



Federal Ministry
of Economics
and Technology



Energy

Renewable Energy Made in Germany

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Renewable energies for climate protection



Climate protection is one of the greatest environmental challenges of our times. There is meanwhile ample scientific evidence to indicate that the climate is changing. There is growing evidence of the consequences of progressive climate change. In the Antarctic, huge chunks are breaking off age-old glaciers; storms, droughts and floods are becoming ever more frequent.

Carbon dioxide emissions resulting, inter alia, from the combustion of fossil energies such as coal, crude oil and natural gas are causing this climate change. Since the beginning of industrialisation in the second half of the 18th century, the concentration of carbon dioxide in the atmosphere has increased by more than 30 percent and is hence higher than ever before in the past 420,000 years.

In order to avoid a natural disaster, it is essential that global greenhouse gas emissions be reduced. This task can only be conquered if the international community takes concerted action. The industrialised countries as the main producers of man-made carbon dioxide emissions have a special responsibility for doing so.

They have accepted this responsibility at numerous international climate summits and have adopted action plans to reduce the greenhouse gas effect.

The Kyoto Protocol that was adopted in 1997 and entered into force in 2005 was one of the very first milestones for the adoption of a global climate protection policy. In the Kyoto Protocol, the vast majority of industrialised countries and threshold countries

pledged to reduce their carbon dioxide emissions by at least five percent compared to 1990 levels between 2008 and 2012. Germany made an above-average contribution towards accomplishing this climate policy goal with the National Climate Protection Programme it launched in 2005 by pledging to reduce its carbon dioxide emissions by 21 percent compared to 1990 levels and in doing so, assumed the role of an international pioneer early one.

The Fourth Report by the Intergovernmental Panel on Climate Change of the United Nations published in the spring of 2007 highlights more clearly than ever before the risks associated with man-made climate change. In order to avoid far-reaching consequences, global warming will need to be reduced from 1.5°C to 2.5°C. This finding has raised awareness among the international community of the need to sustainably reduce carbon dioxide emissions. Swift and decisive action also needs to be taken at political level, not least in view of the fear of the consequences this might have on global economic trends.

Under Germany's EU Council Presidency led by Federal Chancellor Angela Merkel in the first half of 2007, new goals were therefore defined and adopted to reduce carbon dioxide emissions in the countries of the European Union by 30 percent on average before 2020 compared to 1990 levels and to reduce them by between 60 and 80 percent before 2050 compared to 1990 levels.

Germany is actually striving to reduce its carbon dioxide emissions by 40 percent before 2020. The Integrated Energy and Climate Programme adopted

by the Federal Government in December 2007 envisages, inter alia, increasing the share of renewable energies in electricity generation from currently 13 percent to between 25 and 30 percent during the same period and is aiming to increase energy efficiency by three percent per annum.

When the eight leading industrialised countries came together at the G 8-summit that was held in Heiligendamm in June 2007 under the chairmanship of the Federal Chancellor, the countries participating agreed to set common climate protection goals and to implement them within the framework of the United Nations. The aim is to reduce global carbon dioxide emissions by at least 50 percent compared to 1990 by 2050. How this is to be accomplished will be specified in the follow-up agreement to the Kyoto Protocol which is due to enter into force by 2012 at the latest.

In principle, there are three ways in which carbon dioxide emissions can be reduced, namely by saving energy, by using energy efficient technologies and by increasing the use of renewable energies. By saving energy and using energy efficient technologies, it will be possible to reduce energy consumption and carbon dioxide emissions in the short term. Yet only renewable energies will enable global energy supply to be shaped sustainably and in an environmentally compatible way in the long term. Solar energy, wind power, biomass, hydropower and geothermal energy are the earth's natural energy resources; they do not release any polluting emissions. There is



practically an infinite number of ways in which these energy resources can be used. Wind parks and biomass, hydropower and geothermal plants can generate large volumes of electricity whereas photovoltaics, i. e. solar power plants are particularly suitable for small power generation systems. These power plants make it possible to provide a basic electricity supply to remote, non-electrified regions. Biomass, geothermal and solar thermal heating also supply hot water, central heating for residential dwellings and even whole apartment blocks. Biomass in the form of vegetable oils can be processed into fuels for transport.

The Kyoto Protocol currently envisages industrialised countries trading their agreed emission reductions in exchange with other countries. So-called flexible mechanisms offer three possibilities:

- ▶ A country acquires emission rights from another industrialised country or threshold country (“emissions trading”).
- ▶ A country implements a project in another industrialised country or threshold country that is aimed at reducing emissions and acquires emission rights in return (“joint implementation”).
- ▶ A country implements a project in a developing country aimed at sustainable, climate-compatible development and acquires emission reduction credits in return (“clean development mechanism”).

It is precisely the last two mechanisms which renewable energies play an important role for. Old coal-burning power plants that are harmful to the climate can be replaced by wind power plants or biomass power plants in threshold countries. In developing countries, small hydropower plants and photovoltaic plants make it possible to electrify rural regions for the very first time, without harming the climate.

Renewable energies in Germany

Because of the huge benefits of renewable energies, the European Union decided to increase its share of European primary energy consumption from currently 6.6 percent to 20 percent before 2020. The Federal Republic of Germany is aiming to increase the share of regenerative energies in primary energy consumption by at least 10 percent before 2020 and to use regenerative energies to cover 25 to 30 percent of energy supply. The expansion of renewable energies in Germany has been a real success story up to now. Their share in electricity generation has increased greatly in all areas since 2000. The share of regenerative energies in final energy consumption rose from 3.8 percent in 2000 to 7.8 percent in 2006, meaning it has actually doubled in this time.

With a total installed capacity of approximately 21,000 megawatts by mid-2007, no other country has more wind turbines than Germany. A powerful wind energy industry has developed, employing around 70,000 people. This industry is supplying a growing number of foreign markets with electricity in addition to the German market. The prerequisites for generating power from the wind energy boom in Germany were created by the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) which guarantees the payment for electricity from renewable energy fed into the grid.

Photovoltaics has also benefited from this Act and from low-interest rate funding. With photovoltaic installations having an installed capacity of around 2,830 megawatts – 750 megawatts were newly installed in 2006 alone – Germany takes second place only to Japan in the world in photovoltaic power generation. The market is catered for by large and above all highly-innovative small and medium-sized enterprises.

The use of solar thermal energy has also experienced a boom in recent years. Meanwhile, solar collectors covering an area of around 9 million square metres have been installed in Germany, meaning it has the biggest solar thermal industry in Europe.

This is not least the result of the market incentive programme launched by the Federal Ministry for the

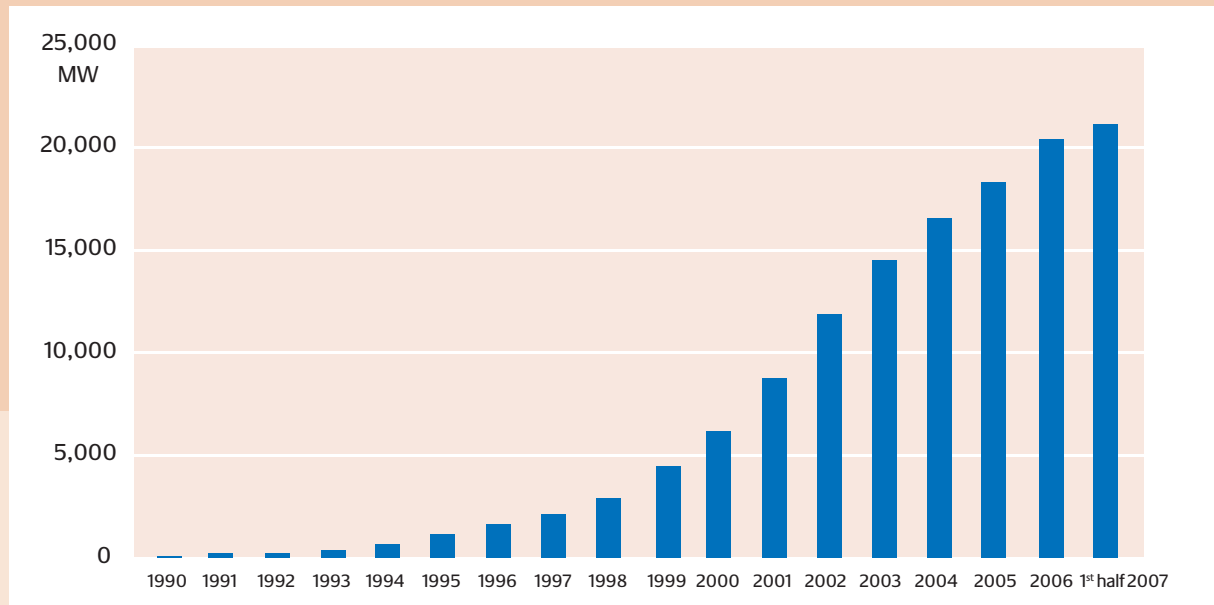
Environment to promote measures to use renewable energies. The programme supports the installation of heat generation plants from regenerative energies by granting low-interest loans and subsidies. Since the programme was launched and up to the end of 2006, over 523,600 solar collector plants covering an area of around 4.6 million square metres had been subsidized. From 2007 onwards, the programme was continued under new promotion guidelines. EUR 213 million were spent on this programme, with funding being topped up to EUR 350,000 in 2008. The sum of EUR 500 million has been earmarked for 2009. This will provide for a sustained installation boom, with market penetration of regenerative energies in the thermal industry gathering apace. Solar energy can also be used to generate electricity. However, solar thermal power plants require a lot more solar radiation than Germany is likely to provide. This perhaps explains why German companies are building solar thermal power plants in areas that have high levels of solar radiation such as Spain and Portugal.

A large number of technologies are being developed to promote the use of biomass as a source of energy that are being used successfully in Germany. The markets for pellet heating systems, biogas plants and biodiesel in particular, but also larger biomass power plants using old timber have recorded a growing demand in recent years, with the Renewable Energy Sources Act providing positive impetus.

Hydropower stations have a long-standing tradition and make an important contribution towards generating electricity. The large number of small hydropower plants is worth noting as they cause minimum pollution to rivers. Although the potential for expanding hydropower energy in Germany is limited, the fully developed technologies are also being used in a large number of other countries.

The use of geothermal energy, so-called geothermics, offers enormous global potential for power generation. There are just a few industrial geothermal power plants in Germany due to the comparatively unfavourable geographic conditions. Nonetheless, this technology is thought to have good growth prospects and other countries are certainly benefiting from the know-how of German companies.

Development of annually installed wind power capacity in Germany



Renewable energies are already making an important contribution towards climate protection in Germany. Their success is based on a favourable environment in terms of the energy industry and energy law on the one hand and on a supply of high quality and flexible technologies by German suppliers on the other. German products distinguish themselves by their high quality standards, efficiency and system flexibility. The newly emerging technology industries are not just promoting climate protection, they are actually boosting the economy. The planning, production and installation of power plants using renewable energies has created more than 200,000 jobs in Germany and this is having a ripple effect on partner countries in which German energy plants are being built and subsidiaries are being established.

The use of renewable energies is not very prevalent in many countries throughout the world even though the geographical and climate conditions offer enormous untapped potential. This applies in particular to Southern countries that have a high level of solar radiation, for instance, in the Mediterranean, Africa and South-East Asia, but also to countries that have a large coastline and good wind conditions such as Brazil or Oceania. The use of biomass is particularly interesting for countries with large forest stands or agricultural land. Although a large number of countries are already making great use of hydropower,

there is still room for expansion particularly for small, environmentally-compatible hydropower plants. Geothermics also offers huge untapped potential in some regions, although geothermal energy is being used extensively in some parts of the world.

If we manage to tap just a fraction of this huge energy potential, the greenhouse gas effect could be stopped and future energy supplies could be safeguarded. More and more countries are becoming aware of the opportunities presented by renewable energies in terms of energy policy and climate policy and are actively pressing ahead with the expansion of technologies. The technical and economic know-how developed in Germany provides valuable assistance for this process. Unnecessary teething problems with the technologies can be avoided with the help of Germany's experience. At the same time, Germany is also benefiting as a business location, with the export of climate-friendly technologies having a sustainable effect.

The Renewable Energy Export Initiative

Even now, German technology providers are helping to generate acceptance of renewable energies in other countries with the efficient, reliable systems and flexible system solutions they provide. The main aim of the Renewable Energy Export Initiative launched by the Federal Ministry of Economics and

Technology is to boost this positive trend and to promote exports in the field of renewable energies. Since 2003, it has been helping above all small and medium-sized enterprises in the industry to tap international markets. The comprehensive package of measures encompasses the following services for German companies:

► **Business trip programme launched by the Chambers of Industry and Commerce Abroad:** the Chambers of Industry and Commerce Abroad assist with networking between German SMEs and foreign SMEs and provide companies with advice.

