
renewable
energy
matters

Renewable
Energies
Agency

The full picture of renewable energy matters

Facts & figures on the most important future energy sources

At first glance, many reservations regarding renewable energy sources appear plausible. Yet they often conceal a completely different picture.
With facts and figures about the most important energy sources, this brochure broadens the perspective to give the full picture.

At first glance: „We can‘t afford renewable energy.“

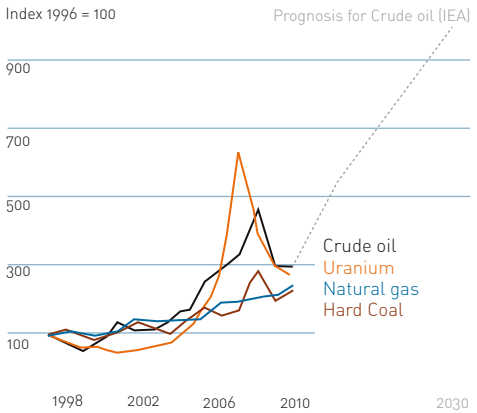
The sun, wind and water don't send bills. Nevertheless, the changeover to renewable energy is no walk-over. We must invest in renewable energy today to ensure we have a secure and affordable energy supply in future.
The cost of building renewable energy systems is still relatively high. However, massive cost cuts were achieved since the 1990s when wind turbines and photovoltaic systems went into series production. On average, the generation costs of one renewable kilowatt-hour have halved. The systems have become more efficient and at the same time have become cheaper due to mass production. Start-up financing for renewable energy therefore pays while coal, oil, natural gas and uranium are becoming more expensive.

Renewable energy - a cost cutter
By feeding electricity produced by wind turbines into the electricity grid, demand for conventional electricity reduces at certain times. This is why a fewer number of expensive coal and natural gas power stations have to be used. The trade price for a kilowatt-hour of electricity then drops on the European Electricity Exchange. Around 3.8 bln euro costs were avoided in this way in 2008. But renewable energy also avoids those costs which aren't even shown on the bill for fossil energy sources: Their mining, drilling and combustion are responsible for climate change and health damage, for landscape destruction and the loss of biodiversity. The general public pays for these costs through taxes and health costs. Renewable energies avoided at least 8 bln euro of these external costs in Germany in 2008.

Fossil energies: Finite and in short supply
The oil price climbed from 30 US$ per barrel (2003) to 145 US$ in July 2008. Currently its price stands at 80 US$. The International Energy Agency (IEA) expects an oil price of more than 200 US$ in the near future. The IEA also considers the current price a short-term low. The prices for coal, uranium and gas have more than doubled in the past 25 years. Three quarters of the energy used in Germany is imported. The best insurance against future price rises is therefore faster and broader development of homegrown renewable energy. In 2009, electricity, heat and fuels from renewable energy already saved imports of fossil energy sources worth 5.1 bln euro. Every one of us can be energy independent. Those who heated their houses with wood, solar or geothermal energy in 2009 saved an average 550 euro of energy costs per year.

Without renewable energy our energy supply would already cost us far more than it does.

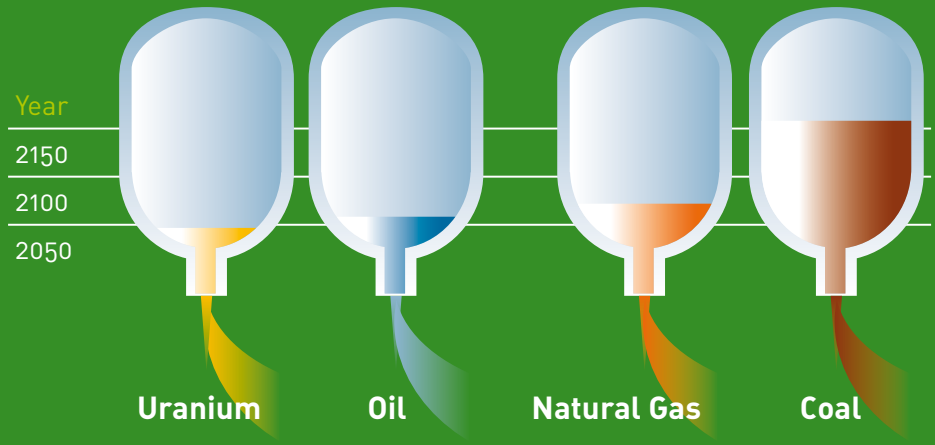
Fossil energy sources are finite—their prices are rising.
(Index 1996 = 100)



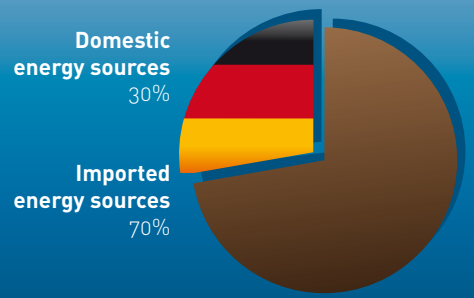
Sources: BMU, BAFA, Cameco

We cannot afford to do without renewable energy.

