Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

TRENDS IN

RENEWABLE ENERGIES IN 2005

- Current situation -

March 2006

The data on trends in renewable energies used in this information document are the findings of the Working Group on Renewable Energies - Statistics (AGEE-Stat), as of February 2006

AGEE-Stat is made up of experts from various federal ministries, government agencies, scientific institutes and the Federal Association for Renewable Energies (Bundesverband Erneuerbare Energien).

The head of AGEE-Stat is Dr. Frithjof Staiß of the Centre for Solar Energy and Hydrogen Research of Baden-Wuerttemberg (Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden–Württemberg - ZSW).

For further information on a broad range of topics connected with renewable energies please visit the relevant section of the BMU's website at www.renewable-energien.de.

Editorial responsibility:
Dieter Böhme, Uwe Büsgen, Andrea Meyer, Dr. Wolfhart Dürrschmidt
Federal Ministry for the Environment, Nature Conservation and Reactor Safety (BMU)
Division KI I1 - "General and fundamental aspects of renewable energies"

Frithjof Staiß, Ulrike Zimmer, Christel Linkohr
Centre for Solar Energy and Hydrogen Research of Baden-Wuerttemberg (ZSW)

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Photographs: BMU; DLR (cloudless earth)

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1 Renewable energies - goals for an energy supply of the future

In addition to reducing energy consumption and increasing energy efficiency, expansion of renewable energies is a central element in the German Government's energy policy. The Federal Government's goal[1] is to increase renewable energy sources' (RES) share in overall energy supply to at least 4.2 % by 2010. In 2005, renewable energies' (RE) share in primary energy consumption was 4.6 %, which means that the 2010 target has already been achieved. That is primarily due to the fact that renewable energies are promoted in the electricity sector under the Renewable Energy Sources Act (EEG) and in the heating sector by a programme of market incentives. Successful expansion has been achieved in the area of biofuels for transport.

The aim is to increase renewable energies share in overall energy consumption to at least 10 % and biofuels' share in transport fuels to 5.75 % by 2020.

The target for 2010 is that renewable energies' share in gross electricity consumption should have risen to at least 12.5 %. In addition, the legislative has set the medium-term goal in the Renewable Energy Sources Act of increasing renewable energies share in the electricity supply to at least 20 per cent by 2020. A recent study commissioned by the BMU considers it likely that under current circumstances the renewable energies share will easily reach 25 % (Figure 1). In the long term, i.e. over the next fifty years, the Federal Government's aim is that approximately half of the energy supply should come from renewable energies [1], [2], [3].

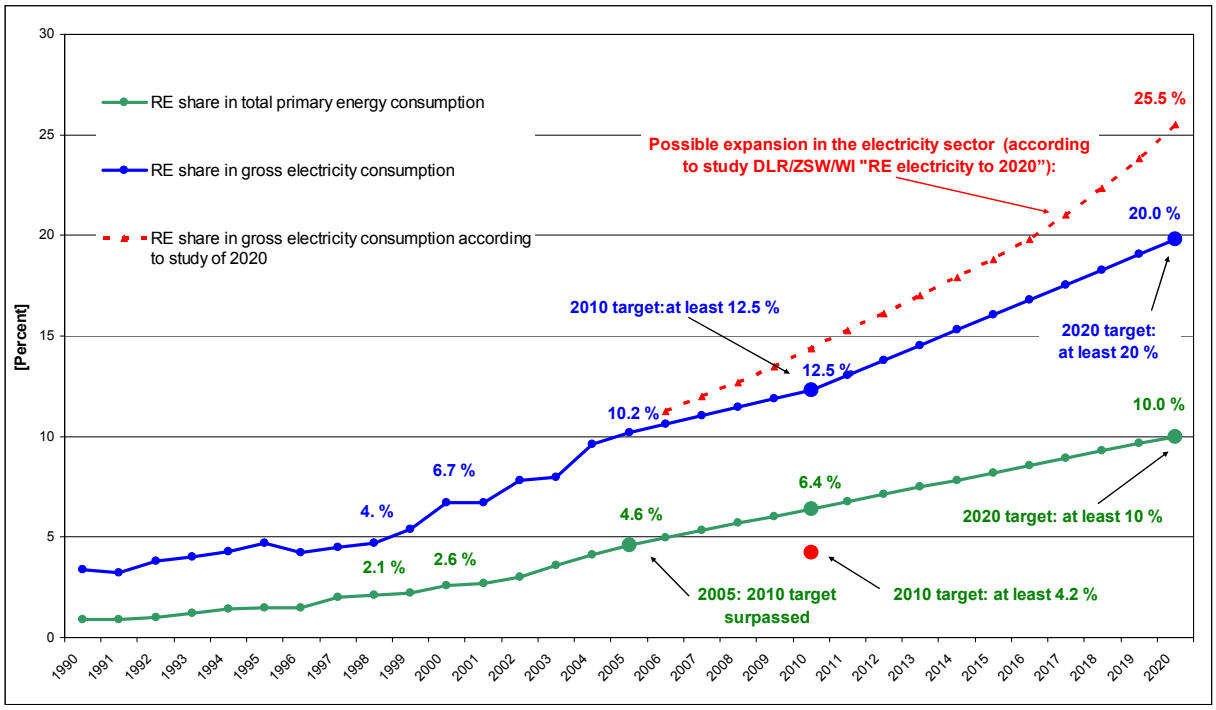

Figure 1: Trends in renewable energies' share in primary energy and gross electricity consumption – the Federal Government's targets and potential development

[1] Federal Government's sustainability strategy of 2002, Coalition Agreement between the CDU, CSU and SPD, November 2005

2 Trends in renewable energies in 2005 at a glance

Renewable energies continued to record excellent growth in 2005 [1].

- Renewables' share in primary energy consumption (PEC) rose to about 4.6 % (2004: 4.0 %).
- Renewables' share in gross electricity consumption rose to 10.2 % (2004: 9.4 %).
- Renewables' share in the heating supply rose to 5.4 % (2004: 5.2 %).
- Renewables' share in fuel consumption in the road transport sector rose to about 3.4 % (2004: 1.9 %).
- Renewables' share in the total final energy supply in Germany (electricity, heat, vehicle fuels) rose to 6.4 % (2004: 5.7 %).
- Approximately 83 million tonnes of CO_2 emissions were avoided in 2005 thanks to renewable energies (2004: approx. 76 million tonnes).

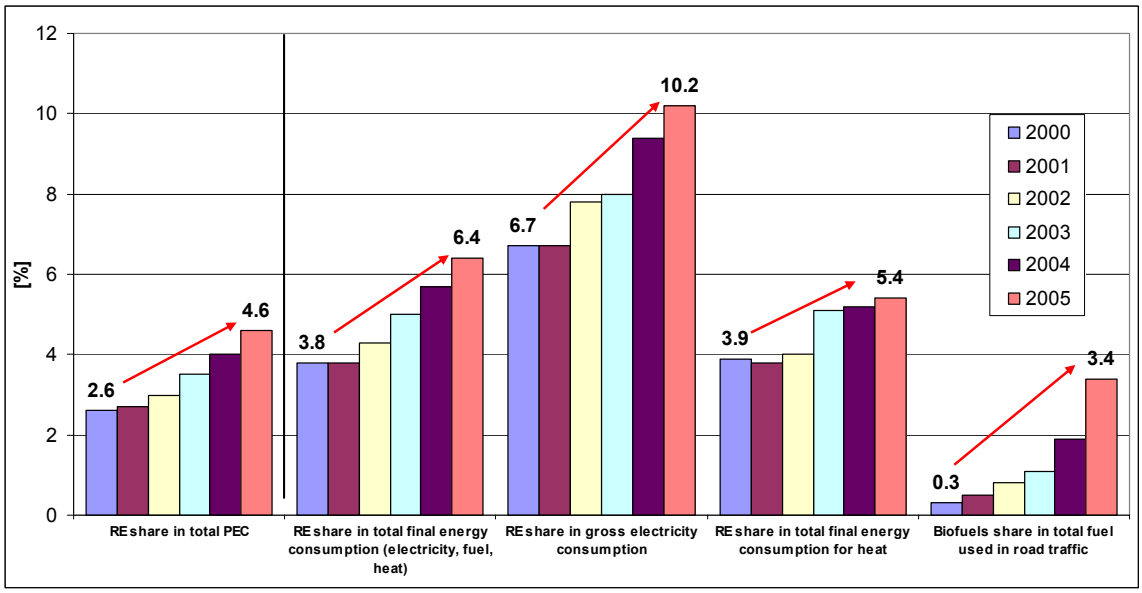

Figure 2: Trends in renewable energies at a glance

In 2005, renewable energies contributed 652 PJ [1] to primary energy consumption (Figure 3), putting their share in Germany's total primary energy consumption (2005: 14,238 PJ) at 4.6 % (2004: 4.0 %) (calculated using the efficiency method[2]). If the calculation is done using the substitution method the renewable energies share in 2005 was 6.6 %.

In 2005 renewable energies contributed 164 TWh[3] [1] to the final energy supply in the form of electricity, heat and vehicle fuels (2004: 147 TWh). As was the case the previous year, the greatest contribution at about 67 % came from bioenergy sources such as wood, biogas and biodiesel (Figure 4). The marked increase in the use of renewable

[2] For electricity generated from sources of energy for which it is not possible to assign a calorific value, - e.g. wind power or photovoltaics, the efficiency method is used in which primary energy is derived from the final energy, assuming 100% efficiency. Using this method, 1 kWh of electricity generated from hydropower for example is given a primary energy equivalent of 1 kWh. In the substitution method, the primary energy equivalent used for electricity from hydropower, wind power or photovoltaics is that of the fuel which would have otherwise been used in conventional power stations instead of the renewable source.

[3] 1 TWh = 1,000 GWh = 1,000 million kWh

energies over the previous year is due, on the one hand, to weather conditions and, on the other hand, to the further expansion of renewable energies.