► **Information and contact events organised by the German Office for Foreign Trade:** the German Office for Foreign Trade organises information events on target markets and target countries for German companies operating in the renewable energies industry in Germany.

► **Buying trips organised by the German Office for Foreign Trade:** the German Office for Foreign Trade organises trips to Germany for prospective customers from other countries who are seeking information about German technologies, giving them the opportunity to do business with manufacturers.

► **Solar Roofs Programme launched by the German Energy Agency (Deutsche Energie-Agentur) (dena):** a combination of photovoltaics demonstration and reference systems and activities in the field of PR, marketing and training is promoting the export of solar technologies and is developing new markets for photovoltaic applications.

► **Federal Ministry of Economics and Technology Trade Fair Programme:** German companies can lease space at the Federal Ministry of Economics and Technology's booth at international trade fairs at affordable rates. The booth at trade fairs also promotes German renewable energy technologies as a whole.

► **GTZ project development programme (PEP):** GTZ (an international

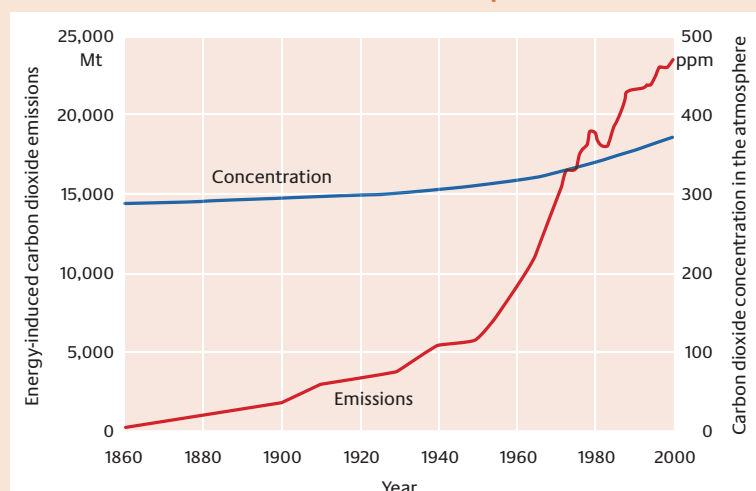
cooperation enterprise for sustainable development with worldwide operations) organises trips for delegations and business people to developing countries and threshold countries. Rural electrification using renewable energies is one of the focal points of its work.

► **Websites** of the Federal Ministry of Economics and Technology, dena and the German-Greek Chamber of Industry and Commerce provide information for companies interested in exporting (www.renewables-made-in-germany.com; www.exportinitiative.de; www.b2brenenergy.com).

The offers of the export initiative are being very well received by companies in the industry and are also being rated positively. The economic dynamics of the companies participating in the export initiative are developing extremely well, there has been a tangible increase in revenue and staff development. This is due not least to the fact that the measures of the export initiative enable German companies to save a lot of time and money.

Yet it is not just German companies, but also the partner countries that are benefiting from the export initiative under the auspices of the Federal Ministry of Economics and Technology. The intensified economic and political cooperation will give many countries all over the world the opportunity in future to implement a climate-friendly energy industry that is not dependent on energy imports.

Development of energy-induced carbon dioxide emissions and carbon dioxide concentration in the atmosphere



Hydropower: sources without emissions



Hydropower is an important source of regenerative energy for electricity generation in Germany. Although the untapped potential does not allow for major growth rates, hydropower does play a major role using a mix of energy sources since power from run-of-river power stations is the only form of renewable energy that can be used to cover the basic load.

Electricity generation from hydropower in 2006 broken down into output categories (not including pumped storage power plants)

	Power plants in %	Power generation in %
<1 MW	93.6	7.4
1 – 5 MW	4.1	13.7
5 – 10 MW	1.0	11.8
10 – 20 MW	0.9	19.5
20 – 50 MW	0.5	28.7
> 50 MW	0.1	19.0

Source: Renewable Energy Yearbook 2007

According to information supplied by the German Electricity Association (Verband der Elektrizitätswirtschaft) (VDEW), the net congestion capacity of hydropower stood at around 8,871 megawatts in 2002 and around 10,300 megawatts in 2006. Thanks to the political support received, the number of low-output hydropower plants operated in Germany rose from 3,700 in 1990 to around 5,000 in 2006. This can be attributed above all to previously disused plants being reactivated. In the long term, for instance, by the year 2050, experts forecast a dramatic rise in the amount of electricity produced by hydropower, with output expected to top 13,000 megawatts. In order to make full use of this potential, some of the already existing dams are to be used.

As the capacity is by and large constant, the electricity generated from hydropower fluctuated minimally in the past few years between 27 and 29 TWh. Only in the year 2003 was power generation lower than the average levels at 24.2 TWh.

For the year 2006, the German Electricity Association determined a net generation volume of 27.9 TWh. Hydropower thus meets 3.5 percent of gross electricity demand. Experts have predicted that production will remain constant in the years to come.

Hydropower plants can be divided into three different types:

► **Run-of-river power plants:** they use the natural run of rivers. Electricity is generated by turbines that are driven by a continuous flow of water. This is why run-of-river power stations are suitable for covering the basic load. This type of power plant accounts for around 72 percent of electricity generated by hydropower.



► **Impoundment hydropower plants:** water from a higher water reservoir (natural lake or dam) is fed into the lower-lying power station through a penstock. The water is forced by gravity through the penstock and drives the turbines where it is converted into electricity. These power plants are capable of going live on the grid very quickly and are hence suitable for covering peak loads. Around 12 percent of hydroelectricity is generated in impoundment hydropower plants.

► **Pumped storage power plants:** when the electricity supply exceeds the electricity demand and there is excess capacity available, the water is pumped from the lower to the upper reservoir and is stored there for generating electricity in the turbines during peak load periods. Pumped storage power plants account for around 16 percent of hydropower production in Germany.



Carbon dioxide emissions saved by the use of renewable energies in 2006

	Emissions saved (1,000t)	Share (%)
Hydropower	23,547	34.6
Wind power	26,289	38.6
Photovoltaics	1,367	2.0
Biogenous solid fuels	6,380	9.4
Biog. fl. fuels	1,197	1.8
Biogas	4,041	5.9
Sewage gas	966	1.4
Landfill gas	1,143	1.7
Biog. share of waste	3,190	4.7
Geothermics	0	0.0
Total	68,120	100.0

Source: Federal Ministry for the Environment

Even though they only account for 0.5 percent of power plants as a whole, power plants with an installed capacity of between 20 and 50 megawatts (around 27 percent of power generation) account for the largest proportion of electricity generation. In addition to around 400 power plants that have a capacity of more than 1 megawatt, there are around

Net generation by power plants owned by public utilities broken down into energy sources 1991 to 2006 in GWh

Year	Running water and stored water	Pumped storage without stream flow
1991	12,585	3,616
1992	14,980	3,605
1993	15,199	3,551
1994	16,133	3,684
1995	17,197	4,187
1996	14,981	4,103
1997	15,148	3,325
1998	15,024	3,792
1999	17,403	3,715
2000*	22,916	3,799
2001	20,200	3,900
2002	20,738	3,956
2003	15,857	5,116
2004	17,798	6,060
2005**	16,873	6,381
2006**	17,500	6,200

*from 2000 including Deutsche Bahn AG; **preliminary

Sources: Federal Statistical Office; Electricity Association (Verband der Elektrizitätswirtschaft) (VDEW)

Hydropower

Electricity generated from hydropower has a long-standing tradition in Germany – and a sound future:

- ▶ 3.5 percent of electricity was generated from hydropower in Germany in 2006; this share is to be increased by around 10 percent over the next ten years using untapped potential.
- ▶ In 2006, Germany had a hydropower plant capacity of just under 18,707 GW: 403 plants with an output of more than 1 megawatt and 5,500 plants with an output of less than 1 megawatt.
- ▶ Due to political support, the installed capacity of small hydropower plants rose from 4,400 megawatts in 1990 to 4,700 megawatts in 2006, which can be attributed above all to previously disused plants being reactivated
- ▶ Around a dozen companies in Germany that employ a total of 1,400 people are currently involved in the construction of hydropower plants
- ▶ The electricity generated with hydropower in Germany saves around 23.5 million tonnes of carbon dioxide emissions each year.

5,000 power plants in Germany with a capacity of up to 1 megawatt. However, not all of them can be fed into the public grid and most of them are operated by smaller and medium-sized enterprises.

There have been no major changes in the number of larger hydropower plants built in the last millennium since the 1990s. Nonetheless, the Electricity Grid Feed Act (Stromeinspeisungsgesetz) (StREG) (1991) and the Renewable Energy Sources Act have led to an increase in the installed capacities of small hydropower plants. In 2006, over 10,300 megawatts of electricity were generated in Germany using hydropower as an energy source. The capacity of pumped storage power plants is around 5,700 mega-

watts, run-of-river power stations and impoundment hydropower plants have a total capacity of around 4,600 megawatts. Hydropower is capable of making a considerable contribution to implementing the Kyoto Protocol. Operators stand to benefit considerably in future particularly from trading in carbon dioxide emission certificates. Individual pilot projects have already been documented in which the proceeds generated from the sale of emission rights have been used to finance hydropower plants.

The electricity generated with hydropower in Germany saves around 23.5 million tonnes of carbon dioxide emissions each year.

Geothermics: energy from underneath the earth's surface



Germany has more than 20 years experience in the use of geothermal energy stored in the form of heat underneath the solid surface of the earth. At the end of 2006, around 30 hydro-geothermal plants were in operation providing a total of around 105 megawatts/h of heating energy. Together with the heating pumps installed, they accounted for around 2.4 percent of the total heating energy generated with renewable energies sources in Germany in 2006.

However, this situation is not necessarily permanent. Experts point out that there is still huge untapped potential in Germany for the use of this regenerative energy source which is available at all times, irrespective of the season, weather or climatic conditions.

Shallow geothermal energy uses energy obtained from the uppermost layers of the earth at depths of up to 200 metres, from the ground or, where new buildings are involved, from the soil. A heat pump generates a temperature that is sufficient for heating purposes. Demand has been rising since 1999. This is particularly due to the fact that a sophisticated new technology in the form of a geothermal energy probe came onto the market in the early 1990s that is easy to install and convenient to use. The total number of systems installed is thought to be in the region of 120,000. By early 2007, a total of almost one GW of geothermal energy output had already been installed in Germany (both shallow and deep).

Generating electricity with the help of geothermal energy has only begun to play a role in Germany in very recent times. The reason for this is that the temperature of thermal water (which is mostly around 100 °C, but is never more than 190 °C) is too low to drive steam turbines. So-called low temperature turbines are used instead, for instance, the ORC system (Organic-Rankine-Cycle) or Kalina machines in which liquid is heated in a heat exchanger of thermal water simmering at a low temperature (with ORC, molecular mass organic fluid is used, with Kalina machines a mixture of ammoniac and water is used) which vaporises and drives a steam turbine.

The generation of electricity in Germany using geothermal energy as a source has to date been limited to a single power plant in Neustadt-Glewe in Mecklenburg-Western Pomerania which came into operation at the end of 2003. It is complementing an already existing geothermal energy plant. It brings hot water at a temperature of around 98 °C up from a depth of 2,200 meters for electricity and heat generation. An ORC turbine with an output of 250 kW generates around 1,400 kWh of electricity combining heat and power – enough to supply around 500 homes in Neustadt-Glewe with electricity.

In 2004, the Renewable Energy Sources Act brought considerable improvements for the use of geothermal power plants. Due to the three to five-year lead time for the planning, approval and implementation of drilling, some time elapsed before additional geothermal power plants were added. However, in 2007 geothermal power plants were put into operation in Landau, Bruchsal and in Unterhaching.

At present, 30 larger geothermal power plants with a total thermal output of around 104 megawatts/h are in operation (the output of the individual power plants varies between 100 kW and 20 megawatts), additional geothermal power plants are currently being built.

A geothermal heating plant was put into operation in Erding in the spring of 1998. It uses water at a temperature of around 65 °C obtained from a depth of 2,350 m both as a heat source and as material. At this plant, thermal water is used for a number of different purposes, to generate district heating (using a

heat exchanger and heat pump to increase the temperature) and as drinking water following refrigeration and filtering. Some of the hot water is also fed into a thermal bath. Work to build a second geothermal heating plant is due to begin in Erding in 2008.