The reserves of most fossil energy sources will only last for a few more decades.



Germany is highly dependent on the import of fossil energy sources.

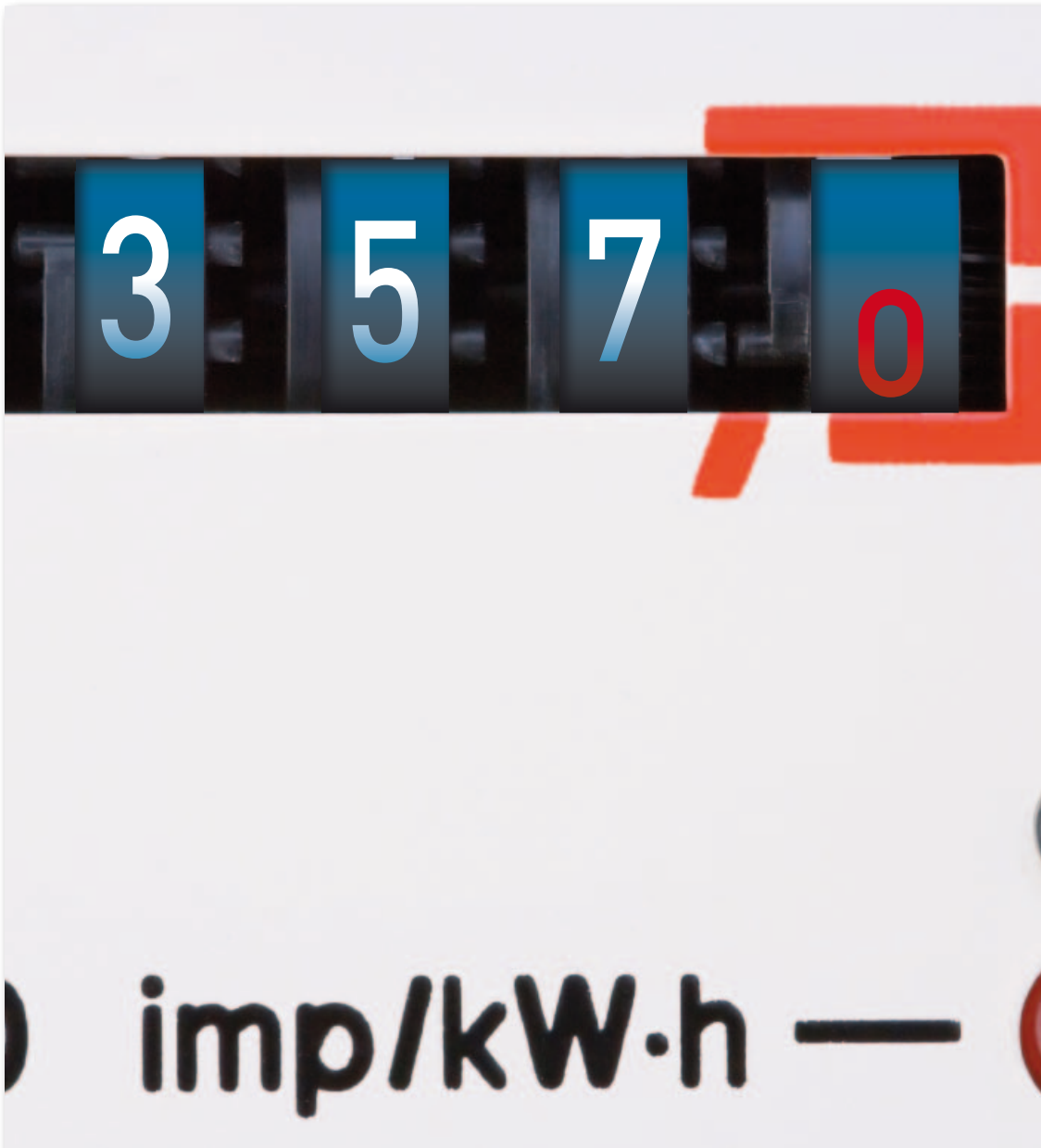


Germany's energy supply is still primarily based on finite fossil energy sources.

Sources: BMWi, BMU, 2010

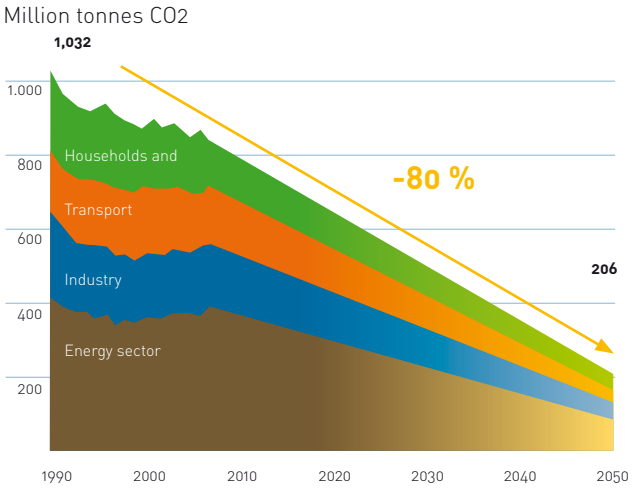
At first glance:

„Renewable energy eats up more energy than it provides.“



Renewable energy systems are made with a relatively small amount of materials and energy.
After a short running time a wind turbine has already recovered the energy required for its production, transport, erection and dismantling as well as its disposal. This period is called the „energy payback period" (amortization period).
After that, each operating hour supplies „net" clean electricity—for at least 20 years with all renewable energy sources. A wind turbine can therefore provide 70 times more energy during its life than was expended for its manufacture. This renewable quantity of electricity replaces fossil electricity from coal and gas-fired power stations and therefore avoids their CO2 emissions.
Both the climate and the energy balance are clearly positive—unlike those of fossil fuel fired power stations. These always require an external energy supply in the form of coal, natural gas or uranium in order to convert them into electricity or heat, frequently with very poor efficiencies. Thereby greenhouse gases harmful to the climate are released.

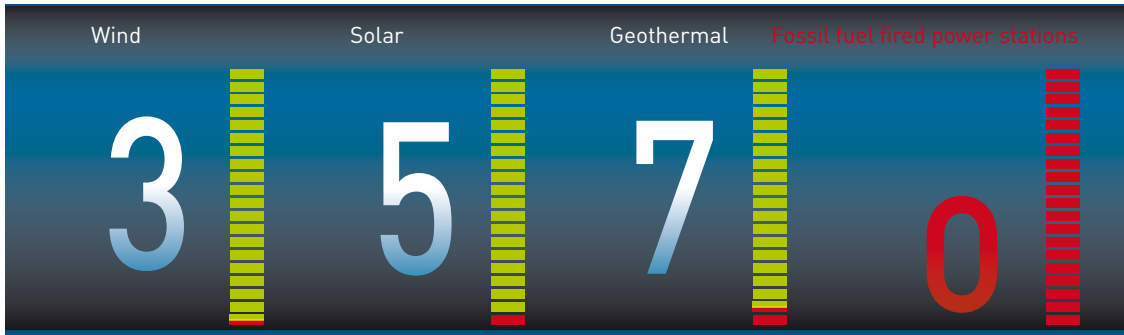
Target set by the German Government: 80% CO2 reduction until 2050



Source: Deutsche Umwelthilfe 12/2009

Newly planned coal-fired power stations will continue to harm the climate. They increase the efficiency of the conversion of coal into electricity, but they are designed for a life of at least 40 years, during which they will emit large quantities of CO2. In 2009 approximately 107 mln tonnes of CO2 were avoided through renewable energies; in 2020 it will be 287 mln tonnes.
If global warming of the earth is supposed to be reduced by 2 degrees Celsius, emissions need to be reduced by 80% until 2050. Renewable Energies will play a major part in achieving this goal.

The plants quickly supply more energy than was required for their manufacture.



Months	Months	Months	Never

Energy payback period

Wind turbines have achieved energy payback after 3 to 12 months.
During 20 years' operation they produce 70 times as much energy as was invested in them.

After 5 to 15 months a solar heating system has achieved energy payback. Photovoltaic systems are currently still more energy intensive during production. But in 20 operating years they produce at least 5 to 10 times the net invested energy.

A geothermal power station needs 7 to 10 months before it has generated as much energy as needed for its construction. Hydroelectric power stations do not need much longer.

Conventional fossil fuel-fired power stations need a permanent new supply of fuels and can therefore never achieve energy payback.

Sources: IfEU/DLR, industry data

At first glance:

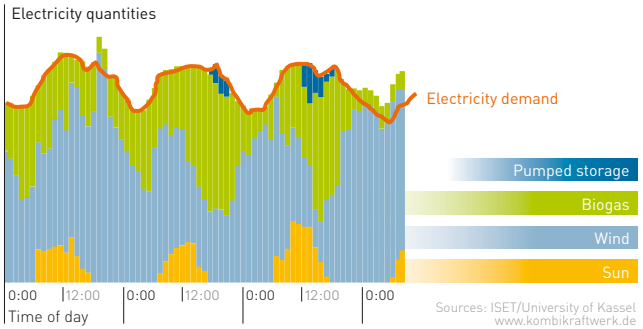
„Wind and sun are not always available.“

Anyone opting for renewable energy does not have to worry about power failures. The feed-in of electricity produced from wind is predictable. Thanks to meteorological forecasts, the network operators can very precisely calculate the quantity of electricity as well as the time and location of when it is fed in.
If, e.g. East Friesland is windless, this power drop is balanced out regionally, nationally and Europe-wide via the existing electricity network. On the other hand, regional surpluses of electricity produced from wind are taken up by the electricity network and forwarded.