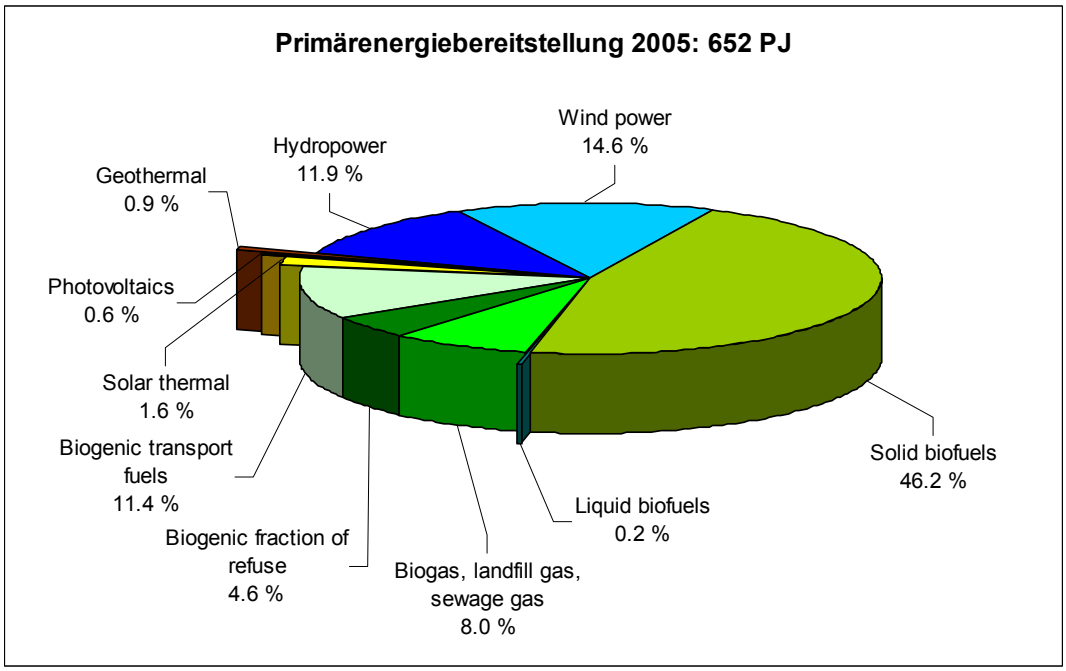

Figure 3: Breakdown of primary energy supplied from renewables in 2005

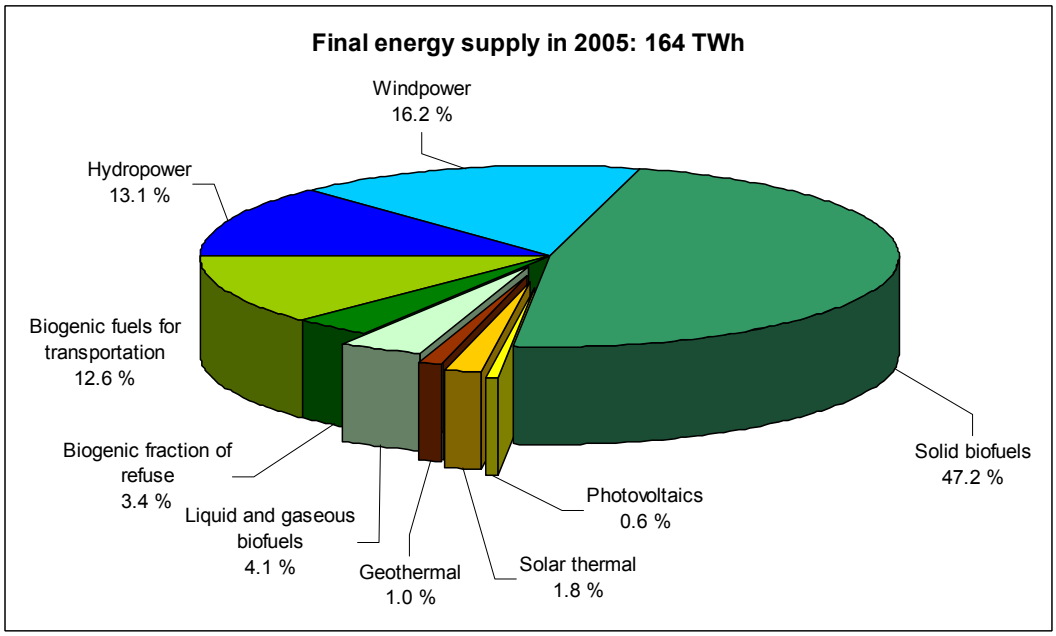

Figure 4: Breakdown of final energy supplied from renewables in 2005

The overall positive trend in renewable energies is reflected particularly strongly in the electricity market (Figure 5). At 62.1 TWh [1]: electricity generated from renewable energies in 2005 contributed 10.2 % to gross energy consumption. This is more than double the level of 1998 (4.7 %). The greatest contribution comes from wind power at 42.6 %, followed by hydropower at 34.6 % and biogenic fuels (including the biogenic fraction of refuse[4]) at 21.1 %.

[4] *This share has been calculated on the basis of various studies and pieces of research and has been agreed by the Working Group on Renewable Energies - Statistics (AGEE-Stat). The biogenic fraction of refuse has been assumed to be 50 %.*

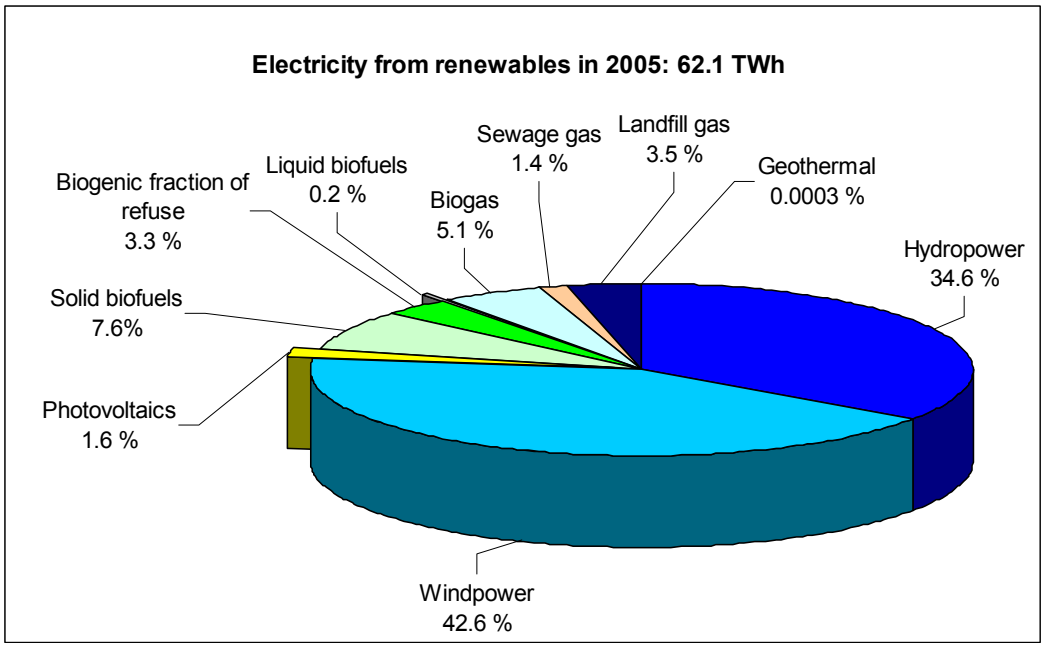

Figure 5: Breakdown of electricity generated from renewables in 2005

The rising trend also continued in the area of heat generation [1]. At approximately 81 TWh (Figure 6), renewable energies' share in final energy consumption for heat in 2005 was in the order of 5.4 % (2004: 5.2 %). The rise is mainly due to the market incentive programme[5] launched to promote the use of solar energy, biomass and geothermal energy in heating. This trend was also influenced by further rises in the price of heating oil and other fuels in 2005.

The trends for the individual types of renewable energy source [1] in recent years are shown in Table 1. Compared to the previous year, growth was particularly strong in the electricity and vehicle fuel sector.

Table 1: Trends in renewable energies share in energy supply

Renewable energies share in energy supply 1998 - 2005								
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Final energy consumption	[%]							
Electricity generation (based on gross electricity supply)	4.7	5.4	6.7	6.7	7.8	8.0	9.4	10.2
Heat supply (based on total heat supply)	3.5	3.5	3.9	3.8	4.0	5.1	5.2	5.4
Vehicle fuel consumption (based on road traffic)	0.1	0.2	0.3	0.5	0.8	1.1	1.9	3.4
RES share in Germany's total final energy consumption	**3.1**	**3.3**	**3.8**	**3.8**	**4.3**	**5.0**	**5.7**	**6.4**
Primary energy consumption (PEC)	[%]							
Electricity (based on total primary energy consumption)	0.8	0.9	1.1	1.2	1.4	1.5	1.8	2.0
Heat supply (based on total primary energy consumption)	1.3	1.3	1.4	1.4	1.5	1.9	2.0	2.1
Vehicle fuel consumption (based on total primary energy consumption)	0.03	0.03	0.06	0.09	0.14	0.2	0.3	0.5
Sum total of RES share in total PEC	**2.1**	**2.2**	**2.6**	**2.7**	**3.0**	**3.5**	**4.0**	**4.6**

[5] *Richtlinie zur Förderung von Maßnahmen zur Nutzung Erneuerbarer Energien, MAP (Directive on Measures to Promote Renewable Energies)*