With water that has a temperature of around 85 °C obtained from a depth of 1,850 m, a geothermal reservoir has been supplying the cities of Braunau and Simbach along the border between Austria and Germany with heat since 2002. Up to 40 percent of both communes' heat requirements has been covered from the geothermal reservoir. In Southern Bavaria, a number of additional power plants and district heating systems are currently being built.

The projects are using the geothermal energy of the South German molasse basin. Actual geothermics uses the temperatures generated by the radioactive disintegration of the rocks that emanate from the hot liquid centre of the earth. Drilling must be conducted at a depth of around three kilometres in order to reach temperatures of around 100 °C. Although this is sufficient for heating purposes, the drilling would need to be twice as deep to generate electricity. However, this type of deep drilling is very expensive. This is why drilling for geothermal energy only tends to take place where geological features indicate there are very high temperatures. The molasse basin in Southern Germany is precisely this type of area where high temperatures are found just a few kilometres below ground. The reason for this is the numerous so-called aquifers found in the rock which are a geological feature of Southern Germany. An aquifer is an underground layer of water-bearing permeable rock from which groundwater can be usefully extracted using a water well.

There are also useful thermal springs (some of which are being used) in the lowlands of Northern Germany, in Schwäbische Alb and in the Upper Rhine Rift. It is estimated that up to 29 percent of heating requirements could be covered if the untapped geothermal resources available in Germany were tapped.



A second possibility of using geothermal energy is currently being researched in several projects, namely the hot dry rock system (HDR). With this technology, geologists drill into the dry rock under the earth's surface, pump water down a borehole into the heat zone. The water travels through fractures in the rock, capturing the heat of the rock until it is forced out of a second borehole as steam. HDR technology is one of the so-called Enhanced Geothermal Systems (EGS), which have the potential to access the earth's vast resources of heat located at depth everywhere in order to help meet energy needs. The German Research Centre for Geosciences Potsdam (GeoForschungsZentrum Potsdam) is conducting research into the development of deep, hot sandstone to generate electricity in Schorfheide. A similar system was developed at the Geological Centre in Hanover that is based on just one borehole and is suitable for supplying heat to large building complexes. Ruhr-University Bochum (RUB) is carrying out a feasibility study in order to see whether the heat found at a depth of around four kilometres can be used to heat the University campus and surrounding residential buildings spanning an area of 4.5 square kilometres.

Geothermal experts estimate that by 2010, a market for geothermal heating plants could develop in Germany offering an installed capacity of 2,000 megawatts/h and a potential heating output of 4,380 GWh per year. This means around three percent of the technically feasible potential would be tapped.

Research institutes/higher education institutes operating in the field of geothermics in Germany

Geothermische Vereinigung – Bundesverband Geothermie e.V. (German Geothermal Association – geothermics e.V.)

www.geothermic.energy.de; Werner Bußmann, Tel.: +49 (0) 5907-545

Bundesanstalt für Geowissenschaften und Rohstoffe (The Federal Institute for Geosciences and Natural Resources)

www.bgr.de

GeoForschungsZentrum Potsdam (German Research Centre for Geosciences Potsdam)

www.gfz-potsdam.de

Institut für Energetik und Umwelt Gemeinnützige GmbH (Institute for Energy and Environment)

www.ie-leipzig.de, click on geothermics

Geothermics

Germany intends to make greater use of geothermal energy sources in future:

- ▶ Geothermal power plants currently cover 2.4 percent of Germany's heat requirements.
- ▶ At the end of 2006, there were 30 major geothermal power plants with outputs of between 100 kW and 20 megawatts in operation in Germany, the total thermal output was around 105 megawatts/h.
- ▶ Within the next ten years, a minimum additional geothermal output of 500 megawatts is to be installed, meaning that around one percent of the technically feasible potential would be tapped.
- ▶ With political support, geothermal energy from extreme depths is to be used above all to generate electricity in future; the first such geothermal power plant that has an output of 250 kW has been operating since 2003.
- ▶ In the field of geothermics, there are, inter alia, 50 heat pump suppliers, around 200 planning companies and around 500 well construction companies in Germany. As geothermal energy systems consist of many different components, it is hard to determine how many German manufacturers there are. Estimates suggest there are more than 10,000 people employed in the geothermal industry. Investments in geothermal systems that use heat from underneath the earth's surface are thought to have been in the region of EUR 100 million in 2006. There is a bigger market for small systems (heat pumps), it is thought to be worth EUR 500 million.
- ▶ The operation of geothermal plants in Germany avoids around 500,000 tonnes of carbon dioxide emissions in Germany each year.

Biomass: growing each day



Biomass is mankind's oldest source of energy since people began using fire. Germany currently covers 4.2 percent of its primary energy needs with timber, straw, biogas and vegetable oil – yet it could be covering up to ten percent. There is a lot of untapped energy in forests and fields.

Slightly more than three percent of the electricity consumed in Germany and around six percent of commercial heat were produced from solid biofuels (waste wood, wood chippings, timber pellets, straw and biowaste) and gaseous biomass (biogas, sewage gas and landfill gas). According to recent surveys conducted by the Federal Ministry for the Environment, around 83.9 billion kWh heat (corresponding to 90 percent of heat generated using regenerative energy sources) and 16.7 billion kWh electricity were generated using biomass as an energy source. It is not possible to provide an exact figure on the amount of electricity generated by biogas plants on farms, the majority of which are run by farmers.

One of the main benefits of using biomass as an energy source is that when combusted, it releases exactly the same amount of carbon dioxide it has previously absorbed during growth. According to the most recent calculations, each kilowatt of electricity generated from biomass produced 577 g less carbon dioxide than electricity generated by a power plant using fossil fuel mixed with nuclear energy and actually 922 g less carbon dioxide than electricity generated in power plants that use fossil fuels only. The 16.7 billion kWh of electricity generated from biomass in Germany in 2006 hence saved 45 tonnes of carbon

dioxide from being released into the atmosphere. It is thought that the carbon dioxide reduction potential would be 236 g/kWh if heat was generated using biomass as an energy source.

The potential of biomass for electricity generation is considered to be substantial. Optimistic estimates indicate that Germany could have around 9,400 megawatts of installed power-generating capacity by 2020.

Firewood is the oldest and most frequent use of biomass today. There has been a real boom in this sector in recent years. The biomass plants available on the market today are fully developed in technical terms – regardless of whether they are small combustion units or larger heating systems.

According to some estimates, there are just under nine million very small biomass combustion systems in the private sector (that have an average capacity of seven kW) in Germany. The number of wood-fired boilers is much lower by comparison. There are thought to be around 120,000 wood-fired boilers in Germany that have an output of between 15 and 50 kW, at least 10,000 wood-fired boilers that have an output of up to 150 kW and around 3,000 wood-fired boilers that have an output of up to 500 kW. The majority of these systems can be allocated to the commercial, trade and services sector, the larger systems can be allocated to industry.

So-called pellets are a special type of solid biomass. Waste wood and wood chippings are com-

pressed which means they can be sold in a form that is suitable for storage. One of the largest pellet heating plants in Germany was put into operation at the water park in Kempten in the summer of 2003. A one megawatt boiler that covers around 95 percent of the total annual heat load of the water park is the backbone of the system. The plant requires between 3 and 4.8 tonnes of pellets a day when it is running at peak capacity.

In 2005, the number of pellet heating systems in Germany rose from around 26,000 to around 44,000. According to the German Energy Pellet Association (Deutscher Energie-Pellet-Verband), around 70,000 pellet boilers and ovens had been installed in Germany by the end of 2006. The industry is responding to the growing demand by expanding capacities also in order to safeguard the availability of pellets.



The market for biogas plants in Germany also recorded its most successful year in 2006. According to the German Biogas Association (Fachverband Biogas) a total of 3,500 biogas plants had been installed by 2006. According to estimates, they generate a total of 1,100 megawatts of electricity. The huge leap in the installed capacity from 400 megawatts in 2005 to 550 megawatts in 2006 can be attributed to the improved payment terms for electricity and gas ensuing from the amendment to the Renewable Energy Sources Act.

As a rule, biogas is generated from fermented substrates of plant and animal origin such as slurry,

waste from food production and also biowaste from households. Since the so-called NawaRo-Bonus (a special bonus introduced by the EEG and paid to the operators of facilities that use only biomass, manure,



and/or residues from agricultural distilleries for heat and power production) was introduced, more and more biogas plants are being cultivated and grown. The total acreage for regenerative resources in Germany skyrocketed to 1.6 million hectares in 2006 accordingly. This is around 200,000 hectares more than the previous year and around 13 percent of all agricultural land.

Biogas is ultimately converted into electricity and heat at thermal power stations. At present, the majority of newly-built biogas plants in Germany have a capacity of between 150 kW and 500 kW. One cattle farmer in Rieth, Thuringia, for instance, handles just under 35 tonnes of slurry produced by 350 cattle and 900 pigs each day as well as two tonnes of corn silage, and uses it to generate on average around 1,000 cubic metres of biogas with an energy value of 6,600 kWh per day. A thermal power station using an Iveco gasoline engine that has 85 kW of electrical output and 176 kW of thermal output uses this to generate electricity which is fed into the local grid.

However, it is not just individual biogas plants – but entire biogas parks – that are being built nationwide. The sum of just under EUR 80 million was invested in the construction of 40 individual biogas plants in Penkun in Mecklenburg-Western Pomerania, for instance. Each biogas plant will have a capacity of 500 kW. There are plans to construct another bioenergy park with 20 megawatts of installed electrical capacity in Güstrow.

The amendment to the Renewable Energy Sources Act in 2004 also made provision for the promotion of new technologies. In addition to dry fermentation (which unlike liquid fermentation uses stackable substrate with a water content of less than 70 percent), the option was launched of processing biogas at natural gas quality levels, of feeding it into the gas grid and of distributing the same heat equivalent in a different place. This offers the benefit of efficient energy usage, because the gas volumes in the plants can be distributed offering a much higher level of electrical efficiency and above all because it can be distributed where it is possible to sell the heat generated.

Since late 2006, biogas has been fed into the high pressure grids of the public utility Stadtwerke Munich in Pliening, Upper Bavaria. The fermentation of around 35,000 tonnes of corn silage and rye silage per year supplied by local farmers is generating around 920 cubic metres of natural gas per hour at this plant.

Power generation capacity from solid biomass sources installed per year

Year	Capacity
1999	154 MW
2000	180 MW
2001	273 MW
2002	377 MW
2003	526 MW
2004	884 MW
2005	1,008 MW
2006	1,170 MW

Source: Federal Ministry of Economics and Technology

Before being fed into the natural gas grid, the biogas initially passes through a desulphurisation unit and is dehumidified before the carbon dioxide is extracted. The methane content in natural gas is enriched from around 53 percent to around 96 percent. This reduces the volume of gas – each hour around 485 cubic metres of biomethane meeting the quality of natural gas is to be fed into the gas grid – with the energy content increasing, by contrast. At present, there are several other biogas plants in the pipeline and under construction in Germany.

The trend of generating electricity from biomass in recent years in Germany shows what a boom this sector of regenerative energies has been experiencing. In 2006, 17.7 TWh of electricity was generated from biomass as an energy source. This means the average rate of increase per year between 2002 and 2006 was around 32 percent. The trend in the area of heat generation is equally positive. In 2006, 84 TWh of heat were generated from biomass. This represents an increase of around ten percent per year since 2002.

At present, there are around 20 companies in Germany that manufacture engines and boilers using biomass to generate electricity. The bioenergy industry generated a total turnover of EUR 8 billion in 2006 and provided employment for around 91,000 people. Although it is assumed that the market for very small biomass heating systems has become somewhat stagnant since then, larger biomass heating plants are generating more and more interest. The eagerness to invest in this industry is being affected by the high costs of district heating grids. Nonetheless, the Renewable Energy Sources Act and the Biomass Ordinance (Biomasseverordnung) have fuelled investment as any cost disadvantages resulting from the system are being offset by special funding.

The share of biofuels in total fuel consumption in Germany was around 5.2 percent in 2006. The annual capacity for the production of biodiesel is currently around 2.8 million tonnes, bioethanol refineries produce 500,000 tonnes a year. The capacities for the production of vegetable oils are around 300,000 tonnes a year.