Renewables as reliable team players
Decentralised and widely scattered renewable energy facilities can support and complement each other. If there is no wind or sun available, e.g. hydroelectric or biogas plants, wood-fired or geothermal power stations can reliably stand in and help out around the clock. This interaction requires no "shadow power stations" at all to stand in if there is a lull in the wind. Between 2000 and 2009, 20,000 Megawatt new wind energy output was erected in Germany alone. If the „shadow power stations" assertion were true, this development in capacity would have had to have been accompanied by a corresponding development of „shadow" power station capacities. In fact, 12,000 Megawatt output from nuclear and coal-fired power stations was shut down during this time. However, renewable energy's increasing share of electricity consumption does require limited development of the electricity networks in order to enable renewable electricity to be better distributed, e.g. through the interaction of North German wind energy and Scandinavian water power. Electricity supply and demand can and must achieve a sensible connection in the future. Even today, time-controlled electricity consumption makes sense for bulk users such as refrigerated warehouses. They can use the electricity supply peaks and relieve the network. Thanks to intelligent electricity meters, end users could use their household appliances with particularly favourable tariffs during surplus supply of electricity from wind power.

The Combined Power Plant
One project of the renewable energy industry shows how a demand-oriented power supply is possible at any time with 100 % renewable energy: The Combined Power Plant links and controls wind, solar, biomass and hydroelectric power plants distributed all over Germany. Wind turbines and solar modules make their contribution to the electricity generation precisely as predicted. They are supplemented if necessary by biogas plants and a pumped storage power station. In future, this modular structure can be extended to include additional storage technologies such as the batteries of electric cars.

At any time and in any weather, reliable supply with renewable energies: The combined power plant



But always somewhere.

At first glance:

„Renewable energy alone leaves us in the dark.“

Are renewable energy sources really sufficient to completely supply a highly industrialised country such as Germany? Question in response: Can coal, natural gas, oil and uranium still guarantee our energy supply in 30 or 40 years? Can fossil energy sources alone secure the energy requirements of the growing world population?

The inexhaustible, natural potential of renewable energy cannot be „used up". It only has to be used correctly. Whether wind, solar energy, water power, bioenergy or geothermal energy: The supply available exceeds current world energy consumption many times over. Full supply through renewable energy sources can be achieved through sensible combination of their diverse potential:

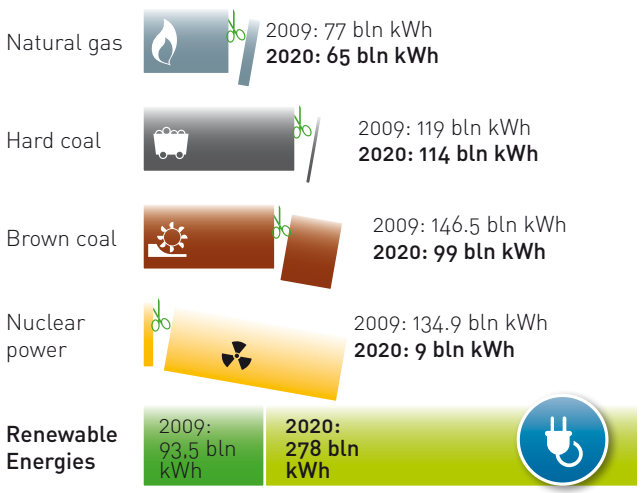
- According to a pilot study of the German Federal Ministry for the Environment solar heating can cover at least an eighth of the German heat requirements.
- If photovoltaic systems were installed on 10 % of all roof and facade surfaces as well as the sealed municipal areas in Germany, the whole current German electricity consumption could be completely covered with solar energy.
- Biomass from domestic energy crops, from wood or from residual materials (e.g. slurry and biowaste) can cover one quarter of the total German energy requirement by 2025. This would utilise one quarter of the agricultural area at the most.
- Doubling the installed output of wind turbines on land and new offshore turbines equates to a quarter of the German electricity consumption.
- The long-term realisable potential of geothermal energy in Germany is sufficient to cover half of electricity consumption and heat requirements.
- Electricity generated from water power can be increased by at least one quarter in the long term.

100 % renewable energy is possible

Complete changeover to renewable energy is technically feasible—without a gap in supply. Numerous solar housing estates, bioenergy villages, many municipal works, 100% regions (and the dynamics in Germany, Spain and Denmark) are demonstrating how to do this. Faster development of renewable energy is gradually replacing old coal-fired and atomic power stations.

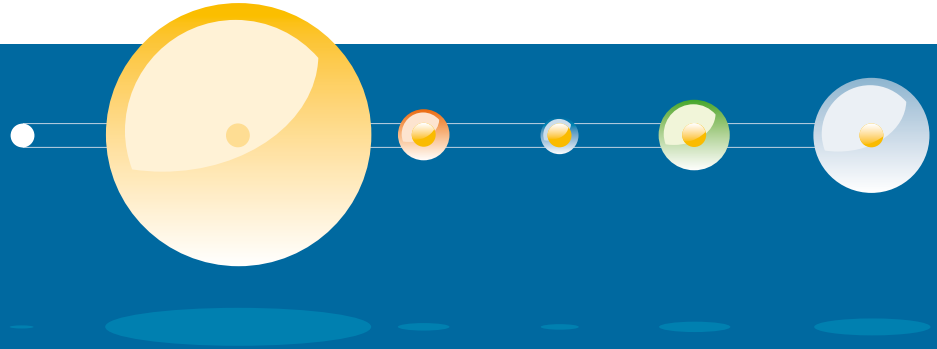
Savings through energy efficiency are making old power stations even more quickly dispensable and new build power stations unnecessary. According to an industry forecast, power generation from renewable energies will be tripled by 2020 to 278 bln kWh. Even under conservative estimates, renewable energies will cover 47 % of total energy consumption.