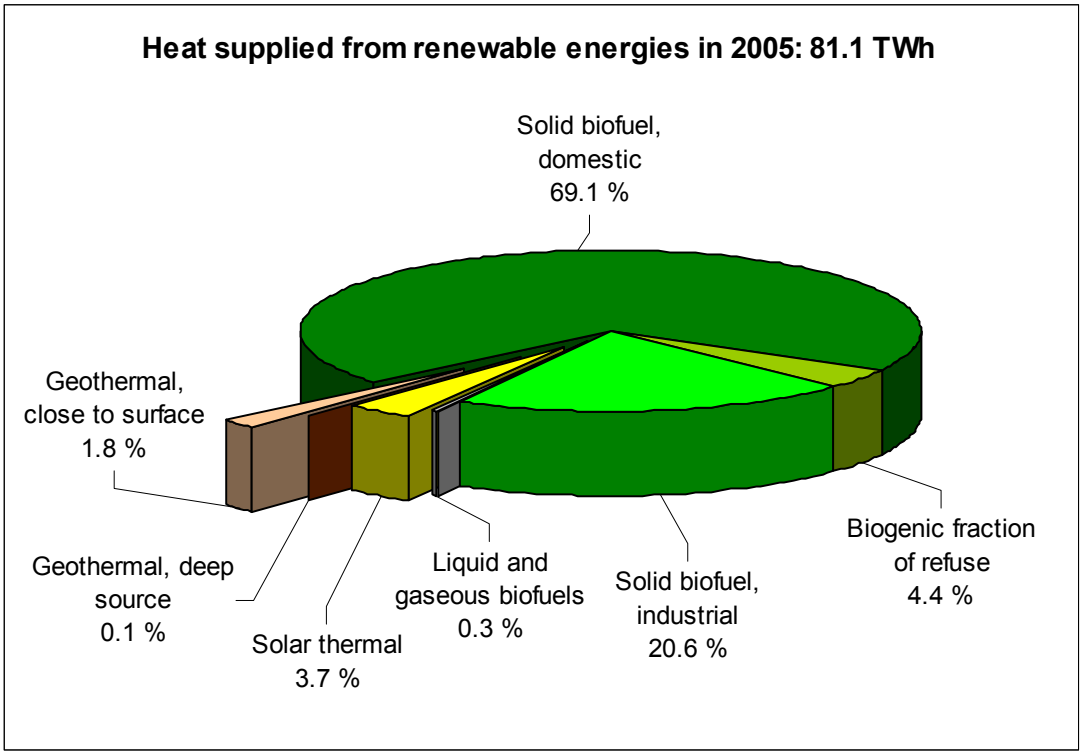

Figure 6: Breakdown of heat supplied from renewables in 2005

3 Trends in renewables by type of energy

3.1 Wind power

Germany is the worldwide leader in the use of wind power. At the end of 2005, 17,574 wind turbines with a total capacity of 18,428 MW were in operation in Germany. A total of 1,049 new wind turbines with a total capacity of 1,808 MW (2004: 2,037 MW) were installed in 2005 (Figure 7). In terms of total installed capacity, the state of Lower Saxony leads the field, followed by Brandenburg, Schleswig-Holstein, North Rhine-Westphalia and Saxony-Anhalt (Table 2) [4]. In 2005 a total of 26.5 TWh of electricity were generated from wind power, representing 4.3 % of the electricity supply.

Although the total number of new wind turbines installed in 2005 did not match that of the previous year, the result was nevertheless better than expected. For the next few years the industry is expecting a further drop in the installation of new land-based wind turbines because the number of available sites is dwindling and the replacement of older plant by more modern plant (re-powering) is still slow to pick up.

The figures prove that the German market for land-based wind turbines is shrinking and that companies are stepping up their activities abroad. According to the industry, the export of wind power technology in 2005 more than compensated manufacturers and suppliers for the decline on the domestic market. On the exploding US market alone an estimated 2,500 MW were installed in 2005; the European markets, in France (approx. 250 MW) and Great Britain (approx. 600 MW) for example, and the Indian market (approx. 900 MW) are gradually gearing up. Similarly high growth rates are expected for 2006 [5].

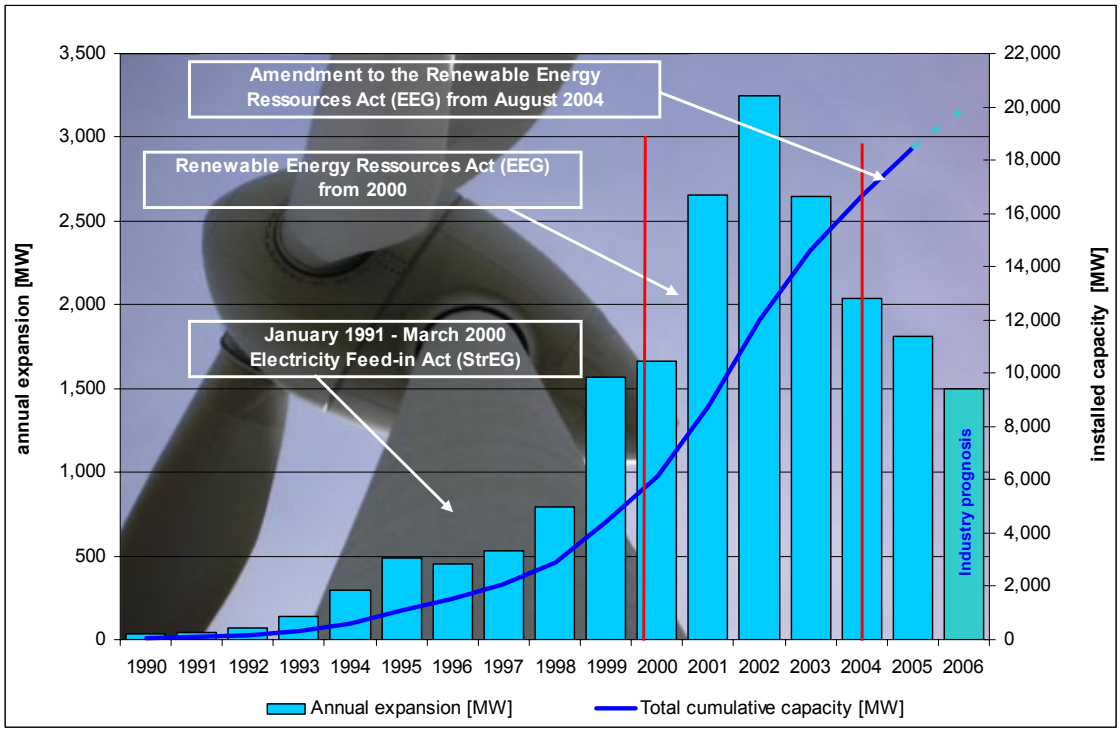

Figure 7: Trends in use of wind power 1990-2005

Offshore wind power has particularly great potential for expansion. In January 2002 the Federal Government presented a strategy for the use of offshore wind power in which areas that might be suitable and areas that have been earmarked for offshore wind farms in the German Exclusive Economic Zone (AWZ) in the North Sea and Baltic were identified. At the same time, protected areas, which will be kept free of wind power installations, are also being defined.

Table 2: Installation of wind turbines by German state

State	Installed capacity 01.01. - 31. 12. 05	Installed capacity Total on 31.12.05	Wind turbines 01.01. - 31.12.05	Wind turbines Total
	[MW]		[Anzahl]	
Lower Saxony	443	4,905	241	4,508
Brandenburg	440	2,620	257	2,033
Saxony-Anhalt	347	2,201	194	1,652
North Rhine-Westphalia	174	2,226	120	2,395
Rhineland-Palatinate	107	810	67	761
Schleswig-Holstein	101	2,275	52	2,740
Mecklenburg-Western Pomerania	77	1,095	42	1,135
Saxony	37	703	21	695
Bavaria	34	258	20	271
Hesse	25	426	18	522
Baden-Württemberg	14	263	9	261
Bremen	5	52	3	46
Thüringia	4	502	4	444
Saarland	1	57	1	54
Berlin	0	0	0	0
Hamburg	0	34	0	57
Total	**1,808**	**18,428**	**1,049**	**17,574**

Future prospects: under current conditions, up to 2,000 to 3,000 megawatts of capacity could be installed at sea by 2010. By 2030, a total of 20,000 to 25,000 megawatts could be installed at sea. Overall – onshore and offshore – wind power would then provide a quarter of Germany's total electricity supply.

Currently, the Federal Maritime and Hydrographic Agency (BSH) has licensed 12 wind farms, 10 in the North Sea and 2 in the Baltic. Thus, around 850 wind turbines with a total capacity of approximately 3,500 – 4,000 MW can be built out at sea. However, in some cases consent by the individual states for the necessary cable connections is still pending.

3.2 Biomass

As a result of the Renewable Energy Sources Act, the Biomass Regulation, the market incentive programme for renewable energies, tax relief on all biofuels and a federal-level loan programme (KfW), the framework conditions for using biomass as a renewable source of energy have improved significantly and led to a noticeable expansion of bioenergies.

The current provisions of the new Renewable Energy Sources Act (in force since 1 August 2004) have ushered in numerous improvements that have led to a marked acceleration of growth in the area of electricity generation from biomass. They include, for example, the optimisation of payment rates according to size of installation as well as a number of special premiums awarded for the use of renewable energy crops or forest waste, for new technologies or for operating biomass facilities in combined heat and power plants (CHP). Table 3 shows trends in biomass plants, both in terms of numbers of installations and installed capacity, comparing 2005 to 2004.

Table 3: Trends in installations for generating electricity from biomass [6]

	Biomass CHP plants		**Biogas plants**		**District heating plants**	
	solid		gaseous		Plant oil/plant oil methyl ester (PME)	
	[Plants]	[MW]	[Plants]	[MW]	[Plants]	[MW]
End of 2004	120	884	2,010	247	160	12
End of 2005	140	1,008	2,700	665	700	60

At the end of 2005, around 140 biomass (heat and) power plants in the capacity range up to 20 MW were in operation in Germany for *converting solid biofuels into electricity*. The total installed electrical capacity of these biomass plants is about 1,000 MW_{el}. They are fired exclusively with solid biomass as defined in the Biomass Regulation. Electricity generated totalled around 4.7 TWh in 2005; the share for the biogenic fraction in refuse converted into electricity amounted to 2 TWh.
Currently some 60 - 80 biomass CHP plants are in the development, planning or construction stage. About 25 installations are currently under construction, the majority of which will go into service in 2006.

There has been a rapid growth in *biogas plants* in Germany; in the area of generation and use of biogas a very positive market trend can be observed. In 1999 around 850 plants were connected to the grid; by the end of 2005, that number had more than tripled, rising to approximately 2,700. More than 600 plants went into operation in 2005, mainly in the agricultural sector. This is a very obvious indication of the positive effect of the amendment of the Renewable Energy Sources Act in 2004. The total capacity of all biogas plants is approximately 665 MW_{el}, electricity generation in 2005 was around 3.2 TWh.