Research institutes/higher education institutes involved in the field of biomass in Germany

Universität Stuttgart (University of Stuttgart), www.iier.uni-stuttgart.de, www.fnr.de

Universität Würzburg (University of Würzburg), ZAE Bayern Bayerisches Zentrum für Angewandte Energieforschung (Bavarian Centre of Applied Energy Research), www.zae-bayern.de

Institut für Energetik und Umwelt gGmbH (Institute for Energy and Environment), Leipzig, www.energetik-leipzig.de

IWR Internationales Wirtschaftsforum Erneuerbare Energien (International Economic Platform for Renewable Energies), Münster, www.iwr.de

Bundesverband Erneuerbare Energien (BEE) (German Renewable Energy Federation), Paderborn, www.bee-ev.de

Bundesverband BioEnergie (BBE) (German Federal Association for Bioenergy), Bonn, www.bioenergie.de

Fachverband Biogas (German Biogas Association), Freising, www.biogas.org

Biomass

The prospects for the use of biomass to generate electricity in Germany are good:

- ▶ Waste wood, regenerative resources, biowaste, biogas, sewage gas and landfill gas are currently contributing 5.8 percent to commercial heat generation and 2.9 percent to electricity generation in Germany; optimistic estimates suggest that by the year 2020 around 9,400 megawatts of electricity could be generated using biomass as an energy source.
- ▶ In 2006, the total output of heating plants using biomass as an energy source in Germany was 38,000 megawatts; plants used to generate electricity had an output of 2,740 megawatts.
- ▶ Owing to state support, there has been a sharp rise in the number of power generation plants based on landfill gas, sewage gas and biogas as well as wood chippings.
- ▶ In Germany, there are around 20 companies that manufacture engines and boilers to generate electricity using biomass as an energy source. The bioenergy industry generated a total turnover of around EUR 8 billion in 2006 and employed around 91,000 people.
- ▶ By generating electricity and heat from biomass, around 45 tonnes of carbon dioxide were saved from being released into the atmosphere in Germany in 2006.

Wind power: turbines for clean electricity



Since the first wind turbines were built at the beginning of the 1990s, power generation from wind energy has seen unprecedented growth. Since the Electricity Grid Feed Act entered into force at the beginning of 1991, specifying fixed feed-in tariffs for electricity generated from regenerative energy sources for the first time, the overall capacity of wind turbines built throughout Germany had risen from around 110 to 21,300 megawatts by mid-2007. By the end of 2006, wind turbines accounted for around 5.7 percent of Germany's electricity consumption.

The starting point for the launch of wind turbines onto the German market was the "100 MW of Wind" support programme initiated by the Federal Government in 1989. This was later raised to 250 MW due to the surge in demand. The wind market received a major boost in 1991 with the introduction of the Electricity Grid Feed Act. In addition to the legally fixed payment for electricity fed into the public grid and the purchase guarantee for wind power issued by network operators, the two core elements of the Electricity Grid Feed Act, funding was also supplied by the Federal Government and the governments of the Federal Länder to subsidise operating costs until the late 1990s.

In early April 2001, the Electricity Grid Feed Act was replaced by the Renewable Energy Sources Act. In addition to the 20-year payment duration, the Renewable Energy Sources Act introduced a digressive and location-independent feed-in payment for electricity generated by wind power. An initial payment of 8.19 cents/kilowatt was laid down for electricity generated from wind power plants in locations

with medium winds which has been paid since the beginning of 2007.

By the end of 2006, according to information supplied by the German Wind Energy Association (Bundesverband WindEnergie) (BWE), 18,685 wind power plants with an installed capacity of 20,622 megawatts were in operation throughout Germany. In the first six months of 2007, another 347 wind power plants with a capacity of 665 megawatts were built.

The newly installed wind power capacity in Germany rose steadily year-on-year up to the year 2002, with just one exception. By 2002, the wind power capacity that was new to the grid was 3,247 megawatts – a level that has not been reached anywhere else in the world since. In the years 2003 to 2005, the wind power industry in Germany faced a decline for the first time. In 2005, the newly installed capacity was 1,808 megawatts. In 2006, it picked up again so that 2,233 megawatts of wind power output was generated nationwide for the first time – by far the highest level in Europe and the second largest increase in the world after the USA.

Germany has the largest wind park in Europe, generating around 100 megawatts of electricity. It is located in "Wybelsumer Polder" near Emden. It was put into operation in October 2002 over an area spanning 380,000 square metres and at that time had a total output of 70 megawatts. Since then, some more wind turbines have been modernized and some new ones have been built. Today the wind park has 55 wind turbines with an output range of 500 kW and six mega-

watts. It generates around 200 million kWh of electricity each year.

In the summer of 2001, Germany's largest offshore wind park was opened near Paderborn. 65 wind turbines with a nominal power of 105 megawatts were put into operation on the "Sintfeld". The project combined 14 different operating companies or limited partnerships into four wind plants. Total investment in the wind park was over EUR 112 million, including EUR 2.5 million for the transformer station that was financed from private funds.



The number of offshore wind locations in Germany is limited. This explains why additional wind power potential is to be tapped by replacing obsolete, smaller plants with new more powerful wind turbines – a process which experts refer to as repowering. Repowering has gained momentum over the years. According to the German Wind Energy Institute (Deutsches Windenergie-Institut), in 2006, 79 turbines with a total capacity of around 26 megawatts were replaced by 55 new turbines with an output of around 136 megawatts. This means repowering led to a 110 megawatts increase in output in 2006, almost as much as in 2004 and 2005 combined.

The technology, the size and output of wind turbines have evolved enormously in the past decade. According to the German Wind Energy Association, the costs of generating electricity from wind power plants have dropped by 60 percent since 1991. Under pressure to reduce power generation costs, the technical trend has been marked by a tendency towards ever-larger wind power plants. The wind parks on the market today have a standard nominal output of two megawatts, although more powerful turbines are also already being used.

The most powerful wind turbines in the world offering a capacity of six megawatts and a rotor blade diameter of 114 metres were built in 2005 in the offshore test field "Cuxhafen Dam" and in Larrelter Polder in Emden. By the end of 2007, three wind turbines of the more sophisticated version of the E-112 went live on the grid. They now have a turbine diameter of 126 m and an output of between seven and eight megawatts. Two of these wind turbines are located in Emden, one is in Cuxhaven.

In addition to repowering, offshore wind parks play a key role in plans to make further use of wind power in Germany. Initial plans were launched in the late 1990s. By the summer of 2007, the Federal Maritime and Hydro-graphic Agency (Bundesamt für Seeschifffahrt und Hydrographie) (BSH) had approved a total of 18 projects, 15 in the North Sea and three in the Baltic Sea. Together they have a capacity of 6,200 megawatts. According to the original plans of the Federal Government, offshore wind parks were to have an installed capacity of between 2,000 and 3,000 megawatts by the year 2010. Because of their far offshore location and the huge water depth required, the construction of offshore wind turbines involves huge logistics planning and licensing and imposes high technical demands. At the same time, the risks associated with the operation of wind parks are difficult to gauge. However, the Infrastructure Planning Act (Infrastrukturplanungsgesetz) adopted by the Federal Government will shorten planning procedures considerably in future.

Germany's first offshore wind park is due to be put into operation in October 2008. The project entitled "alpha ventus" is the so-called offshore test field which is being built around 40 kilometres from the

North Sea island of Borkum. The test field is to comprise twelve wind turbines that have a capacity of five megawatts. The wind energy industry, banks and insurance companies hope that the project will shed more light on the operation of wind turbines at huge water depths a significant distance away from the coast. The first commercial offshore wind park Baltic I off the peninsula of Darß in the Baltic Sea is slated for commissioning in summer 2009.

All in all, the wind energy industry in Germany generated a turnover of around EUR 7.2 billion in 2006, with exports accounting for around EUR 4.1 billion. Electricity generated by wind power saved around 26 million tonnes of carbon dioxide emissions in 2006.

Wind power

No other country has more wind turbine capacity than Germany:

- ▶ In 2006, wind power covered around 5.7 percent of Germany's total electricity consumption.
- ▶ By the end of 2006, a capacity of 20,600 megawatts was in operation on German soil; in addition to further expanding offshore wind turbines, there are plans to build several large wind parks at sea offering a total capacity of between 20,000 and 25,000 megawatts by 2030.
- ▶ The fact that the wind energy industry has seen such an unprecedented boom in recent years can be attributed to the support programmes launched by the Federal Government and the Governments of the Federal Länder.

- ▶ Annual addition of wind turbines (installed capacity):

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006
MW	793	1,568	1,665	2,659	3,247	2,645	2,037	1,808	2,233

- ▶ In Germany, around a dozen companies are selling complete, large wind power plants; according to a survey conducted by the German Wind Energy Association in 2005, there are at least 750 companies working in the wind energy industry in Germany.
- ▶ In 2006, the German wind energy industry generated revenue of around EUR 7.2 billion, with around EUR 4.1 billion accounting for the export of wind turbines.
- ▶ The generation of electricity using wind power saved around 26 million tonnes of carbon dioxide emissions in 2006.



Contacts in Germany (associations, websites, telephone number, contacts, e-mail-addresses)

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Research institutes/higher education institutes in the field of wind power in Germany

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Institut für Solare Energieversorgungstechnik (Institute of Solar Energy Technology)

www.iset.uni-kassel.de
Windtest, www.windtest.de

TU Stuttgart (Technical University Stuttgart), Institut für Flugzeugbau (Institute of Aircraft Design)

www.ifb.uni-stuttgart.de

Universität Oldenburg (University of Oldenburg), Fachbereich Physik (Department of Physics)

www.physik.uni-oldenburg.de

TU Berlin (Technical University Berlin), Institut für Luft- und Raumfahrt (Institute for Aviation and Space Travel)

www.ilr.tu-berlin.de/WKA/windkraft

Germanischer Lloyd, www.germanlloyd.de

Internationales Wirtschaftsforum Regenerative Energien (Institution of the Renewable Energy Industry)

www.iwr.de

Photovoltaics: the infinite power



It is possible to generate electricity with the help of solar cells (photovoltaics) wherever the sun shines. It already makes economic sense today for areas that are far removed from the electricity supply grid to generate electricity from solar energy, but it still requires financial support in areas supplied by the grid.

Research and development work in the field of photovoltaics (PV) in Germany began in the mid-1960s. The first photovoltaic plants that had a capacity of just a few kilowatts were put into operation in the 1980s. The intensity of further developments is also highlighted by the fact that a number of global records have since been broken in Germany in terms of the electrical plant capacity of these power plants, for instance, with the largest solar roofs having a capacity of 1,000 kilowatts and subsequently 2,000 kilowatts.

Solar cells supply electricity just like a battery which is converted via an inverter to operate electrical aggregates.

In the past, the majority of systems used monocrystalline and polycrystalline solar cells. There has been a growing trend to use the more transparent thin film amorphous solar cells – both due to the shortage and resultant increase in the price of silicon and for architectural reasons.

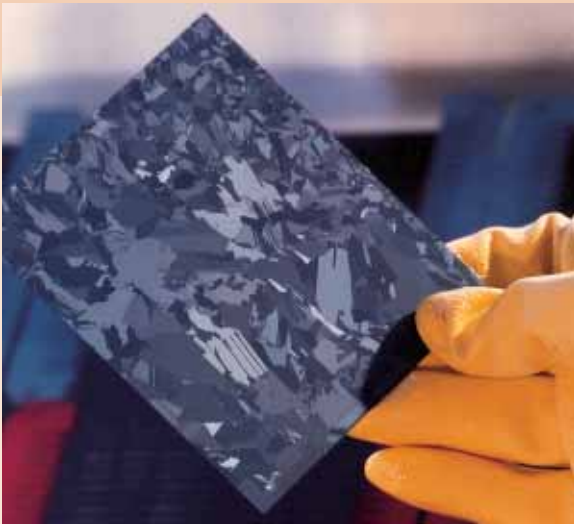
The development of photovoltaics has been and continues to be supported in Germany by the Federal Government and the Federal Länder as part of the state's need to make provision for the future but it is also being supported by parts of the private sector in

a number of different ways. The Renewable Energy Sources Act of 1 April 2000 and the so-called 100,000 Solar Roofs Programme (HTDP), aimed at installing solar power technology on 100,000 roofs, have been the main drivers behind the sharp rise in the number of photovoltaic systems installed in Germany. The 100,000 Solar Roofs Programme expired in 2004 and was replaced by the Renewable Energy Sources Act. The Renewable Energy Sources Act guarantees operators of electricity generation plants that use renewable energy sources a fixed payment for each kWh they feed into the electrical grid, based on the type of renewable energy used. The level of payment will be raised over the years and will be graduated according to output categories. In parallel, making payment obligations contingent upon electricity generating installations with a capacity of over five megawatts as it had applied up to then in the Renewable Energy Sources Act and on the overall output of all solar energy plants installations of 1,000 MWp at the same time was abolished. Furthermore, a bonus was introduced for solar installations on buildings, above all for facade-mounted installations, in order to provide a special incentive to develop this potential, taking the higher power generation costs into account.

