deutschland [Solar Promotion Association for Germany, 28]. Taking half the capacity increase allows for the fact that newly installed capacity of the respective year can only contribute to electricity generation on a pro rata basis.

Solar thermal energy
The specified heat supply is calculated from the installed collector area and an average annual heat yield of 450 kWh/m²*a for water heaters. In addition, however, solar thermal plants are not only used for hot water supply, but also for combined hot water supply and heating support. For 2006, the proportion of newly installed glazed collector surface is estimated at 55 %.

Because in the summer months the generation potential cannot be fully utilised with heating support systems, they are ascribed a reduced heat yield of 300 kWh/m²*a. In the case of swimming pool absorbers, a yield of 300 kWh/m²*a is likewise used for calculation purposes.

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 electricity production during that year.

6. Saving fossil fuels through renewable energy sources

The saving of fossil fuels for electricity generation is calculated using the typical utilisation rates for lignite, hard coal and natural gas power plants.

Power plant type	Lignite power plants	Hard coal power plants	Natural gas power plants
Average efficiency factors	36.6 %	37.6 %	43.9 %

Source: ISI [41]

It should be borne in mind that the various renewable energy sources save different fossil fuels. For example, hydropower reduces the energy generation of base load power plants (lignite), while wind energy primarily reduces electricity generation in medium load power plants (hard coal, natural gas). The system is explained in detail in ISI [41] (cf. also Appendix, para. 1).

In contrast to electricity generation, when calculating the saving of fossil fuels through heat generation from renewables, the upstream energy supply processes are also taken into account. By way of approximation it is assumed that wood heaters are the principal use of renewable energies. Therefore, for each used kilowatt hour of energy from renewable sources there is a saving of 1.11 kilowatt hours (primary energy) compared with oil heaters or 1.08 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) respectively. The extent to which fossil fuels are substituted is determined according to the structure of the heat supply mix described under point 2. For coal heaters, it is assumed that 79.6 % of lignite briquettes, 12.9 % of hard coal briquettes and 7.5 % of hard coal coke are substituted. Electrical heaters were disregarded for the purposes of this calculation.

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
Lignite briquette heating	1.89
Wood heating	0.09

	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

Source: Öko-Institut/IZES [22]

When calculating the saving of fossil fuels through biofuels, the upstream energy supply processes are likewise taken into account.

Therefore, every used kilowatt hour of biodiesel results in a saving of 1.26 kilowatt hours (primary energy) compared with diesel fuel. In the case of biodiesel, credits for by-products are included in this calculation. For bioethanol, the figure compared to petrol is 0.72 kWh, while the figure for rapeseed oil compared to diesel is 0.99 kWh. Vegetable oil is equated with rapeseed oil for the purposes of this calculation.

7. Sales proceeds from the use of renewable energy sources

Sales from the generation of electricity may be estimated based on the quantities of electricity fed into the grid and the fee rates paid under the Renewable Energy Sources Act. The revenues from facilities that fall outside the scope of the Act must also be added, especially hydropower plants over 5 MW capacity and electricity generation from thermal waste handling (biogenic portion only). An average value of 4.4 cents/kWh is assumed, based on the stock market price for base load electricity. With electricity generation at around 20.5 TWh in 2006, this produces a figure of approximately 0.9 billion Euros.

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 88 cents/litre net (102 cents/litre gross), for example, was estimated for the sale of biodiesel to public petrol stations, while lower prices were assumed for sales to vehicle fleets and the blending of diesel fuel.

The value of heat supplied from renewable energy sources is disregarded in this case, since the bulk of the heat is used internally. One conceivable option here, however, would be to calculate the avoided costs for fuel oil or natural gas. Assuming a substituted heat volume of approximately 78 TWh and an average fuel oil price of 59 cents per litre, this would correspond to approximately 4.6 billion Euros for the private household sector. The costs of the maintenance and repair of heat-generating plants as well as the revenues from the sale of heat in district heating systems have been disregarded here. This leaves the valuation of biogenic input materials such as logging residues, industrial wood residues, wood pellets etc. as well as a proportion of firewood, which have been estimated at 1.4 billion Euros in total.

8. The European Union (EU)

The EU enlargement in 2004 was the most extensive enlargement to date of the European Union. Ten new Member States – Estonia, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, the Czech Republic, Hungary and Cyprus – joined the Community when the Accession Treaty entered into force on 1 May 2004. Following the recent accession of Bulgaria and Romania (1 January 2007), the EU now comprises 25 Member States.

Where this brochure contains data on the development of renewable energies, the new Member States are included in the figures from their year of accession.

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

When calculating the primary energy equivalent for electricity generated from hydropower, wind energy and photovoltaics, in agreement with Eurostat, primary energy is equated with the generation of electricity according to the physical energy content method. 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, para. 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 here. In both case the physical energy content method is applied (cf. page 52).

The deviations arising from the different methodologies used compared with German accounting practices are minimal and are disregarded when calculating the overall share of renewable energy sources as a share of primary energy consumption. Major disparities would result if analogically to the energy supply in Germany (cf. pages 11, 52), the substitution method were to be implemented.

10. Renewable energy sources as a share of global primary energy consumption

Various sources give different figures for the share of global primary energy consumption that is attributable to renewable energy sources. The reasons for this include the accounting of the thermal recovery of domestic and industrial waste, as well as the generation of electricity in pump storage power stations. However, the greatest influence is attributable to the so-called traditional use of fuel wood and charcoal, which can only be estimated with a great deal of uncertainty, and for which the various figures deviate from one another by 50 % or more. For this reason, traditional biomass use is not always included in energy statistics. Allowing for the current status of knowledge in this field, renewable energy sources are thought to account for around 13.1 % of primary energy consumption (calculated acc. to physical energy content method, cf. page 52).

11. OECD

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

Conversion factors

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

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

Units for energy and output

Binding as statutory units in Germany since 1978. The calory and related units such as coal equivalent (ce) and crude oil equivalent (oe) are also used for information purposes.

Joule	J	for energy, work, heat quantity
Watt	W	for output, energy current, heat current
1 Joule (J) = 1 Newton metre (Nm) = 1 Watt second (Ws)		

Conversion factors

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

Greenhouse gases

CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous 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

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