There has also been growth in the area of electricity generation from *liquid bioenergy sources*. For example, in 2005 approximately 700 district heating plants fuelled by plant oil were installed; their electrical capacity was 60 MW_{el}. It is not clear how plant-oil-fuelled district heating plants will develop. There are reports not only of problems with economic

availability of fuels of a specified quality but also of technical difficulties in converting them into electricity.

In the area of *small-scale heating systems* it is estimated there are currently some 2.6 million solid-fuel heating systems, 2.5 million open fires/multi-fuel stoves and 1.8 million tiled stoves, in other words around 7 million units that can use biomass. They are mainly in use in single- and two-family homes.

In recent years a dynamic development was observed in the field of *biofuels for transport* (Figure 8). Sales rose from 1.1 million tonnes in 2004 to over 2 million tonnes in 2005. Apart from sales of biodiesel, which are still dominant, (2005: 1.7 million t), appreciable quantities of bioethanol (0.21 million t) and plant oil (0.15 million t) were also noted in 2005. Decisive factors in this development were the commissioning of new capacities, further increases in price levels for fuel for both diesel and petrol vehicles and the effects of the Mineral Oil Tax Act, under which, since the beginning of 2004, pro rata tax exemption has also been granted in cases where biofuels are added to fuels for diesel and petrol vehicles [7].

Currently biofuels' share in final energy consumption – based on total road traffic – is 3.4 %. Many automobile manufacturers have now given official approval for biodiesel, which means that it is now safe to use in these vehicles. Over 1,900 filling stations in Germany sell biodiesel.

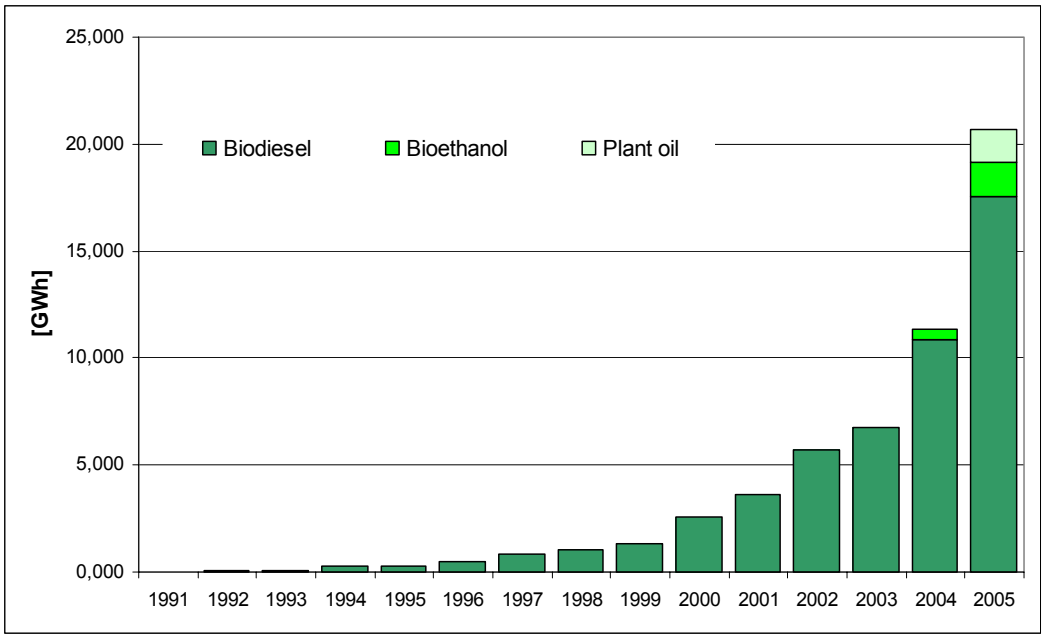

Figure 8: Trends in energy generated from biogenic vehicle fuels

3.3 Solar energy

The possibilities for using the sun's energy currently available in Germany are applications using solar thermal collectors, passive solar systems and generation of electricity using photovoltaics.

Solar heat – solar thermal energy

Low-temperature solar thermal technology converts the sun's energy into heat for heating water or buildings.

Solar thermal technology is enjoying high growth rates in Germany. According to the German Solar Industry Federation (Bundesverband Solarwirtschaft or BSW,) 950,000 square metres of solar collectors were installed in 2005 (2004: approx. 750,000 m^2). That meant that at the end of 2005 the total solar collector area installed in Germany was 7.2 million m^2 (Figure 9); that corresponds to 800,000 solar collector systems [1], [8]. The programme to promote renewable energies – the Federal Government's market incentive programme - remains the decisive factor behind this expansion. Between the time the programme started in 2000 and 2005 a total of 421,510 investment projects in solar thermal systems were given grants under this programme.

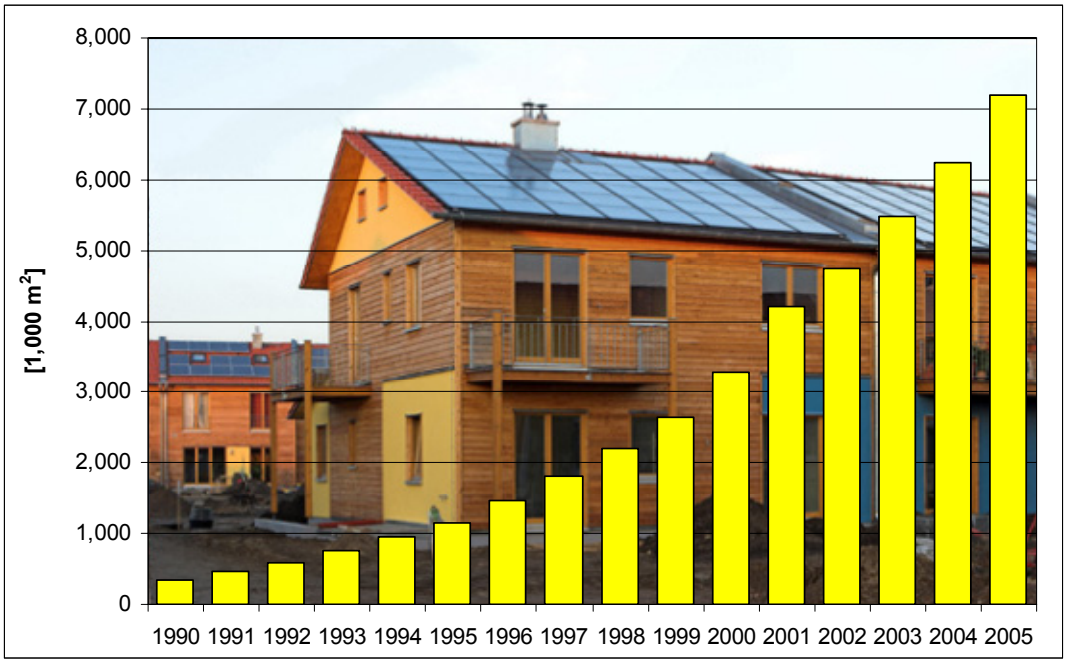

Figure 9: Trends in collector area for solar thermal systems 1990 – 2005

Solar electricity - photovoltaics

As a result of the significantly better payment rates for solar electricity provided for under the Renewable Energy Sources Act, which have been applicable since 1 January 2004, the number of photovoltaic systems being installed has risen sharply. For example, a marked growth could be observed in 2005 with an estimated 600 MW_p of new capacity going into service in 2005. That means that photovoltaic installations with over 1,400 MW_p are connected to the grid in Germany and generated around 1,000 million kWh of electricity in 2005 (Figure 10). This represents three times as much as 2003 (333 MW_p). Nevertheless, its overall contribution to electricity generation was still only around 0.16 % in 2005 [1], [8].

In addition to R&D measures, the Renewable Energy Sources Act and other federal programmes (KfW's promotional bank) have also been instrumental in further developing photovoltaic technology and helping it to become established on the market. They have already ensured the rapid development of electricity generation from photovoltaic installations. The main aim is therefore to expand the use of solar electricity generation

and in the long term exploit the potential of photovoltaics, which is vast - not only in Germany and Europe, but worldwide. Important future markets for the German solar industry are thus to be found not only in our part of the world, but more particularly in the earth's "sun belt." Photovoltaics could thus become a real export hit.

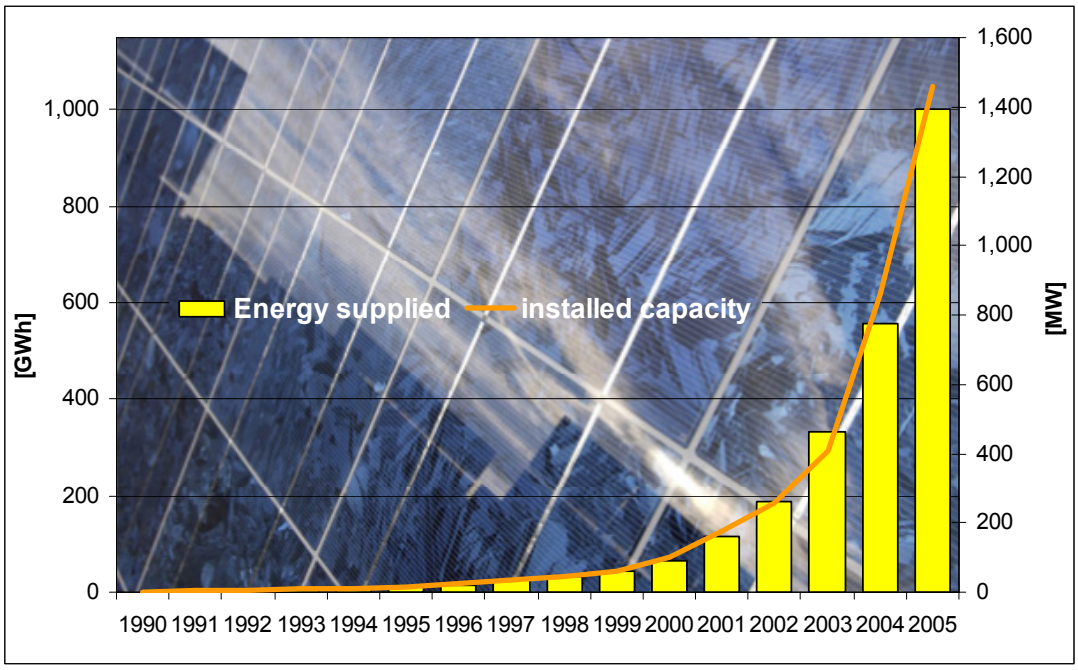

Figure 10: Capacity and electricity generation from photovoltaic installations 1990–2005

3.4 Hydropower

In 2005, 21.5 TWh of electricity were generated from renewable hydropower, which gives it a 3.5 % share in electricity supplied (Figure 11). This makes hydropower the second most important renewable source of energy for electricity generation after wind power [9]. The Electricity Feed Act (StrEG), which was introduced in 1990, and the Renewable Energy Sources Act in force since 2000 have led to a revival of small hydropower plants and stopped the threat of decline in this area.