The growth rates of newly installed, annual photovoltaic capacity were over 50 percent between 1998 and 2002, breaking the 500 megawatts limit for the first time in 2004. By the end of 2006, photovoltaic systems in Germany had a total installed capacity of 2,831 megawatts.

The size of photovoltaic systems varies between a few kilowatts to several megawatts, small-scale

systems are most often to be found on the roofs of private homes. The open countryside is also being used to a growing extent. The world's largest photovoltaic power station that has an output of 40 megawatts is currently being built at the former Waldpolenz military air base in Brandis near Leipzig. A solar park with a total peak capacity of around 3.3 megawatts is being built near Passau, in which thin film modules will be mounted on a uniaxial solar tracking unit.



Against the backdrop of strong support and promotion of photovoltaics in Germany, the photovoltaic industry and trading have meanwhile developed into a branch of industry that is gaining momentum globally. After Japan, Germany has the highest annual turnover in photovoltaics – German manufacturers accounted for around 34 percent of global market sales of photovoltaic systems in 2006.

There are more than 80 manufacturers of photovoltaic cells, modules and components in Germany; around 7,000 companies are involved in the industry and the installation of photovoltaic systems. The photovoltaics industry in Germany generated revenue of around EUR 5.4 billion in 2007; it employed around 40,000 people.

The total capacity of solar cells produced in Germany in 2006 amounted to roughly 530 megawatts and the production capacity of photovoltaic modules is around 370 megawatts. The capacity is to be further increased in the next few years. With its state-of-



the-art production plants, the German photovoltaic industry will be able to produce more solar modules in future than the number of solar modules that has been installed in Germany so far. This will be a huge boost for international competitiveness.

In addition to the market for grid-coupled photovoltaic systems, the wide product spectrum of the industrial and commercial use of photovoltaics will be interesting for telecommunications, signalling equipment, surveillance, corrosion prevention etc. in future.

Furthermore, decentralised solar energy used to generate electricity which requires very little investment in the infrastructure is an important area of application for German solar technology exports offering top quality products and know-how. Solar technology hence represents an important development aid factor. This is where financial support by the World Bank and various relief organisations plays a major role in the electrification of rural areas in less developed regions. There are a number of ways in which the German state can support exports of solar technology – for instance, by offering Hermes cover (export credit guarantee). By granting Hermes cover, the Federal Government is able to cover in particular exports to so-called developing countries against economic risks and political risks.

In Germany, a large number of higher education institutions and research institutions as well as other institutions (e.g. Technischer Überwachungsverein

(TÜV) [Technical Inspection Board]) are involved in the photovoltaic industry. The research landscape is marked by an increase in cooperation between the private sector and the institutes. Manufacturing technologies are playing an ever more important role in the development of technology. As such, there is a continual supply of innovations for practically all steps of process technology. The intensive cooperation between industry and research within the frame-

work of EU projects has also proven to be very fruitful. The carbon dioxide emissions saved in Germany is currently a mere 0.3 percent at around 1.4 million tonnes a year owing to the relatively small share of photovoltaics in electricity generation. Nonetheless, the spectrum of application for solar energy is becoming ever more diverse and the market is certainly expanding.

Photovoltaics

Germany is the world's second largest manufacturer of photovoltaic plants for the generation of electricity after Japan:

- ▶ German manufacturers met around 34 percent of the global demand for photovoltaic systems in 2006.
- ▶ German manufacturers currently have an annual manufacturing capacity of around 530 megawatts for solar cells and a production capacity of around 370 megawatts for the production of photovoltaic modules. In the next few years, capacity is to be increased even further and international competitiveness is to be greatly enhanced.
- ▶ By the end of 2006, the capacity installed in Germany was around 2,830 megawatts, accounting for around 0.3 percent of the power generated in Germany.
- ▶ The installation of photovoltaic systems has experienced a boom in recent years thanks to political support.

Annual installed capacity:

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
MWp	13	12	15	45	80	83	157	500	600	750

- ▶ There are more than 80 manufacturers of photovoltaic cells, modules and components in Germany; around 7,000 companies are involved in the industry and the installation of photovoltaic systems in Germany.
- ▶ The photovoltaics industry in Germany generated revenue of around EUR 5.4 billion in 2006; it employed around 35,000 people.
- ▶ At present, around 1.4 tonnes of carbon dioxide emissions are saved due to electricity generated from solar energy.

Solar thermal energy: harnessing the sun's heat



It is, in principle, possible to use solar energy to supply warm water to any household, public building and industry anywhere in the world using solar collectors (using solar thermal energy). This system can be used economically even today where there is good solar radiation and many countries are promoting the use of solar energy for the future in order to ease the burden on the environment.

In Germany, a very powerful solar thermal industry has developed in the past few years against the backdrop of growing interest among the state and the public in protecting the environment. Solar thermal systems can provide heat in order to heat water and to support central heating systems. Absorbers used to heat open-air swimming pools are less prevalent; a few systems have been installed for solar cooling.

Information campaigns, purposeful training of craftsmen, a technology that has been further developed in customers' interest and attractive promotion programmes such as the market incentive programme launched by the Federal Government comprising investment grants and a number of programmes initiated at the level of the Federal Länder have all helped to generate greater acceptance of solar heat among the population.

The use of solar heat has increased sharply in recent times, the sale of solar power plants rose by more than 35 percent in Europe in 2006 to a solar thermal capacity of more than 1,900 megawatts. The most dynamic markets alongside the German market

are France and Great Britain which have seen growth rates of between 40 percent and 70 percent.

The share of solar energy in the generation of heat has soared against this backdrop in recent years. By 2006, around one million solar collectors spanning an area of around nine million square metres had been installed on German roofs.

Solar thermal plants used to heat water in Germany are already able to cover up to 60 percent of an average household's annual requirements and up to 30 percent of total heat requirements using large solar thermal plants with collectors to support central heating systems. The collector area required to heat the water of a single-family home is between three and eight square metres, depending on consumption patterns. Within just a few months, solar thermal plants generate the same amount of energy that was required to manufacture them, after which they produce heat for more than 20 years.

The vast majority of solar thermal systems installed are the less expensive flat plate collectors; tube collectors are capable of operating with greater efficiency and are acquiring an ever increasing market share. In addition to single-family houses, more and more apartment buildings and residential estates are installing solar collectors.

The integration of solar collectors into the product range of the construction material industry has had a positive impact on the trend. Large solar thermal technology has meanwhile been tried and tested

in a large number of solar thermal plants with considerable success. A number of government buildings such as the Federal Ministry of Economics and Technology in Berlin are using solar energy. Solar collectors on the roofs of the Federal Ministry of Transport and the Federal Press Office are being used for solar cooling purposes where the heat from solar collectors is used to drive thermal refrigerators. As larger solar thermal systems facilitate lower heat prices, apartment buildings and large building complexes are particularly interesting in terms of costs.

At present, solar thermal energy accounts for over 0.5 percent of heat generation for residential buildings and has the potential to rise to over ten percent in the long term.



In Germany, just under 100 companies are manufacturing solar collectors; around 4,000 companies are involved in the solar thermal industry and in solar thermal installation. Around 19,000 people are employed in the solar thermal manufacturing industry. The revenue generated by solar technology revenue in Germany was around EUR 1.2 billion in 2006.

German solar thermal plants are marked by high output, high quality standards and by a decrease in the price of solar thermal systems. Yet there has been an increase in efficiency in recent years. This has led to these systems moving closer to reaching the prof-

itability threshold – however, unless subsidised, solar thermal energy is still more expensive than heat generated from oil or natural gas. The use of solar thermal energy in heat generation saved over 750,000 tonnes of carbon dioxide emissions in 2006, and the number of house owners in Germany who believe that solar thermal systems are a sound investment is growing steadily. Those operating a solar thermal system are contributing towards environmental and climate protection, are acting responsibly vis-à-vis future generations and at the same time are reducing their



dependency on fuel price trends and hence on the anticipated increase in the price of oil and gas. In order to further develop solar thermal technology, manufacturers are cooperating closely with a number of higher education institutes and research institutions which have also contributed to product developments in recent years.

Examples of other research and development programmes are:

- ▶ Developing new collector concepts using new materials in order to reduce prices.
- ▶ Optimising solar storage in order to increase the use of solar energy in the generation of heat.
- ▶ Developing new applications using solar district heating systems that facilitate seasonal storage.
- ▶ Sophisticated solar cooling systems.

The close cooperation with research is promoting the competitiveness of the German solar thermal industry accordingly which expects to see a growing demand for such systems. As it has expanded its manu-

facturing capacities, the German solar thermal industry is also gearing itself to meet growing international demand. The European Union would like to double the area of solar collectors in Europe by 2010 com-

pared to 2000. The German solar thermal industry is aiming not just to promote the trend-setting solar energy technology in Europe, but globally too.

Solar thermal energy

Germany has by far the largest market for solar thermal energy plants in Europe:

- ▶ At present, solar thermal energy accounts for just under 0.5 percent of heat generation for residential buildings, having the potential to rise to over ten percent in the long term.
- ▶ By the end of 2006, around one million solar thermal plants had been installed in Germany with solar collectors covering an area of around nine million square metres; the vast majority of them are flat plate collectors, however, tube collectors are capable of operating with greater efficiency and are acquiring an ever increasing market share.
- ▶ The market has seen a very positive trend in recent years thanks to the political support received. With the entering into force of the Renewable Energy Sources Act adopted by the Federal Cabinet in December 2007, this positive market trend will improve even further. The bill of the Federal Government envisages obliging owners to use renewable energies to generate heat in new buildings. At the same time, the use of such regenerative energies is being steadily promoted.

▶ Annually installed collector area:

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
in 1,000 m ²	320	350	420	610	900	650	750	750	950	1,500

- ▶ In Germany, just under 100 companies are manufacturing solar collectors; around 4,000 companies are involved in the solar thermal industry and in the installation of solar thermal systems.
- ▶ Revenue generated by solar technology was around EUR 1.2 billion in 2006. Around 19,000 people are employed in the solar thermal manufacturing industry.
- ▶ The use of solar thermal energy in heat generation is currently saving over 750,000 tonnes of carbon dioxide emissions from being released into the atmosphere each year.



Research institutes/higher education institutes involved in the area of solar energy in Germany

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Photovoltaics

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Helmholtz-Zentrum Berlin für Materialien und Energie (Helmholtz Centre Berlin for Materials and Energy)

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ISET Institut für solare Energieversorgungstechnik – Kassel

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Zentrum für Sonnenenergie und Wasserstoff (ZSW) – Stuttgart (Research Centre for Solar Energy and Hydrogen Technologies)

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Photovoltaics and solar thermal energy

Fraunhofer-Institut für Solare Energiesysteme (ISE) – Freiburg (Fraunhofer Institute for Solar Energy Systems)

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Institut für Solarenergieforschung GmbH (ISFH) – Hameln/Emmertal (Institute for Solar Energy Research)

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Solar thermal energy

Deutsches Institut für Luft- und Raumfahrt (DLR/PSA) – Köln (German Aerospace Centre – Cologne)

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Promoting exports of renewable energies