Renewable energies replace electricity generated by natural gas, coal and uranium



Source: Industry forecast 2020, 1/2009

Sunlight alone supplies 2,850 times the worldwide energy requirements.



Annual world energy consumption	Solar energy: 2850-fold	Geothermal energy: 5-fold	Hydro power: 3-fold	Bioenergy: 20-fold	Wind energy: 200-fold

The annual world energy consumption is theoretically covered 2,850-fold by the natural supply of solar energy—200-fold alone by wind energy supply.

This potential can also be used in Germany. Only the solar radiation, which reaches Germany, contains around 80 times our energy consumption.

Sources: FVS, DLR

At first glance:

„Solar energy is only worthwhile in Africa.“

Around 10 square metres of solar collectors is sufficient to cover a quarter of the heat requirements of an average detached house in our part of the world. A photovoltaic system with the same size supplies one quarter of the electricity requirement. The path from the heat or electricity generation to the consumer is extremely short. Photovoltaics can be flexibly integrated in buildings, in consumer goods and in vehicles. Energy supply could not be any easier or more decentralised than that.

A 10 m² photovoltaic system generates approximately 900 kilowatt-hours electricity per year.
This corresponds to ca. 25% of the annual electricity consumption of an average household

10 m² solar collectors generate approximately 4,500 kilowatt-hours heat per year.
This corresponds to ca. 20 % of the annual heat requirements of an average household

Theoretically, the world's energy requirements could be completely covered by solar energy over an area of 700 times 700 kilometres in the Sahara. The challenge lies in utilising this potential technically and economically. Solar power stations in the Sahara would first have to bridge the very wide distance to the electricity consumers— a challenge unsolved to date. Initial experience with solar thermal power stations in California and Southern Spain is very promising. They already provide electricity generated by the sun regionally at competitive prices. By using heat accumulators this electricity is available with the same output around the clock.