The potential for further expansion of hydropower lies particularly in replacing or modernizing and extending existing plants. Apart from increasing the electricity yield, that would also improve the overall ecological situation of water bodies.

The amended Renewable Energy Sources Act has also created an incentive to modernise larger plants with a capacity of over 5 MW that were previously not covered by the Act.

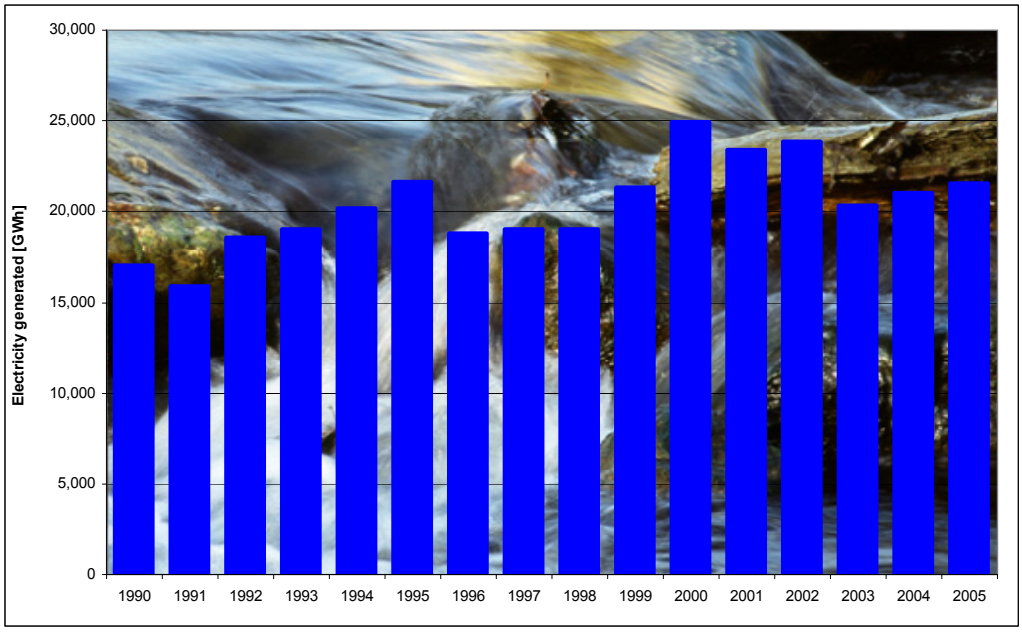

Figure 11: Electricity generation from hydroelectric power 1990 -2005

3.5 Geothermal energy

There are currently over 30 geothermal installations in Germany, as well as around 100,000 heat pump systems for heat production; they produced approximately 1.6 TWh of heat in 2005.

But geothermal energy also offers an interesting perspective for electricity generation, because it is available around the clock and can be controlled to meet needs at all times. This means that geothermal power stations supplying electricity and heat could make an important contribution to the base-load supply. In November 2003, the first installation converting heat from deep inside the earth into electricity went into service in Neustadt-Glewe in Mecklenburg-Western Pomerania. Other sites now need to be identified if geothermal electricity in Germany is to be established. The Federal Environment Ministry is funding a number of projects at selected locations.

4 Investment in the future – instruments and measures to promote renewable energies

4.1 The Renewable Energy Sources Act (EEG)

The most important instrument for promoting renewable energies is the “Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act - EEG)” of 29 March 2000 and its comprehensive amendment which entered into force on 1 August 2004.[6]

The Renewable Energy Sources Act regulates the connection of installations generating electricity from renewable energies and from mine gas in Germany including the German Exclusive Economic Zone (AWZ) to the grids responsible for the general supply of electricity. It also stipulates that grid operators give priority to this kind of electricity with regard to purchase, transmission and payment and provides for a nationwide equalisation scheme for the electricity purchased.

[6] Amendment to the Renewable Energy Sources Act (EEG) of 21 July 2004.

The new Renewable Energy Sources Act aims to increase the contribution renewable energies make to overall electricity supply to at least 12.5 % by 2010 and at least 20 % by 2020. To enable these targets to be achieved the amended Act has significantly improved the framework conditions for the feed-in, transmission and distribution of electricity from renewable energies. This has also provided the planning and investment security needed by manufacturers, installation operators, investors and credit institutes.

The Renewable Energy Sources Act is one of Germany's most effective and efficient instruments for climate protection[7]. For example, as a result of the Renewable Energy Sources Act alone, 38 million tonnes of CO_2 were saved in 2005; that figure is expected to reach 52 million tonnes in 2010 and 90 million tonnes in 2020 (Figure 12).

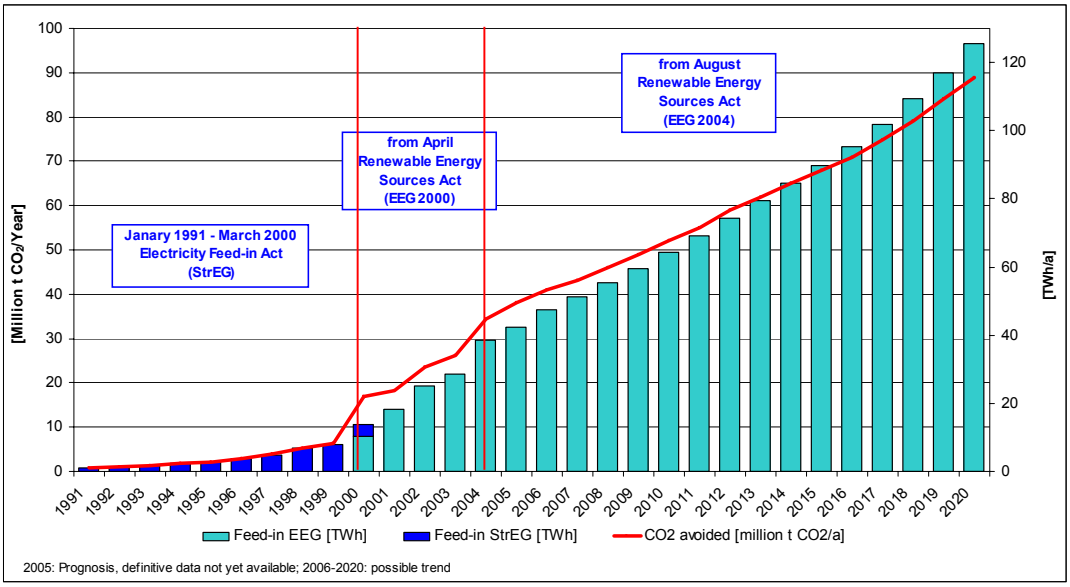

Figure 12: Electricity fed into the grid from renewable energies under the Electricity Feed-in Act (StrEG) and the Renewable Energy Sources Act (EEG), as well as CO_2 avoidance and possible trends

Figure 13 shows the estimate given by a current study [2] on trends in renewable energies on the German electricity market. According to this estimate, renewable energies' share in gross electricity consumption could rise from 10.2 % in 2005 to 14 % in 2010 (target for 2010: 12.5 %) and to 25 % in 2020 (target for 2020: 20 %). This trend would mean that the Federal Government's targets for 2010 and 2020 would be achieved and surpassed. This assumes that electricity consumption remains more or less constant.

The expected expansion will lead to a rise in electricity from renewables from the current (2005) level of 62 TWh/a to 86 TWh/a in 2010 and 151 TWh/a in 2020. However, only electricity that comes under the Renewable Energy Sources Act is remunerated within the framework of that Act. The curves in Figure 13 show that over the next decade an increasing proportion of electricity that is currently still paid for under the Renewable Energy Sources Act will probably no longer rely on this measure to promote it. The reason for this: due to degressive tariffs payment rates, combined with the increasing value of the electricity generated, growing proportions of electricity generated from renewable energies will reach the threshold at which they become economically viable.

7 *Cf. Chapter 5*

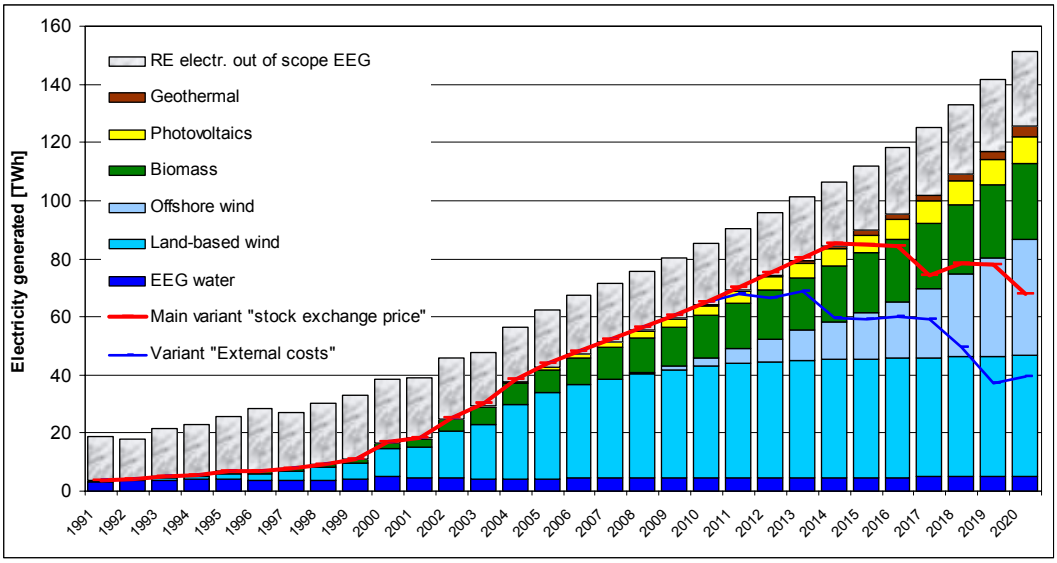

Figure 13: Trends in electricity generation from renewable energies 1991 – 2020

Figure 14 depicts the costs of the Renewable Energy Sources Act – the so-called EEG levy – to an average German household with an annual electricity consumption of 3,500 kWh/a. Based on these assumptions, it can be expected that in real terms the monthly EEG levy for an average household will rise from the current (2005) level of 1.60 euros to a maximum of 2.80 euros per month (corresponding to 0.97 cents/kWh) by 2017 and will then drop again (2020: 2.70 euros per month). The greater part of the levy will then be used for electricity generated from solar radiation energy and the innovative use of biomass.