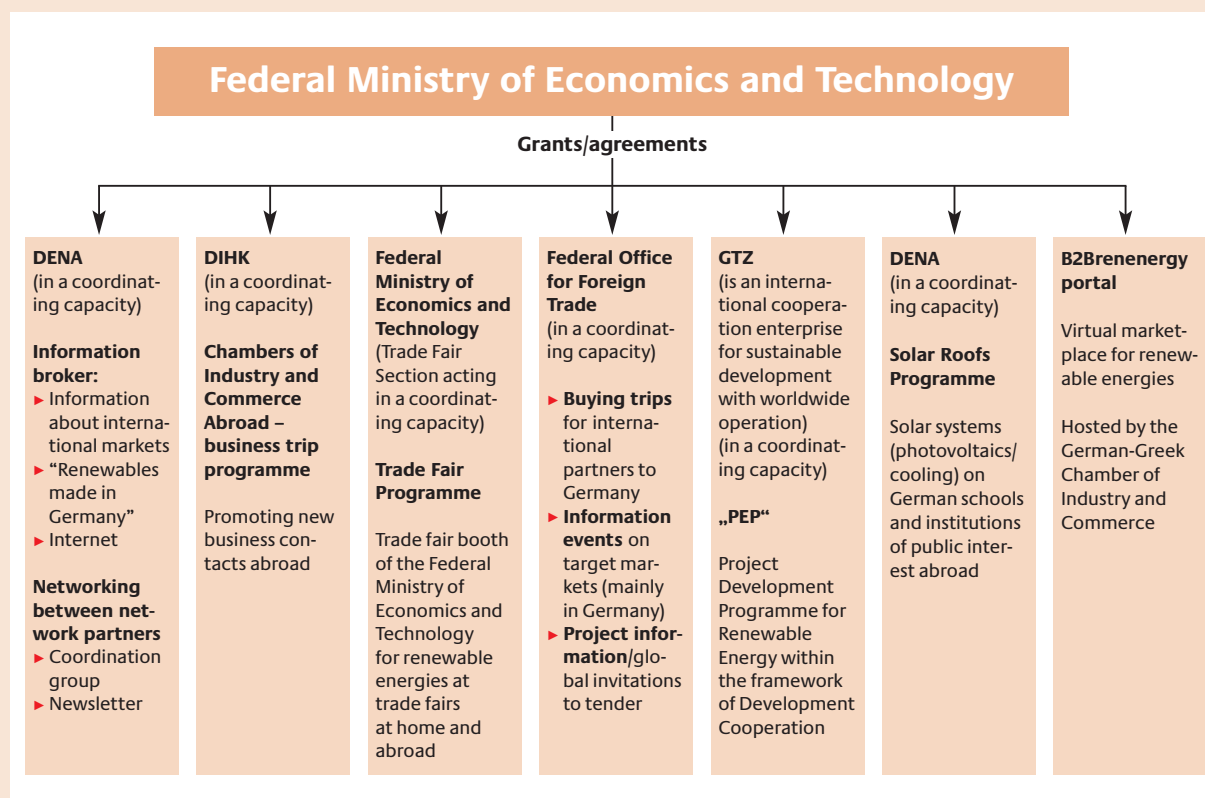
Having a reliable supply of energy is the key prerequisite for the development of any national economy, both as an economic community and as a stable, social unit. Yet only a sustainable and hence environmentally-compatible energy supply can guarantee people a sound basis for economising and coexistence. This is why the Federal Government is promoting the sustainable development of the energy sector in partner countries in a number of different ways. The use of renewable energies is gaining momentum because of the contribution they make towards climate protection.

Although technologies are available to use regenerative energy sources, in many cases they are not yet being used on a wide enough scale. In order to promote them, it is not just investment in the relevant technologies and funding that is needed to enhance the competitiveness of renewable energies, but also a transfer of technology and know-how in order to create the prerequisites for efficient and sustainable operation.

In addition to the diverse forms of investment promotion and technology transfer, programmes aimed at promoting exports have also fostered trading between German companies, companies that are domiciled in the European Union and partners in developing and threshold countries. The most important initiatives and their achievements are outlined briefly in the following.

The Renewable Energy Export Initiative

The aim of the Renewable Energy Export Initiative developed in 2002 and launched in 2003 by the Federal Ministry of Economics and Technology is to assist German companies by providing information services, by integrating existing initiatives and activities and by monitoring international projects involving the export of technologies based on renewable energies. The aim is to help small and medium-sized enterprises in particular to tap international markets.



The intention is not just to raise the export share of the renewable energy industry in the long term, but to make a significant contribution towards climate protection at the same time.

To this end, the Federal Ministry of Economics and Technology is offering a comprehensive package of measures in cooperation with various partners represented in the coordination group (associations involved in the renewable energies industry, Ministries, public authorities, Federation of German Industries (Bundesverband der Deutschen Industrie), Association of German Chambers of Industry and Commerce (Deutscher Industrie und Handelskammertag (DIHK)), KfW and German Energy Agency (dena), that is modular in structure and therefore facilitates systematic development of international markets:

1. German Office for Foreign Trade – information and contact events: the German Office for Foreign Trade organises information events on target markets and countries on behalf of the renewable energies industry in Germany. The events provide companies with information to which they would not normally have access or that would be extremely difficult for them to obtain. These include, inter alia, information on general terms and conditions (statutory regulations, approval procedures etc.) and market structures. Experts from the target country are usually involved. The target group is primarily German SMEs in the early stages of market development. Some of the events are oriented to renewable energies, some relate specifically to certain segments, e. g. wind power, solar energy or the use of solid biomass as an energy source.

2. Federal Ministry of Economics and Technology

Trade Fair Programme: the Trade Fair Programme gives German companies the opportunity to showcase their products and services at a booth of the Federal Ministry of Economics and Technology at selected trade fairs both at home and abroad. As such, the companies benefit not just from cost-effective participation terms, but also from marketing measures. The booth at trade fairs also advertises for Germany as a business location and publicizes its expertise in the area of renewable energies.

The aim of the programme is to enhance the presence and awareness level of German companies in the field of renewable energies. The target group primarily comprises small and medium-sized enterprises that cannot afford to have a booth of their own at an international trade fair. The Trade Fair Programme gives companies the opportunity to showcase their products and services especially in developing markets and regions, requiring little financial outlay and organisation, and hence enables them to gain access to new markets.

The event known as German Renewable Energy Day is an important component of marketing measures. The prime goal is to highlight the opportunities and benefits of using German technologies in the field of renewable energy to trade fair visitors in their country. Technical lectures on certain technologies and on the latest trends of renewable energies in Germany are an important element of the German Renewable Energy Day. The speakers come from companies, German technical associations and energy agencies.

The Trade Fair Programme of the Federal Ministry of Economics and Technology is complemented by the website: www.german-renewable-energy.com where interested parties at home and abroad can find the very latest information about renewable energies and on trade fairs and other events in German, English and Spanish. Presentations given at the German Renewable Energy Day can be downloaded.



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New Independent States (NIS), Asia-Pacific and Latin America
as well as events in the field of renewable energies

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South-East Europe, Africa, the Middle East and Arab countries

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International/national trade fair policy/trade fair participation
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**3. Chambers of Industry and Commerce Abroad –
Business Trip Programme:**

the Chambers of Industry and Commerce Abroad help to establish business contacts between German and foreign SMEs. These contacts are initiated and intensified within the framework of business trips lasting several days at which the Chambers offer one-to-one service to German companies. These business trips comprise two components: seminars and presentations are held on the first day, with the speakers from both the target market and from Germany outlining the general conditions of the respective markets and important cooperation. At the same time, companies also have the opportunity to showcase their products and services. The local Chamber of Industry and Commerce Abroad arranges one-to-one meetings between potential business partners on subsequent days. Alternatively they arrange for individual talks to be held with important decision-makers in the target country.

The programme is directed primarily at small and medium-sized enterprises that are on the brink of exporting from their domestic market or that intend to develop additional international markets. The goal is to give interested companies better access to international markets, i. e. to provide information and to arrange for contacts that would be difficult for the companies to make themselves or for which they would not have sufficient resources available.

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**Contact for those wishing to participate in events
organised by the Chambers of Industry and
Commerce Abroad-business travel programme****Deutsche Energie-Agentur GmbH
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Regenerative energies

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**4. Business trips for buyers organised by the
German Office for Foreign Trade:**

the German Office for Foreign Trade organises trips for interested parties from other countries to Germany so that they can obtain information about German technologies locally and can strike business deals with manufacturers. The aim is to enhance the level of information of interested parties from other countries in relation to the use of renewable energies, to advertise German technologies, to spread the word on how efficient they are and to build business contacts between potential customers and partners. Elements of a business trip for buyers can include providing an overview of certain themes (e.g. best available technologies in Germany), organising inspection tours of German companies, demonstrating power generation plants and networking opportunities.

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**5. Solar Roofs Programme launched by the Ger-
man Energy Agency (Deutsche Energie-Agentur)**

(dena): The installation of solar roofs on German school or other suitable facilities abroad for demonstration purposes is subsidised within the framework

of the solar roofs programme. The companies participating in this programme can simultaneously avail of support from the German Energy Agency. The aim of the programme is to help German manufacturers of photovoltaic, solar thermal and solar cooling systems to tap international markets and to raise awareness of German technology abroad (acting as an inspiration for others).

The programme is divided into a “Technology” section and a “PR, Marketing, Training” section. The “Technology” section encompasses planning, delivery, installation and putting into operation of the demonstration system. The activities in the field of “PR, Marketing, Training” encompass PR work, knowledge transfer, skills upgrading, networking and lobbying for solar systems in the target country.



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6. GTZ project development programme: meetings are arranged between political decision-makers and companies involved in the renewable energies industry from Germany and the target country within the framework of delegation trips with a view to establishing business contacts and developing more complex projects. As such, the focus is placed on organising business trips to developing and threshold countries. The project development programme is directed at export-oriented German companies involved in the renewable energies industry. GTZ endeavours to identify new companies that had not previously considered the possibility of bringing their project to a developing country.

Senegal was selected as the target country for the 2007 pilot measure as it offers good conditions and prospects for renewable energy exports and has markets and structures that can be used for this project. The potential business prospects include:

- ▶ Export of German technologies by establishing contacts with important customers and/or decision-makers.
- ▶ World Bank loans for communes for rural electrification (ERILs¹²), anticipated business volume: ca. EUR 150,000 per ERIL (1 ERIL supplies electricity to a maximum of 200 households). The business could potentially be worth EUR 30 million.
- ▶ World Bank concessions for certain regions for the development of a power supply by consortia involving public utilities (at least 20 percent renewable energies, financed by the World Bank, KfW, African Development Bank), the business could potentially be worth EUR 70 million for all concessions (currently 12).

Further information on the pilot project “Project development Senegal – renewable energies and rural electrification” can be obtained at: www.gtz.de/energie.

GTZ and the Federal Ministry of Economics and Technology are currently working on further projects within the framework of the project development programme.

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These services are expanded by:

- ▶ **Provision of export know-how for German companies:** the initiative provides information for German companies on the website: www.exportinitiative.de on the latest industry-specific general conditions on international target markets and offers expert know-how on various forms of international project finance. It is also possible to download or order publications providing detailed, technology-specific and practical information about target markets on the website.

▶ **Special export and industry-specific forums, technical seminars** (inter alia on finance-related issues)

▶ **Online services** provided by the Federal Ministry of Economics and Technology, dena and the German-Greek Chamber of Industry and Commerce which provides information for companies interested in exporting (www.renewables-made-in-germany.com; www.exportinitiative.de; www.b2brenenergy.com).

▶ **www.b2brenenergy.com**: b2brenenergy.com provides a full range of services for companies involved in the areas of solar energy, wind power, hydropower, geothermics and biomass. The services are divided into three main areas: a business centre, a service centre and an information centre.

The electronic marketplace where products and technologies involving renewable energies are sold and traded at regional, national and global level is the backbone of the business centre. The business services are completed by a web forum for entrepreneurs, a presentation platform and the Yellow Pages.

The service centre integrates the range of services offered by b2brenenergy.com. This is where users will not just find a job forum and cooperation forum but also detailed market analyses and targeted B2B advice. In addition, an automatic search agent trawls the Internet daily for information that is sent to the customer in a personalised newsletter.

Up-to-date information on events and invitations to tender is supplied within the framework of the online services provided by the information centre. A calendar of events also provides a handy overview of trade fairs, conferences and training involving renewable energies. This enables companies to identify global business opportunities and to analyse and implement them.

The online services are complemented by the services offered by the German Chambers of Industry and Commerce Abroad. They provide everything from legal advice through to sales advice right up to arranging appointments. There are around 120 branches of Chambers of Industry and Commerce Abroad that employ 1,400 experts and have 40,000 member companies.

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▶ **Comprehensive marketing measures**: the export initiative informs interested parties abroad about the range of renewable energy technologies available and the ways in which they can be used.

Investments in partner countries

Direct investments in partner countries are promoted with the help of programmes launched by the Federal Government, with funds appropriated by the Federal Länder and by the European Union. The relevant services include investment aid, project finance, information and advice.

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Bilateral agreements on the promotion and protection of investments

The Federal Republic of Germany has concluded bilateral agreements on the promotion and protection of investments with more than 125 target countries. They provide a binding framework under international law for investors, in particular by granting

- ▶ free transfer of capital and proceeds,
- ▶ non-discrimination based on nationality and most-favoured-nation treatment,
- ▶ obligatory compensation and guaranteed recourse to law in the event of expropriation measures,
- ▶ legal protection in all disputes regarding investments, in particular by agreeing on international arbitration.

Bilateral agreements on the promotion and protection of investments also provide the basis for the assumption of investment guarantees by the Federal Government.

Government guarantees for direct investment abroad (investment guarantees)

The Federal Government issues guarantees for direct investment in order to hedge political risks. All companies that are domiciled in the Federal Republic of Germany are entitled to avail of these federal guarantees. The Federal Government can issue guarantees for loan participations, loans with equity features and endowment capital. The investors cover themselves against risks such as expropriation, failure to honour commitment, war, revolution, insurrection, freezing of payments, moratoria as well as conversion or transfer restrictions.