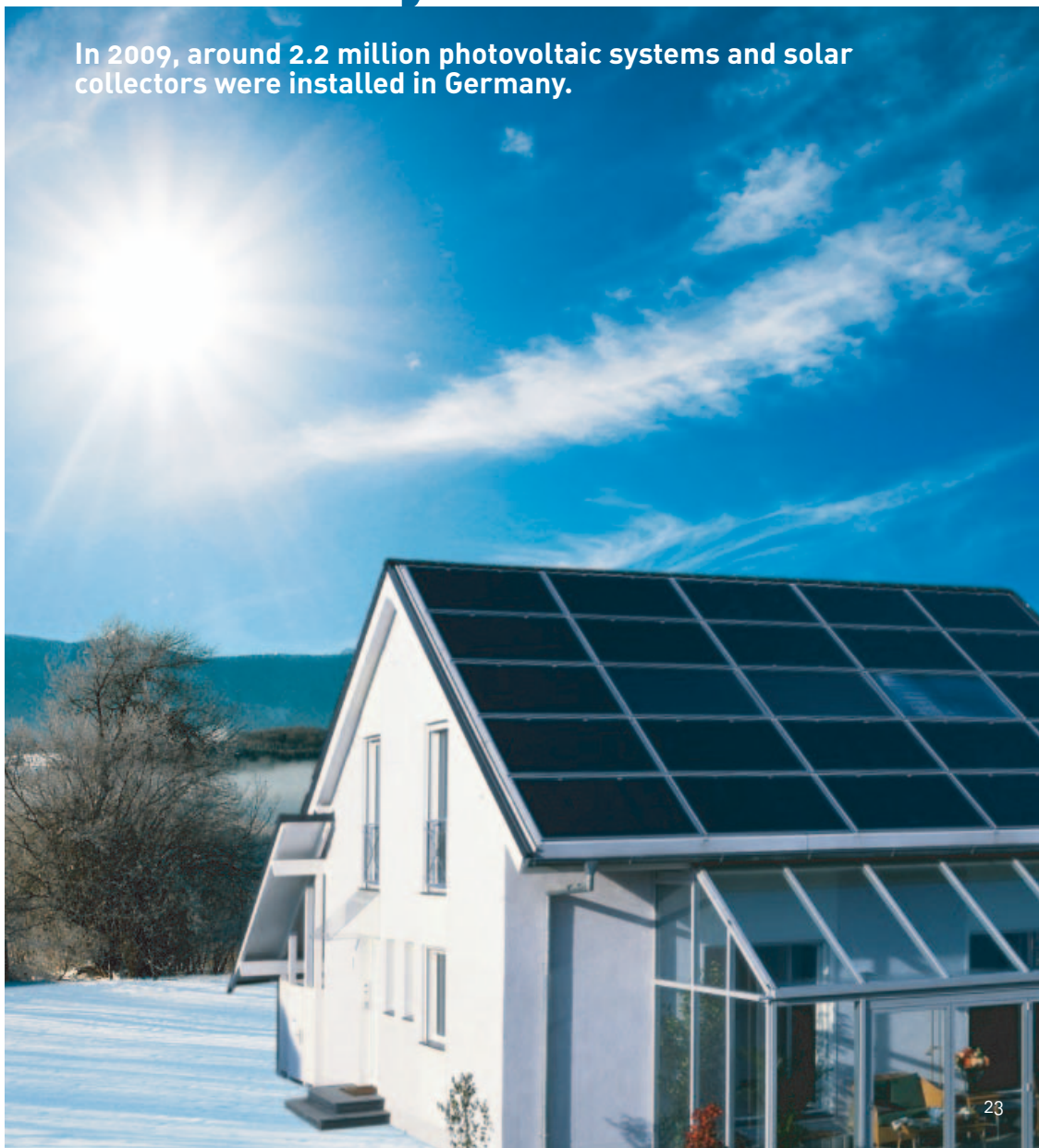
Advantages due to consumer proximity

But why roam so far afield: Just because theoretically up to 50 % more solar energy could be collected in the desert it does not make the solar harvest in Central Europe bad. On the contrary: Its advantages act best for the user in-situ. With solar panels the energy consumer becomes a producer who makes a direct contribution to the energy transition. Electricity and heat generated from solar energy make us independent of imports of fossil energy sources. Once the system has been installed the running costs cannot subsequently rise. In the medium term, the price of electricity produced from solar energy on a house's own roof will be less than the end user prices for electricity from the socket. Here a photovoltaic system directly protects against rising electricity prices.

Due to know-how and economic power, the conditions for fast, mass market launch of cost-effective electricity generated from solar power are far better in industrialised countries than in Africa. In developing countries, electricity generated from solar energy is nevertheless the best way to decentralised electricity supply as the basis of social and economic development.

Solar systems pay off on almost every roof in Germany.

In 2009, around 2.2 million photovoltaic systems and solar collectors were installed in Germany.



At first glance:

„Subsidised electricity generated from solar energy makes our electricity bill rise.“

The costs for electricity from photovoltaic systems have fallen over the past 15 years. While a kilowatt-hour of electricity generated from solar energy still cost around 2 DM in 1995, today this is produced for 25 cent by new systems in solar parks.

Series production, a considerable increase in the number of suppliers and consumers as well as leaps in technological development have made photovoltaics affordable. But this would not have happened without any start-up support at all. In the 1990s, progressive municipal utilities and local authorities enabled initial cost-effective, break-even operation of photovoltaic systems by paying a fixed tariff for each kilowatt-hour of electricity which was fed into the network. The Renewable Energy Sources Act (EEG) adopted this principle at federal level. It grants a fixed tariff for a period of 20 years. The feed-in tariffs reduce every year so that manufacturers of photovoltaic systems constantly have to offer more cost-effective and efficient technology if they want to continue to find buyers. This innovation pressure has already paid off.

Photovoltaics are quickly becoming competitive

From around 2015, the costs will have fallen so much that one kilowatt-hour of electricity generated from solar energy will cost less than the electricity price for the conventional kilowatt-hour from the socket. Anyone who harvests electricity themselves from their own roof thus creates the best insurance against further price rises and the shortage of fossil resources. Until this time support will continue to be necessary—and justified:

- The allocation spreads the additional costs (approximately 2.4 bln euro in 2009) between all electricity consumers. An average household with a monthly electricity bill of 67.50 euro pays only around 1,78 euro per month for the photovoltaic contribution of the EEG (end consumer electricity price 23.1 ct/ kWh, 3,500 kWh annual consumption). Anyone who uses electricity more economically pays less.
- Electricity generated from solar energy is an economic gain: By 2030 it will save around 28 billion euro in fuel costs and avoid climate and environmental damage with a value of over 16 billion euro.
- The allocation principle benefits domestic manufacturers and tradesmen. This promotes local added value.
- Over 64,600 jobs have been created in the photovoltaic industry. This is forecast to rise to 100,000 jobs by 2020.

Falling feed-in tariffs have proven to be a cost-effective instrument for well-directed market introduction. The subsidy accusation has long since been invalidated: The European Court of Justice dismissed cases lodged against the EEG by several electricity suppliers. More than 40 countries have now adopted the German model of feed-in tariffs.

A household invests only 1.78 € per month in electricity generated from solar energy.

* The amount of EEG allocation results from the difference in total remuneration volume for EEG electricity and the total costs for the same quantity of conventional electricity at a price of 6.9 ct/kWh.