According to a recent study carried out for the BMU, the external costs associated with generating electricity from fossil fuels that are avoided by use of renewables are higher than the costs incurred under the EEG. Greater internalisation of the “external costs” would thus mean that EEG electricity would lower costs even now – seen in terms of the economy as a whole [1], [2].

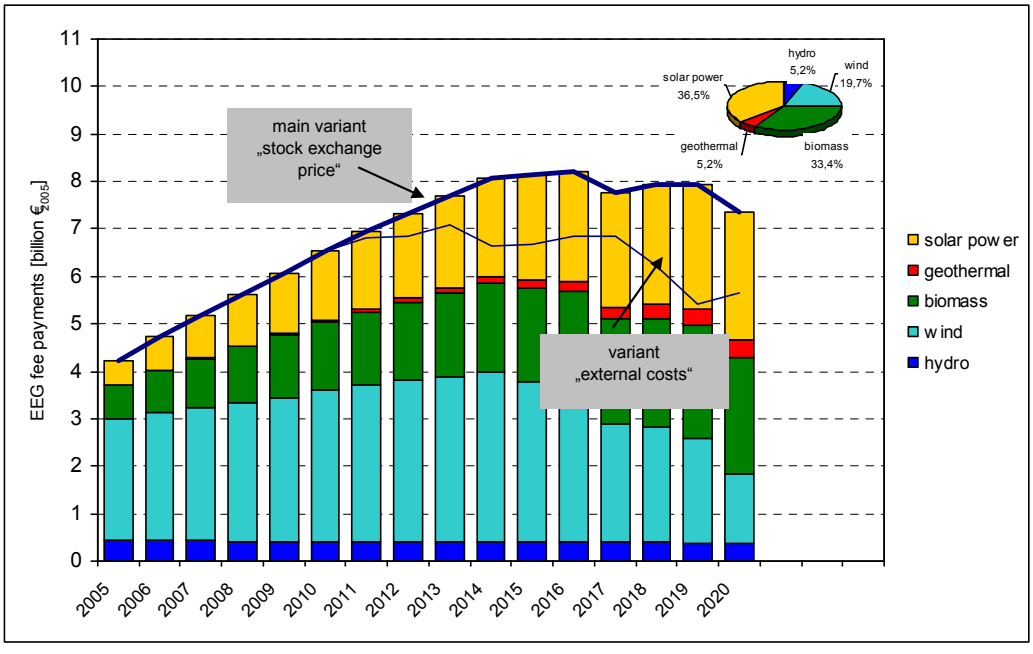

Figure 14: Possible trends in payments under the Renewable Energy Sources Act (EEG) up to 2020

4.2 Market incentive programme for promoting the use of renewable energies

The market incentive programme for renewable energies (MAP)[8] is financed from revenue from the ecological tax reform. In 2005 the federal budget allocated a total of 193 million euros for MAP. The draft budget for 2006 envisages making 180 million euros available for this programme.

Overall, between the start of the programme in September 1999 and the end of December 2005, over 483,330 projects (funding approvals) have received financial aid in the form of subsidies granted by the Federal Office of Economics and Export Control (BAFA). Funding totalled over 588 million euros (Table 4.) and triggered investments of over 4.2 thousand million euros which had correspondingly positive effects on industry, commerce and trades [10].
The main area funded by these subsidies was solar collectors used for heating water and assisting space heating systems and for installations firing solid biomass. Furthermore, additional measures to improve the demonstration effect have recently started to be funded as part of the "heating from renewables in schools" programme.

In terms of the individual technologies that have received financial aid in the form of an investment cost subsidy, funding has developed as follows since the programme began:

Table 4: Overview of applications that have received subsidies under the market incentive programme by funding segment in the period between 2000 and 2005

	Solar collector installations without energy saving	Solar collector installations with energy saving	Heat pump systems *	Photovoltaic systems "Sunshine in schools"	Biomass plants	Total
2000	14,556	11,494	111	28	3,228	29,417
2001	37,655	34,443	543	120	6,660	79,421
2002	60,727	21,423	181	267	9,903	92,501
2003	67,858	683	3	184	6,023	74,751
2004	90,444	52	1	212	12,049	102,758
2005	82,169	6		151	22,156	104,482
Total	353,409	68,101	839	962	60,019	483,330

* Heat pump systems and investments connected with energy-saving measures received funding for a limited period
For the "Heat from renewables in schools" part of the programme a count for 2005 has not yet been carried out

In the second part of the MAP, larger projects are given assistance low-interest loans from the KfW. The projects in question are biogas plants, biomass heating plants and installations to use geothermal energy. In the case of biomass heating plants and geothermal systems, the heating grids connected to them are also eligible for support.

Table 5: Use of the loans approved within the market incentive programme since the start of the programme in the part administered by the KfW

Use	Applications received	Number of loans approved	Value of loans euros
Biogas		1,218	509,623,205
Biomass		1,081	166,189,280
Hydropower		251	45,587,754
Geothermal		8	18,371,420
Solar thermal		3	225,656
not specified		5	1,029,488
Total	**3,172**	**2,566**	**741,026,802**

8 *Richtlinie zur Förderung von Maßnahmen zur Nutzung Erneuerbarer Energien (Directive on Promoting Measures to Encourage the Use of Renewable Energies)*

Looking at all the subsidies and loan options together, a total of 485,894 projects with an investment volume of over 4.9 thousand million euros received funding in the period from September 1999 to the end of 2005 under the market incentive programme for renewable energies [11].

4.3 Programmes funded by other bodies

Renewable energies are also subsidised by a number of other institutions at EU, central government, state government and local level (foundations, associations, business etc.). An up-to-date overview of promotional programmes offered by the EU, the Federal Government and the individual states is available in a database compiled by the Federal Ministry of Economics and Technology (BMWi). The data can be accessed on the Internet at http://www.bmwi.de/BMWi/Navigation/Mittelstand/foerderdatenbank.html.

5 The effects of the expansion of renewable energies

5.1 Emissions avoided by the use of renewable energies

The use of renewable energies avoids the release of air pollutants and climate gases. Their continued expansion is therefore an indispensable part of Germany's climate protection strategy. Backed by numerous Federal Government measures, such as the Renewable Energy Sources Act, the market incentive programme for renewable energies and tax relief for all biofuels, significant positive effects have already been achieved. For example, in 2005 the emission of some 83 million tonnes of CO_2 was avoided due to renewable sources of energy alone. Overall, approximately 57.5 million tonnes of CO_2 were avoided in the electricity sector, 18.5 million tonnes in the heating sector and 6.9 million tonnes in the vehicle fuel sector (Figure 15) [1], [12].