Federal guarantees and loan guarantees for untied loans

This tool covers political and economic payment risks in association with deliveries or loans granted by German companies to public or private debtors in the partner country. Untied loans are not tied to any specific supplies and services. Yet in order to qualify for a guarantee, they must be tied to a specific project.

Tax allowances

The Federal Government has concluded "Conventions on the avoidance of double taxation and the prevention of fiscal evasion with respect to taxes on income and capital" – so-called Double Taxation Agreements – with numerous partner countries. These are agreements under international law that are aimed at ensuring a business or individual who is resident in one country does not have to make a taxable gain (earnings, profits) in another country for the same tax period. This means, for instance, the country where the gain arises deducts taxation at source ("withholding tax") and the taxpayer receives a compensating foreign tax credit in the country of residence to reflect the fact that tax has already been paid. For partner countries with which no Double Taxation Agreement has been concluded, unilateral regulations in the German corporate tax law ease the burden on the relevant companies.

Credit programme of KfW Bankengruppe for investment abroad

KfW Bankengruppe (KfW banking group) supports small and medium-sized enterprises in Germany by granting low-interest loans with long repayment periods and interest-only loans for the first few years. It also provides risk capital for direct investment by small and medium-sized enterprises in newly-emerging markets. Loans are organised via the investor's local bank which also assumes liability vis-à-vis KfW.

As a bank owned by the Federal Government (80 percent) and the Federal Länder (20 percent), the KfW's role in promoting exports and development cooperation is enshrined in the KfW law. In its activities, KfW espouses, inter alia, the values of sustainability, humanity and tolerance which explain its strong commitment to financing regenerative energy projects in developing countries and threshold countries.

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Meeting basic needs, pressing ahead with climate protection

KfW Entwicklungsbank is one of the three largest financiers of renewable energies in developing countries alongside the World Bank and Global Environment Facility (GEF). Within the framework of the Federal Government's development cooperation, KfW Entwicklungsbank finances the introduction and use of renewable energies in the respective partner countries. Between 2001 and 2006, KfW und DEG appropriated a total of EUR 748 million for the promotion of biogas, hydropower, wind power, solar thermal energy, photovoltaics and geothermics, which corresponds to 47 percent of all financial commitments made in the energy sector.

In addition, KfW initiated the **Special Facility for Renewable Energy and Energy Efficiency (4E Facility)** in 2005 with which KfW Entwicklungsbank grants low-interest loans for investments in partner countries in the field of renewable energy and energy efficiency. Between 2005 and 2006, the



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sum of EUR 300 million was pledged for new projects. Since 2007, the funds available have been doubled.

Project example 1: KfW has granted loans and construction subsidies worth EUR 15 million since 1997 to assist the Government of Nepal in promoting the construction of biogas plants that supply gas for stoves and lamps.

Up until now 160,000 biogas systems have been installed under the financial cooperation project, and an additional 200,000 systems at the very least are to follow by 2009. In October 2006, KfW also reached an agreement with the Nepalese Government within the framework of its climate protection fund to purchase one million carbon dioxide certificates that will be generated by the programme. This will generate additional revenue that is to be used to promote the installation of additional biogas plants.

The Agricultural Development Bank of Nepal is the financial intermediary between KfW and the farmers, the recipients of funds who also render services of their own.

Project example 2: KfW has been promoting the expansion of wind power in Egypt since the late 1990s.

The amount of electricity that can be generated along the Red Sea coast is twice the amount of electricity that can be generated in the average location along the North Sea and the Baltic Sea coast in Germany. KfW has co-financed the "Zafarana" Wind Park that has a total capacity potential of around 600 megawatts. Germany has appropriated funds worth EUR 149 million in support of the expansion. Between 2001 and 2004, 137 wind generators with a total output of 80 megawatts were commissioned, additional plants with a total output of 80 megawatts are currently being installed. The wind generators currently being installed under German financial cooperation with a capacity of 160 megawatts will be enough to supply electricity to over 250,000 Egyptian households.

Thanks to Germany's contribution alone, around 360,000 tonnes of carbon dioxide can be saved from being released into the atmosphere each year. A contract of sale was concluded with Egypt within the framework of the KfW climate protection fund on a

portion of the emission reductions between 2008 and 2012. The additional revenue generated will contribute to the sustainability of the project.

Financial assistance for companies by DEG

DEG – Deutsche Investitions- und Entwicklungsgesellschaft mbH, a member of KfW Bankengruppe, is the German development finance institute for the promotion of investment by private companies in developing countries. It assists private companies in the partner countries as well as German and international companies investing in these countries by offering loans, guarantees, equity capital and mezzanine finance (a combination of equity and borrowed capital finance) and advises the companies on their investment projects.

In 2006, DEG concluded new business worth EUR 930 million. The projects it co-finances must not only be sustainable from a business perspective, they must also make an effective development policy impact, meet environmental standards and comply with social principles. Since the mid-1990s, the promotion and financing of climate-protection projects has been a declared aim of DEG. It has co-financed wind parks, hydropower and biomass plants, for instance in China, India and Brazil.

Project example 1: DEG granted a long-term loan to a Brazilian subsidiary of the German company Enercon GmbH that was used to build and operate the first privately-owned wind park in Brazil. Enercon was awarded the contract within the framework of an international invitation to tender issued by the local public utility. As commercial banks were not willing to shoulder the currency risk associated with the project, DEG agreed to provide non-recourse finance. The wind park has an installed capacity of 15 megawatts.

Project example 2: DEG formed a joint venture with the German company PCC SE which is involved in international electricity trading. The partners will invest in around 30 small hydropower plants with a total capacity of 45 megawatts in South-East Europe, particularly in Bosnia-Herzegovina, Bulgaria and Macedonia. The plan is to expand the capacities for power generation and to promote the use of renewable energies. Considerable carbon dioxide emissions have been saved due to the use of hydropower.

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Funding provided by the Federal Länder

The Federal Länder assist with the investment of German companies abroad in many different ways and by forming joint ventures. Relevant information can be obtained from the Ministries of Economics of the Federal Länder and the Chambers of Industry and Commerce.

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Funding provided by the IFC

The International Finance Corporation (IFC), a member of the World Bank, finances private sector investment above all in developing countries along the same lines as DEG. It grants long-term loans and offers loan participation in companies in the host country the same as investors from the industrialised countries. However, investors can also acquire an indirect participating interest via the IFC by providing the relevant capital for a certain period. During this time, the IFC manages this sum within its own portfolio and shares the profits with the investor. An IFC commitment is of special importance in countries in which the IFC limits the participation by foreign companies to a certain ceiling.

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Technology transfer in the partner countries of GTZ – investing in the energy markets of developing countries and threshold countries

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) (an international cooperation enterprise for sustainable development with worldwide operations) supports the Federal Government in achieving its development policy objectives. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalised world and promotes complex reforms and change processes. Its corporate objective is to improve people's living conditions on a sustainable basis. GTZ employs some 10,000 staff in more than 120 countries of Africa, Asia, Latin America, the Eastern European countries in transition and the New Independent States (NIS). Around 9,000 of these staff are national personnel.

GTZ offers private companies cooperation opportunities for the use of renewable energies and efficient energy technologies in development and threshold countries through a number of (supraregional) programmes. In doing so, it is pursuing the goal of enhancing access to state-of-the-art energy services as the key element of sustainable development at local level. The following services are offered via these programmes:

- 1) The sector project “Strengthening partnerships and networks for renewable and sustainable energy in developing countries”** supports economic (and scientific) collaborations for renewable energies in the international context, focusing on the initiation and intensification of partnerships with companies in the field of renewable energies. The services and activities encompass
 - a) implementing and/or financing technical seminars and workshops for interested companies on selected regions and energy-specific themes
 - b) providing information services and processing information on renewable energies in the partner countries (e. g. regional reports/national reports on energy markets),
 - c) identifying possibilities of development partnerships with companies involved in renewable energies (Public Private Partnerships – PPPs) and networking

between players in the renewable energy industry both in Germany and in the partner countries.



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2) GTZ supports long-term commitments undertaken by private companies in developing countries by way of **development partnerships** that are implemented within the framework of the **PPP programme** launched by the Federal Ministry for Economic Cooperation and Development (BMZ). The main idea behind this programme is the win-win effect: if both sides pool their resources, the respective goals are reached more efficiently, faster and more cost-effectively. PPP projects between GTZ and companies are jointly planned, financed and implemented. GTZ participates in projects by contributing human resources and/or finance. GTZ also contributes relevant contacts from its network of international cooperation. Companies and associations from EU countries can become partners, with additional companies in the respective countries being enlisted as additional partners. Proposals for PPP projects can only be accepted if they meet four criteria:

- a) The projects must promise to be a commercial success and offer development policy benefits, generating tangible benefits in the partner country.
- b) The project must conform to the development policy principles of the Federal Government.
- c) The scope of PPP projects must clearly go beyond the limits of normal commercial activity, as PPP funds are not subsidies.
- d) The private partner must make a major contribution to the project in terms of financing and/or mate-

rials. As a rule, the private partner bears at least 50 percent of the PPP project costs.

Since the PPP programme began, GTZ has successfully formed more than 500 partnerships with private firms and associations in more than 60 countries. The PPP programme is open to all industries and hence offers the energy sector interesting opportunities of tapping the energy markets of developing and threshold countries via PPP partnerships.

Interested companies can submit their project proposals informally to a PPP office or to GTZ.

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3) **The TERNA (Technical Expertise for Renewable Energy Application) wind power programme** assists partner countries in assessing and utilising the potential of wind power. In successful cases, this enables wind power projects that are ready for investment to be initiated. Alongside this programme, GTZ advises partner countries on how to create and improve their energy policy framework. The services that form part of the TERNA programme can include location-specific measures, energy policy advice and initial and advanced training as well as dissemination of information. If a planned wind park project is to qualify for a financial subsidy, it must be possible to implement the project in both technical and economic terms.

TERNAs are not involved in investment financing. The prerequisite for cooperation with the business sector within TERNA projects is that the use of private know-how and capital must enhance the prospect of implementing the plans for a wind park project that is supported by TERNA. Hence, TERNA offers project developers a support option in the country of operation by arranging for a local partner to submit an application for a TERNA project to GTZ and subsequently receiving assistance with the implementation of the

TERNA project. If a TERNA measure is implemented, GTZ cooperates closely with the initiating project developer in implementing the measure. However, the project developer is also expected to provide and finance his own contributions. As a rule, this is done on the basis of a cooperation agreement which regulates the contributions made by both sides and the exploitation of project results. It should be noted that a TERNA measure always aims to provide assistance to a partner in the developing country and is tailored to meet the latter's needs. It also continues if cooperation with the initiating (European) project developer ends while a measure is being implemented.

In the case of TERNA measures that have not been initiated by the business sector, the results of the measures (wind reports, feasibility studies, other project studies) are disseminated (via information events, the TERNA website, trade publications, etc.) in consultation with the relevant project partner in the developing country in order to enable the business sector to position itself in good time regarding the implementation of the wind park project. To date, 13 country-specific measures in Africa (Ethiopia, Senegal, Mali, Namibia, Morocco), Asia (China, Bangladesh, Jordan, Yemen) and Latin America (Colombia, Brazil, Venezuela) have been successfully completed or are still underway.



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Export credit guarantees provided by the Federal Government

This funding instrument provides comprehensive insurance cover in connection with risks that may arise in relation to German export transactions and the financing thereof. The importance of export credit guarantees lies in the fact that they provide financial and political coverage on higher-risk overseas markets. Supplies and services for environmentally-compatible technologies and regenerative energy resources are particularly eligible for aid. The Federal Government has commissioned a consortium comprising Euler Hermes Kreditversicherungs-AG (Euler Hermes credit insurance in Germany) and PricewaterhouseCoopers AG to implement the instrument.

Contact

Euler Hermes Kreditversicherungs-AG (Euler Hermes credit insurance in Germany)

Friedensallee 254, 22763 Hamburg, Germany

Export credit guarantees issued by the Federal Government – export loan guarantees
Tel.: +49 (0) 40-88 34-91 92
Fax: +49 (0) 40-88 34-91 75
www.exportkreditgarantien.de



AKA export financing

AKA Ausfuhrkredit GmbH (AKA export finance bank) is an institute established by a consortium of banks for purposes of export financing and securing the relevant transactions. The funds come from different credit ceilings and are allocated to exporters or even to foreign customers. As a rule, the financing is handled via the principal bank or banks that have a stake in the company – the current number of banks being 23.