** KWK = CHP: Combined heat and power (cogeneration)

Sources: BMU, BDW
Dated: 7/2010

of which:
Taxes and charges

Electricity tax:	5.83 euro
VAT:	10.79 euro
Concession charge:	5.25 euro
	21.88 euro

of which:
Electricity generation

Electricity wholesale trade:	20.13 euro
EEG contribution solar*:	1.78 euro
EEG contribution other*:	1.72 euro
KWK** contribution:	0.71 euro
	24.34 euro

of which:
Sale and distribution

Network usage:	17.21 euro
Sales:	2.04 euro
Measuring costs:	2.04 euro
	21.29 euro

At first glance:

„Wind turbines are a blot on the landscape.“

Whether wind turbines are attractive or not is debatable. But windmills are nothing new in the landscape developed and cultivated by man. In 1900, around 30,000 windmills still stood in Northwest Germany. Today around 21,000 wind turbines produce electricity for more than 11 mln households. Their impact on nature and the environment is comparatively small.

At a distance of 250 metres the audible noises of a wind farm are comparable with those of a quiet conversation. At a distance of more than 500 metres the wind itself is louder than the wind turbines. A turbine must comply with this minimum distance from housing developments anyway. The space required is limited to a few square metres for the foundation and access paths. The risk of birds colliding with wind turbines has in the past been exaggerated in the opinion of the German League for Nature and Environment (DNR). Most species fly above the rotors during migration and otherwise fly below. Risks to birds of prey and bats can be prevented by careful site selection and partial shutdowns. In addition, careful site selection avoids disruption of humans and the environment. An approval procedure for wind energy always includes an assessment of the project from a nature conservation point of view. Larger wind farms must run through an environmental impact assessment. In addition, each person can express their objections, which must be dealt with within the scope of a consultation meeting, before an independent authority makes a decision after comprehensive checking and weighing up. The extensive approval procedures are correct and important - but they can also slow down the development of wind energy. Though, 69 % of all Germans are in favour of an increased development of wind energy—even and especially in their immediate vicinity.

Wind energy creates regional added value

The wind industry rejuvenates the economy in many structurally weak areas. It creates new jobs, increases purchasing power, contributes municipal trade taxes to local communities and strengthens farms which tap an additional income source with. Investments and energy expenditure no longer flow out of the area but instead are retained locally. Use for their „personal" abandoning of coal and nuclear power has brought people together in many places, from which numerously locally rooted public wind farms have evolved. Wind turbines are therefore a landmark of the ecological trailblazing role of a region. Recent studies show that tourists welcome wind turbines in their holiday resort and most do not feel disrupted by them. In many places wind turbines are already integrated in tourism concepts, e.g. as viewing towers—all a question of perspective.

Subsidies for lignite coal and coal mining in Germany

Subsidies for
Coal mining
1950 to 2007 **approx 160-180 bln euro**

Phasing out of coal mining
(aid and adaptation allowance under the Coal Funding Law)
2008 to 2018: **21.6 bln euro**

Mining damage, groundwater pumping, Opencast mining remediation
annually: **approx 0.5 bln euro**

In addition: Relocation of around 300,000 people to date and destruction of approximately 100 km² landscape

Sources: BMWi, MWME NRW, BEE.

Wind energy lets the landscape live.

Mining of fossil fuels destroys whole areas of land.

Opencast lignite coal mining in Garzweiler.

At first glance:

„Enough wind only blows on the coast. “

Wind is everywhere.

And the right turbine is available for every location.

Only a fraction of the natural wind energy potential is currently used in Germany. Especially inland locations, e.g. in low mountain range, have not yet been developed. Their yields are comparable with good coastal locations.

The idea that wind energy is only worthwhile by the sea is a misconception. Average wind speeds on the coast are slightly above those inland. Nevertheless, e.g. the wind turbines in the inland state Saxony Anhalt generated more electricity from wind energy (5.2 bln kilowatt hours in 2009) than in the coastal state of Schleswig-Holstein (4.6 bln kilowatt hours).
There are often only 30 metres difference between the low mountain range and the sea: Increasing the hub height of a wind turbine by this length is often enough to achieve the yield of a good coastal location at average locations inland. Every additional metre hub height produces one percent more yield, because in higher areas the wind is stronger and blows more regularly.

More electricity from wind energy with fewer turbines

The emerging mass market has been accompanied by the onset of a rapid increase in output: While in 1980 wind turbines with an output of 30 kilowatt were standard, today 2 to 3 Megawatt are offered as a standard. Turbines with up to 6 Megawatt are being launched on the market. At the same time the costs for electricity generated from wind energy fell by around 60 %. In 2009, around 21,000 turbines with 26,000 Megawatt output covered 6.5 % of German electricity consumption.