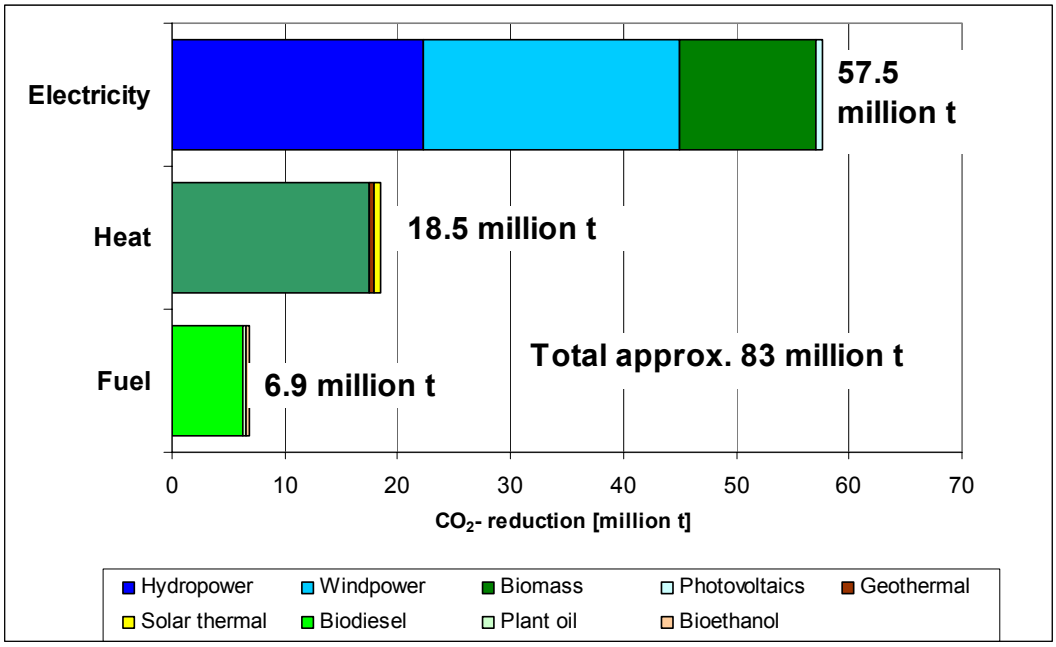

Figure 15: CO_2 emissions avoided by the use of renewable energies in 2005

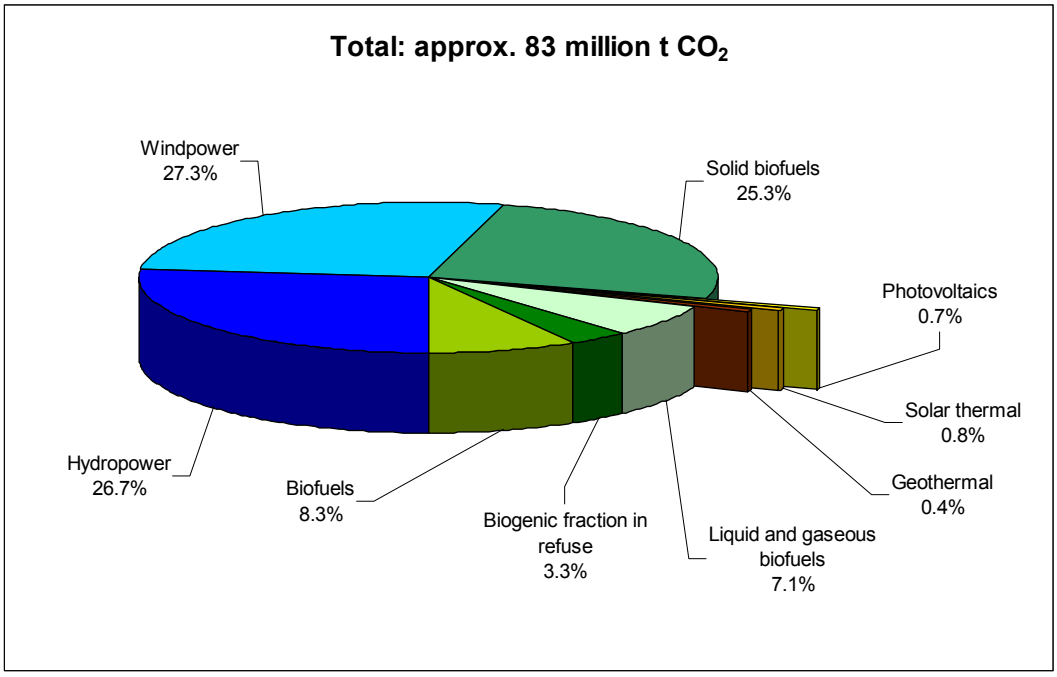

Figure 16: Breakdown of the CO_2 emissions avoided by the use of renewable energies in 2005

The following emissions factors were used to calculate the CO_2 emissions. These factors were ascertained as part of a report prepared for the Working Group on Renewable Energies – Statistics (AGEE-Stat) [12]:

Table 6: Emission factors for calculating the reduction in CO_2 brought about by using renewable energies

	Electricity	Heat	Biofuels
	[kg/kWh]		
Hydropower	1.030		
Windpower	0.856		
Solid and liquid biomass, biogenic fraction of refuse	0.929		
Sewage and landfill gas	1.030		
Biogas	0.790	0.2285	
Photovoltaics	0.584		
Geothermal	1.030		
Solar thermal			
Biodiesel			0.3521
Plant oil			0.2729
Bioethanol			0.1545

In ratifying the Kyoto Protocol and as part of the EU Burden Sharing Agreement, Germany has committed to achieving a 21 per cent reduction in greenhouse gas emissions in the period 2008-2012 compared with the baseline year of 1990. We are now only two percentage points away from reaching that target. The various measures taken to expand renewable energies, in particular the Renewable Energy Sources Act, have made an important contribution to this achievement.

5.2 Renewable energies – a positive effect on jobs and an important economic factor

In 2005, total sales of around 16,000 million euros were achieved with renewable energies. Of that about 8.7 thousand million euros came from investments in new installations and 7.3 thousand million euros came from sales connected with operating the installations (Figure 17). Compared with 2000, the industry as a whole generated a 43 % increase in sales. The pacesetter was biomass, recording sales of 5.8 thousand million euros, followed by the wind sector [13].

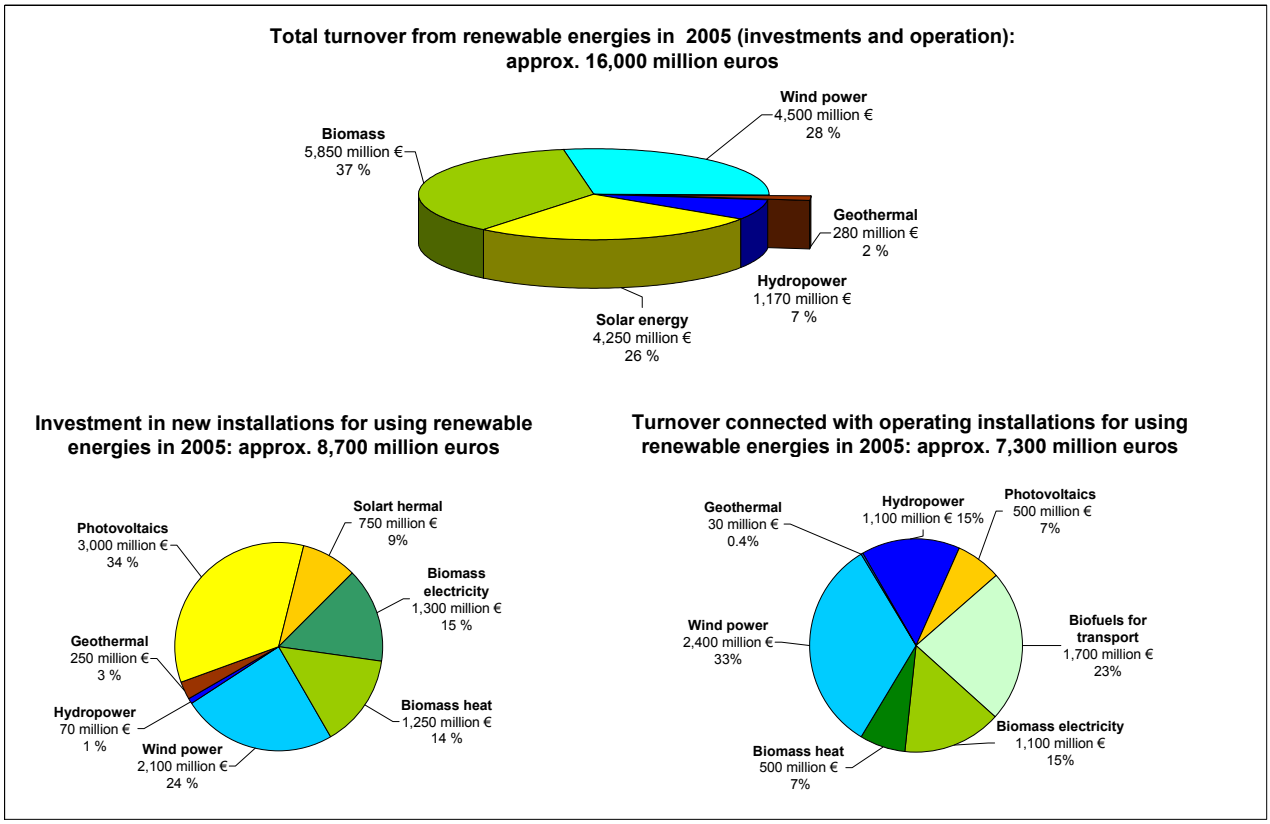

Figure 17: Sales figures for renewable energies in Germany 2005

Renewable energies thus not only benefit the climate but are increasingly creating jobs. A recent research project commissioned by the BMU identified 157,000 jobs in this industry of the future in 2004 [14]. According to estimations, the number of people employed in the renewable energies sector in 2005 was already as high as 170,000. The main employer in 2004 was the wind power sector with 64,000 jobs, followed by biomass with 57,000 jobs, the solar industry with 25,000 and the hydropower and geothermal sectors with 11,000 jobs (Figure 18). These figures will rise in parallel to the expansion of renewables, with many of the jobs being created in rural regions due to the increased use of biomass. Still more jobs will be created as a result of growing export markets. By 2020 we can therefore expect a further rise in numbers of jobs to approximately 300,000.

Thus, continuing the successful policy on renewable energies is not merely an ecological necessity but, seen in terms of industrial policy, it is also an investment, creating modern jobs with a future.

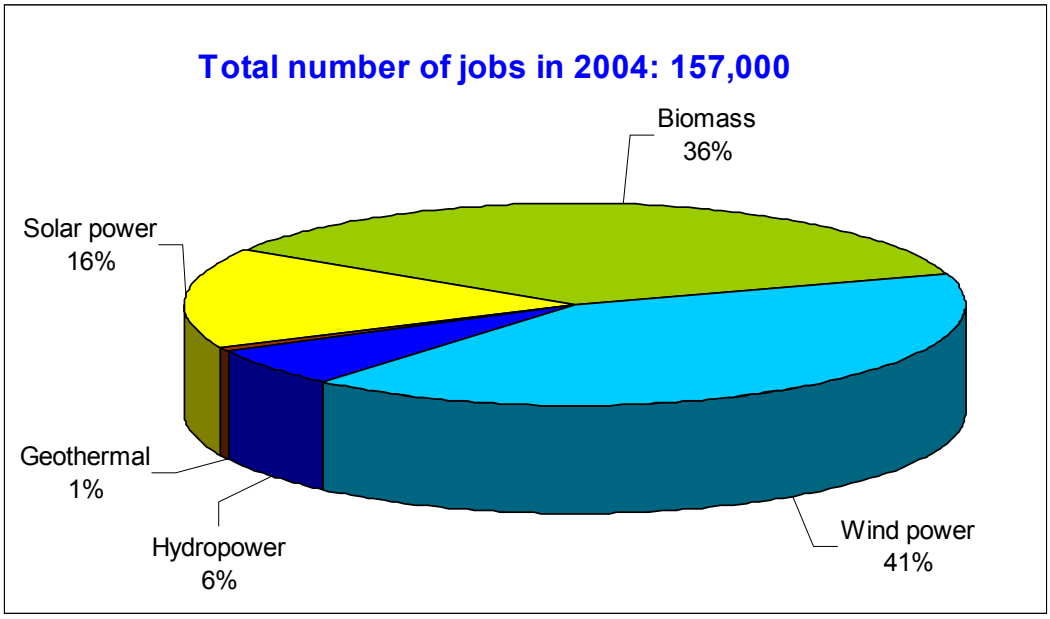

Figure 18: Overall effect on employment of renewable energies in 2004

6 Research and development in the field of renewable energies

The Federal Government is flanking the expansion of renewable energies with a high level of research funding. Germany leads the field here internationally and is characterised by a broad technological base and high scientific potential.