Contact

AKA Ausfuhrkredit-Gesellschaft mbH (AKA export finance bank)

Große Gallusstrasse 1–7, 60311 Frankfurt am Main, Germany
Tel.: +49 (0) 69-29 891-00
Fax: +49 (0) 69-29 891-200
www.akabank.de



Energy efficiency – made in Germany



At a time when energy prices are steadily rising, fossil fuels are becoming scarcer and climate change is continuing apace, the demand for innovative technologies that use energy efficiently and reduce energy consumption is growing all over the world. Targeted use of energy and raw materials can play a major role in enhancing a country's competitiveness.

The European Union has set itself the goal of increasing energy efficiency by 20 percent relative to the predicted trend by 2020. According to the International Energy Agency, energy consumption is set to double by the year 2030, particularly in newly industrialised countries such as China and India. Many of these countries but also industrialised countries with a high energy consumption are making increasing efforts to improve their energy efficiency. In this regard, they stand to benefit from German companies' experiences.

Germany is a global leader in the area of energy efficiency. This is confirmed by the energy consumption calculations for 2006, according to which primary energy consumption in 2006 was three percent lower than the 1990 figure even though gross domestic product (GDP) increased by more than 25 percent during the same period. Hence, relative to its compiled GDP figures, Germany consumes comparatively little primary energy, making it one of the most productive industrialised countries in the world. Germany also has an excellent reputation as an international market leader and leader in innovation both in the area of energy efficiency technologies and in energy consulting. This creates major export opportunities for

German companies providing products or services that are aimed at enhancing energy efficiency.

Against this backdrop, the energy efficiency export initiative has been launched under the umbrella brand "Energieeffizienz – made in Germany". It supports German providers of products, systems and services in the context of energy efficiency in the small and medium-sized business sector. Even though numerous German companies already have a presence in foreign markets, governments and multipliers in target countries have not been targeted in a coordinated way up to now. The aim is to change that via the energy efficiency export initiative. Under this umbrella brand, an information infrastructure extending across different projects and participants is provided as well as comprehensive information in major areas of activity.

The newly established secretariat for the export initiative has been available as a point of contact at the Federal Ministry of Economics and Technology since February 2008. It offers a comprehensive service to any small and medium-sized enterprises that would like to participate in the export initiative. In parallel, interested entrepreneurs can also obtain information online by visiting www.encyency-from-germany.info. The backbone of the Internet portal is a database providing the details of all German companies that are participating in the energy efficiency export initiative. With the aid of a search mask, interested parties from all over the world can find a German provider in the database who will be a competent partner. In a closed area of the portal, German companies, in turn,

have access to the umbrella brand logo and to specific information such as target market analyses and reports on experiences gained by companies. They also have the opportunity to register for the database with their products and services.

In addition, the energy efficiency export initiative supports German companies via:

- ▶ **Business trips organised by the German Chambers of Commerce Abroad:** participating companies are first presented at one-day seminars. Subsequently, the German Chambers of Commerce Abroad organise direct discussions with interested partners in the particular country.
- ▶ **Information and contact events:** these events provide German companies with an opportunity to find out more about the foreign target market they aim to enter at a seminar.
- ▶ **Buyers' trips:** foreign parties who are interested in German technologies and services are taken to German companies.
- ▶ **Foreign Trade Fair Programme:** German companies can participate in foreign trade fairs on favourable terms.
- ▶ **Other modules** (advice on multipliers and policies, multiplier trips, skills upgrading of trained personnel) were at the preparatory stage when this document went to press.

Germany is actively contributing towards international climate protection via the energy efficiency export

initiative. At the same time, the market opportunities and sales prospects for German technologies and services in the energy efficiency sector in foreign markets are being significantly enhanced. As a result, energy efficiency markets in major industrial and growth markets are being further expanded and boosted, and new markets are being opened up. However, reducing greenhouse gas emissions and lowering energy consumption not only makes a major contribution towards global climate protection. Without a global improvement in energy efficiency, it is not possible to provide an economically and ecologically acceptable energy supply. Furthermore, an industrialised country's competitiveness depends particularly on its energy use. Lower energy costs considerably strengthen its competitiveness.

The energy efficiency export initiative basically relates to all relevant markets. Activities in countries with high economic growth, industrial markets that are of strategic importance to the export industry and newly industrialised countries are a particular focus of the initiative. The latter include, for instance, China, India, Russia and the USA, but also Brazil, Mexico and South Africa. Many of these countries have recently set themselves ambitious energy savings targets and intend to achieve them via targeted measures, thereby creating opportunities for German companies.

Contact

**Sekretariat Exportinitiative Energieeffizienz
(Office Export Initiative Energy Efficiency)**
c/o Bundesministerium für Wirtschaft und Technologie
Scharnhorststrasse 34–37, 10115 Berlin, Germany
Tel.: +49 (0) 30-18 615-63 00/63 01
Fax: +49 (0) 30-18 615-53 00
e-mail: sekretariat@efficiency-from-germany.info
www.efficiency-from-germany.info



Renewable energies – Internet addresses

Water power

Bundesverband Deutscher Wasserkraftwerke e.V.

www.wasserkraft-deutschland.de

(including links to the regional associations)

www.wasserkraft.org

European Small Hydropower Association (ESHA)

www.esha.be

International Hydropower Association (IHA)

www.hydropower.org

International Association for Small Hydro (IASH)

www.iash.info

Hydro Equipment Association (HEA)

www.thehea.org

Wind power

Bundesverband WindEnergie e.V.

(German Wind Energy Association)

www.wind-energie.de

Here, you will find addresses for the following sectors:

banks and financiers, fund providers, measuring

instruments, engineering design offices, lawyers,

experts, other services, technical service, insurance

companies, wind experts, suppliers

Fördergesellschaft Windenergie e.V. (Federation of German Windpower)

www.wind-fgw.de

Wirtschaftsverband Windkraftwerke e.V.

www.wvwindkraft.de

Deutsches Windenergie-Institut (DEWI) (German Wind Energy Institut)

www.dewi.de

Fachgemeinschaft Powersystems im Verband deutscher Maschinen- und Anlagenbau e.V. (VDMA)

(VDMA)

www.vdma.org

Stiftung der deutschen Wirtschaft für die Nutzung und Erforschung der Wind power auf See

www.offshore-stiftung.de

Bundesamt für Seeschifffahrt und Hydrographie (BSH) (Federal Maritime and Hydro-graphic Agency)

www.bsh.de

Deutsche Energie-Agentur GmbH (dena) (German Energy Agency)

www.offshore-wind.de

European Wind Energy Association (EWEA)

www.ewea.org

Global Wind Energy Council (EWEC)

www.gwec.net

Geothermics

Geothermische Vereinigung e.V. (German Geothermal Association – geothermics e.V.)

www.geothermie.de

Bundesanstalt für Geowissenschaften und Rohstoffe (The Federal Institute for Geosciences and Natural Resources)

www.bgr.de

GeoForschungsZentrum Potsdam (German Research Centre for Geosciences Potsdam)

www.gfz-potsdam.de

Institut für Energetik und Umwelt gGmbH (Institute for Energy and Environment)

www.ie-leipzig.de (click on geothermics)

European Geothermal Energy Council (EGEC)

www.egec.org

International Geothermal Association

<http://iga.igg.cnr.it>

Biomass

Bundesverband BioEnergie (BBE)

www.bioenergie.de

Fachverband Biogas e.V. (German Biogas Association)

www.biogas.org

C.A.R.M.E.N. e.V. (Centrales Agrar-Rohstoff-Marketing- und Entwicklungs-Netzwerk)

www.carmen-ev.de

Fachagentur Nachwachsende Rohstoffe e.V. (FNR)

www.bio-energie.de

University of Stuttgart, Biomass Info Centre

www.biomasse-infonet.de

University of Würzburg, Bayerisches Zentrum für Angewandte Energieforschung (ZAE Bayern) (Bavarian Centre of Applied Energy Research)
www.zae-bayern.de

Institut für Energetik und Umwelt gGmbH (Institute for Energy and Environment)
www.energetik-leipzig.de (for bioenergy, click on solid biomass, biogas or biofuels)

European Biomass Association (AEBIOM)
www.aebiom.org

European Biomass Industry Association (EUBIA)
www.eubia.org

Photovoltaics & solar thermal energy

Bundesverband Solarwirtschaft (BSW) (German Solar Industry Association)
www.solarwirtschaft.de
www.solarbusiness.de
www.solaratlas.de
www.regiosolar.de

ForschungsVerbund Sonnenenergie (FVS)
www.FV-Sonnenenergie.de

Fraunhofer-Institut für Solare Energiesysteme (Fraunhofer ISE) (Fraunhofer Institute for Solar Energy Systems)
www.ise.fraunhofer.de

Photovoltaics

Forschungszentrum Jülich GmbH (FZJ)
www.fz-juelich.de

Helmholtz-Zentrum Berlin für Materialien und Energie (Helmholtz Centre Berlin for Materials and Energy)
www.hmi.de

Institut für solare Energieversorgungstechnik (ISET)
www.iset.uni-kassel.de

Zentrum für Sonnenenergie und Wasserstoff (ZSW) (Research Centre for Solar Energy and Hydrogen Technologies)
www.zsw-bw.de

ISFH Institut für Solarenergieforschung GmbH
www.isfh.de

European Photovoltaic Industry Association (EPIA)
www.epia.org

Solar thermal energy

ForschungsVerbund Sonnenenergie (FVS)
www.FV-Sonnenenergie.de

Bundesverband Solarwirtschaft (BSW) (German Solar Industry Association)
http://waerme-von-der-sonne.de

Initiative Solarwärme Plus
www.solarwaerme-plus.info

DLR/PSA Deutsches Institut für Luft- und Raumfahrt (German Aerospace Centre – Cologne)
www.dlr.de

European Solar Thermal Industry Federation (ESTIF)
www.estif.org

Forschungszentrum Jülich GmbH (FZJ)
www.fz-juelich.de

Fraunhofer IBP Fraunhofer-Institut für Bauphysik (Fraunhofer Institute for Building Physics)
www.ibp.fraunhofer.de

Fraunhofer-Institut für Solare Energiesysteme (Fraunhofer ISE) (Fraunhofer Institute for Solar Energy Systems)
www.ise.fraunhofer.de

GFZ GeoForschungsZentrum Potsdam (German Research Centre for Geosciences Potsdam)
www.gfz-potsdam.de

Helmholtz-Zentrum Berlin für Materialien und Energie (Helmholtz Centre Berlin for Materials and Energy)
www.hmi.de

ISFH Institut für Solarenergieforschung GmbH (Institute for Solar Energy Research)
www.isfh.de

Institut für solare Energieversorgungstechnik (ISET)
www.iset.uni-kassel.de

**ZAE Bayerisches Zentrum für Angewandte
Energieforschung e.V. (Bavarian Centre of Applied
Energy Research)**

www.zae-bayern.de

**Zentrum für Sonnenenergie und Wasserstoff
(ZSW) (Research Centre for Solar Energy and
Hydrogen Technologies)**

www.zsw-bw.de

Renewables in general

Federal Ministry of Economics and Technology

[www.bmwi.de/BMWi/Navigation/Energie/
erneuerbare-energien.html](http://www.bmwi.de/BMWi/Navigation/Energie/erneuerbare-energien.html)

**Federal Ministry for the Environment, Nature
Conservation and Nuclear Safety**

www.bmu.de/erneuerbare-energien
www.erneuerbare-energien.de

**Deutsche Energie-Agentur GmbH (dena) (German
Energy Agency)**

www.dena.de
www.thema-energie.de

**Kreditanstalt für Wiederaufbau (KfW) (KfW
banking group)**

[www.kfw-foerderbank.de/DE_Home/Umweltschutz/
Erneuerbar17/index.jsp](http://www.kfw-foerderbank.de/DE_Home/Umweltschutz/Erneuerbar17/index.jsp)

**Bundesverband Erneuerbare Energien (BEE)
(German Renewable Energy Federation)**

www.bee-ev.de

European Renewable Energy Council

www.erec-renewables.org

**European Renewable Energy Centres Agency
(EUREC Agency)**

www.eurec.be

European Forum for Renewable Energy Sources

www.eufores.org

**Bundesagentur für Außenwirtschaft, (German
Office for Foreign Trade), Service Unit of the
Federal Ministry of Economics and Technology**

www.bfai.de

Invest in Germany

www.invest-in-germany.com

**Deutscher Industrie- und Handelskammertag
(Association of German Chambers of Industry and
Commerce)**


www.dihk.de

**Exportinitiative Erneuerbare Energie (Export
Initiative Renewable Energy)**

www.german-renewable-energy.com

**Exportinitiative Energieeffizienz (Export Initiative
Energy Efficiency)**

www.efficiency-from-germany.info



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