In 2005, the BMU approved new research and development projects on renewable energies worth 98 million euros. For 2006, 83 million euros of research funds are earmarked in the energy research programme alone for projects in the field of renewable energies. The basis for research funding in the field of energy is the Federal Government's 5th energy research programme, which came into force on 1 January 2006. Its key areas include renewable energies and improving efficiency in energy conversion and use.

The main areas of the BMU's research funding are technologies with high innovation and expansion potential: photovoltaics, hydropower and geothermal energy. The BMU also funds research and development projects on high-temperature solar thermal energy, low-temperature solar thermal energy, hydropower and crosscutting issues connected with the use of renewable energies. Bioenergy research falls under the remit of the Ministry of Food, Agriculture and Consumer Protection (BMELV).

The central aim of research funding in all areas of renewable energies is to achieve a further reduction in their costs and thus improve the starting conditions for their further expansion. If this is to be achieved, the efficiency of technologies will have to be increased and the production processes made more efficient and economical.

In **photovoltaics** it is possible to reduce costs by increasing the efficiency in the various kinds of technology (silicon wafer technology, thin-film technologies, other combinations of material), material savings and optimisation of manufacturing processes. The basis for the research is the "photovoltaics research 2004 – 2008" funding concept.

Research on **wind power** is also aiming to reduce costs, increase yield and integrate wind power output into the grid. The impact on nature and the environment of building and operating wind farms is also important. The research funding focuses on the use of offshore wind farms.

In the field of **geothermal energy** technologies for long-term, efficient and economical use of the earth's heat to produce electricity and heat are being developed. Processes to better identify deposits are being developed in order to increase the success rate of exploration drilling and reduce the exploration risk.

Research and development on **solar thermal power stations** includes parabolic trough power stations, solar tower power stations and dish/Stirling systems (see also 5.3). Storage systems are being studied for all technologies and potential and system studies on solar thermal electricity generation are being carried out.

The basis for the research funding in the field of **low-temperature solar thermal energy** is the "Solarthermie2000plus" funding concept. The aim is to extend the use of solar thermal energy beyond water heating to systems for assisting space heating, solar air conditioning and solar process heat for industrial applications.

Some of the areas of **crosscutting research** include social and economic issues.

The BMU is supported in its research funding by the project sponsors PtJ Jülich and VDI/VDE-IT Berlin. It holds regular strategy discussions and status seminars to ensure the research funding is well targeted and used efficiently, and to monitor success.

7 International conference on renewable energies - *renewables2004*

The Renewables Conference, held in Bonn from 1 to 4 June 2004 at the invitation of Federal Chancellor Schröder, was a resounding success. It sent out a signal to the world to step up efforts to expand renewable energies. A total of 3,600 participants, including 121 Ministers and representatives of international organisations, civil society and private industry demonstration their commitment to a "global turnaround on energy" and conveyed two central political messages:

- Renewable energies – as well as increasing energy efficiency – are crucial to climate protection and can create a secure energy supply that is less dependent on oil.
- Renewable energies can make a significant contribution to combating worldwide poverty.

The International Action Programme (IAP), one of the three official outcomes of the conference, was instrumental in the success of the conference. Almost 200 initiatives from all the regions of the world cover the entire spectrum of themes dealt with at the conference: expansion targets, how to design favourable political framework conditions, increasing private and public financing, developing capacities in training, research and development.

The effects of the IAP on climate protection, combating poverty, and investment in renewable energies are enormous. It is estimated that implementation of the International Action Programme will reduce the worldwide emission of CO_2 from 2015 by 1.2 thousand million tonnes per year. This represents around 5 % of global CO_2 emissions.

The Chinese contribution is extremely significant: for example, China plans to increase the share of renewable energies in the total installed electrical capacity to 10 % by 2010. This target has even been increased since then (see below). To reach this target, China has passed legislation similar to the German Renewable Energy Sources Act, which

comes into force in 2006 and stipulates specific feed-in payments. The Government in collaboration with other actors will raise over 50,000 million euros.

Germany has also made a special contribution to the IAP. Federal Chancellor Gerhard Schröder announced that for five years starting in 2005 the Federal Government will make an extra 500 million euros available for a new financing facility at the Reconstruction Loan Corporation (KfW). This means that Germany has increased the pledge it made back in 2002 in Johannesburg to make 1,000 million euros available for energy efficiency and the expansion of renewable energies. The official conference documentation that contains all the central conference documents and an analysis of the IAP is available at www.renewables2004.de.

Another outcome of the conference that has already been implemented is the establishment of a global policy network (Renewable Energy Network (REN 21). Governments, international organisations and representatives of civil society will work together in REN 21 and continue the high-level political dialogue. At the follow-up conference in November 2005 in Beijing, the REN21 network published its "Renewables 2005: Global Status Report." According to this report, 17% of global energy consumption already comes from renewable sources. The report provides a comprehensive overview of established promotional policies, markets and investments and the jobs they provide (report available at http://www.ren21.net).

The report on progress of implementation of the follow-up process and the German contributions to the IAP was published to coincide with the first anniversary of the renewables2004 conference. It can be downloaded at http://www.renewable-energien.de/inhalt/20073.

From 7 to 8 November 2005, the Chinese Government held the first follow-up conference - Beijing International Renewable Energy Conference (BIREC 2005) – with the support of the German Government. The conference was attended by 1,300 participants from 100 countries, including 30 government representatives at ministerial level. It was extremely successful, making clear that renewable energies are not exclusive to industrialised countries. The Chinese Government stepped up its country's commitment to renewable energies by comparison with its contribution to the Bonn conference, announcing its goal of increasing the proportion of electricity from renewable energies to 30% by 2020. BIREC 2005 also sent a clear signal to the 2006/07 session of the Commission for Sustainable Development: renewable energies and the question of how their expansion can be reviewed on a regular basis are on the agenda of that meeting. The results of the conference can be downloaded at www.birec2005.cn.

8 European expansion of renewable energies

In the field of renewable energies, Germany – along with Spain, Finland and Denmark – is making good progress towards fulfilling its contribution to achieving the EU target for electricity from renewables. Investment security for industry can only be achieved if the expansion targets are continued beyond 2010 and compliance is more strictly monitored. The integration of renewable energies into the electricity sector also requires EU-wide optimisation of integration into the grids and the expansion of offshore-wind power. The EU also needs a regulation that gives greater consideration to the use of heat from renewable energies. As announced in the biomass action plan, further measures are also needed in promoting the use of biomass and, to an even greater extent, biofuels. The Federal Government will work towards ensuring that the 7th Framework Plan for

Research gives clearer priority to energy efficiency and renewable energies and that a separate portion is set aside for renewable energies.

In its recently released Green Paper “A European Strategy for Sustainable, Competitive and Secure Energy,” the EU Commission recognises the contribution that wind and solar energy, biomass and hydropower as domestic sources of energy make to a secure electricity supply – particularly in view of the ever growing dependency on imports throughout the EU. Referring to the 300,000 jobs they have created in the EU, the Green Paper emphasises the significance of renewable energies for industry and the leading role Europe plays in this sector in terms of technology. In order to achieve the targets set, the Commission is urged to put forward a corresponding timetable for the further expansion of renewable energies in the EU.

A. List of Tables

B. List of Figures

Notes on this document

The figures to some extent reflect preliminary findings, estimates or our own calculations. Updates and more precise details can be found at www.renewable-energien.de.
Any differences between values in the tables and the column or row totals are a result of figures being rounded up or down.

Units of measurement and conversion factors

	Unit	***Equivalencies***
Work/energy(Joule)	J 1 kJ = 10^3 J	1kJ = 0.000278 kWh = 0.2388 kcal = 0.000034 kg CE = 0.000024 kg OE
Power (Watt)	W 1 kW = 10^3 W 1 MW = 10^6 W 1 GW = 10^9 W 1 TW = 10^{12} W	1 kWh = 860 kcal = 3.600 kJ = 3.6 MJ = 0.123 kg CE = 0.086 kg OE
Heat (calorie)	cal	1 kcal = 4.186 kJ = 0.001163 kWh
Coal equivalent	CE	1 kg CE = 7000 kcal = 8.14 kWh = 29.308 kJ = 0.7 kg OE
Oil equivalent	OE	1 kg OE = 41.868 kJ = 11.63 kWh = 1.428 kg CE

Prefixes and their abbreviations

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

References

[1] This status report and the graphs and tables in it are based on the findings of the Working Group on Renewable Energies - Statistics (AGEE-Stat), as of February 2006, incorporating data provided by the Bundesministerium für Wirtschaft und Arbeit, Bundesministerium der Finanzen, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Statistisches Bundesamt, Umweltbundesamt, Zentrum für Sonnenenergie- und Wasserstoff-Forschung, Fachagentur Nachwachsende Rohstoffe, Arbeitsgemeinschaft Energiebilanzen, Institut für Solare Energieversorgungstechnik Kassel, Institut für Energetik und Umwelt Leipzig, Institut für technische Thermodynamik Stuttgart, Wuppertal-Institut für Klima, Umwelt; Energie Wuppertal, Fraunhofer Institut Systemtechnik- und Innovationsforschung Karlsruhe, Institut für angewandte Ökologie Darmstadt, Deutsches Windenergie-Institut Wilhelmshaven, Institut für Solare Energieversorgungstechnik Kassel, Institut für Energetik und Umwelt Leipzig, Fraunhofer Institut Systemtechnik- und Innovationsforschung Karlsruhe, Institut für angewandte Ökologie Darmstadt, Verband der Elektrizitätswirtschaft, Verband der Netzbetreiber, Bundesverband Solarwirtschaft, Bundesverband Windenergie, Deutsches Windenergie-Institut Wilhelmshaven, Institut für Solare Energieversorgungstechnik Kassel, Institut für Energetik und Umwelt Leipzig, Fraunhofer Institut Systemtechnik- und Innovationsforschung Karlsruhe, Institut für angewandte Ökologie Darmstadt,

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