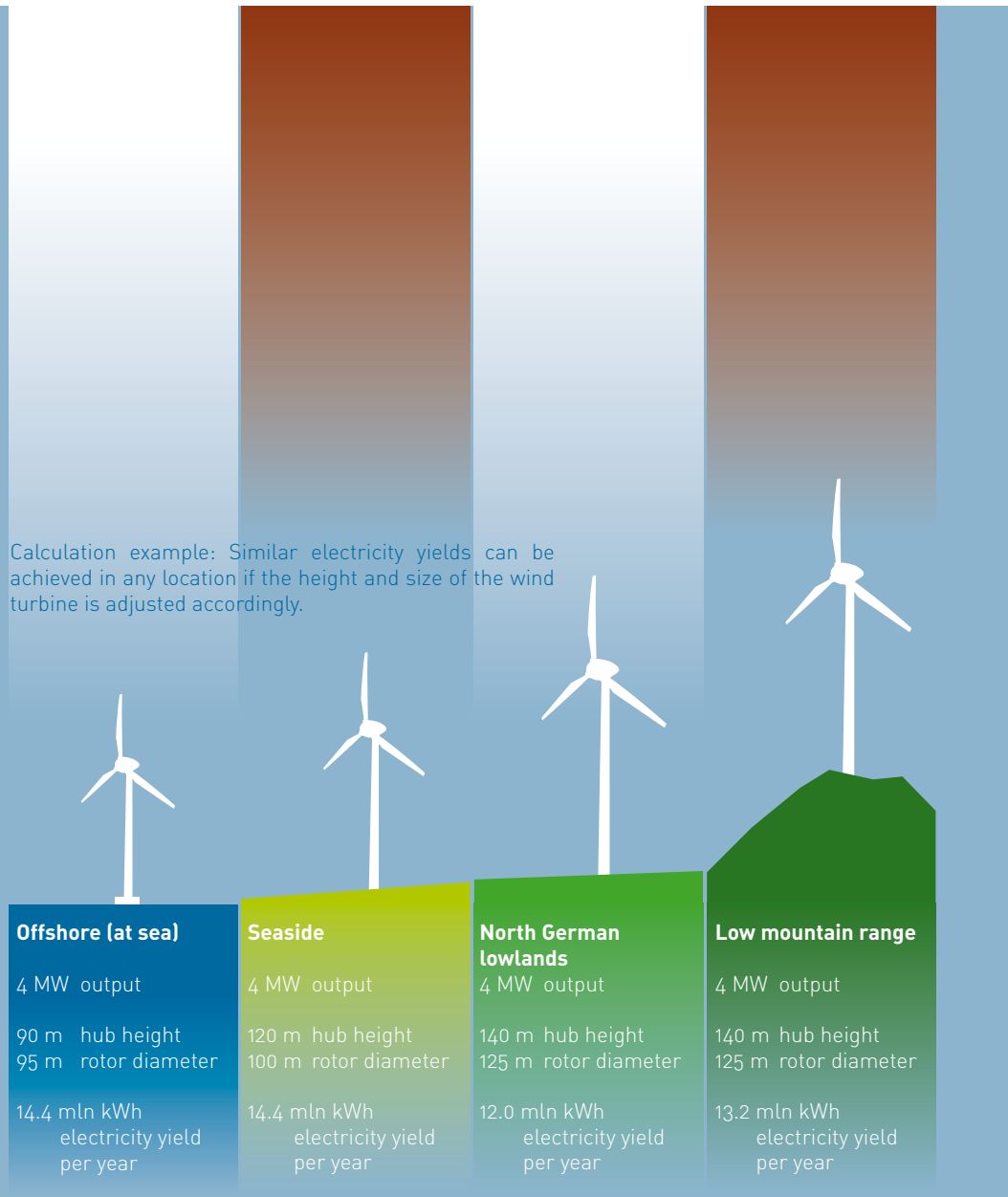
If only one percent of the area in Germany were to be allocated for harvesting wind energy, wind turbines with up to 60,000 Megawatt output could be built by 2030. With an average output of 4 Megawatt, only 15,000 turbines would be sufficient for this. The replacement of old wind turbines with new, more efficient turbines is called „repowering". It means that less but more powerful and more efficient wind turbines will generate more electricity.
The construction of wind turbines at sea, so-called „offshore wind farms", taps additional potential. It is forecast that by 2030, up to 25,000 Megawatt wind energy output will be generated there. Wind energy would then cover around 45 % of the German electricity consumption.

More electricity from wind energy with fewer turbines

2009
21,000 wind turbines on land
= 6.5 % of German electricity consumption

2030
15,000 wind turbines on land
+ 5,000 wind turbines at sea
= approx. 45 % of German electricity consumption

Calculation example: Similar electricity yields can be achieved in any location if the height and size of the wind turbine is adjusted accordingly.



At first glance:

„People in developing countries have to go hungry because of bioenergy.“

In the spring of 2008 world prices for agricultural products hit record highs. Biofuels were taking the blame. Despite the fact that the amount of cereals used for the production of biofuel increased again in 2008, global prices for cereals dropped below the level of the previous year. Several factors are responsible for this:

- Crop failures due to climate extremes in important growing countries
- Worldwide historically low stocks
- Increased demand for cereal as a feedstuff due to increasing meat consumption, especially in China and India

Due to the relatively low producer prices in recent years, land areas continue to lie fallow all over the world. There have also not yet been any new investments in increasing agricultural production—which is why there are now bottlenecks. Against this background, investors from outside the market with speculative intentions are increasingly pushing their way onto the markets. The price trend is becoming increasingly volatile and dissociated from the real relationship between supply and demand. After an initial record harvest (+7%) prices collapsed again in the summer of 2008 due to an oversupply of agricultural products.

On the currently tight world agricultural markets, the increasing demand for biofuels is also making a direct or indirect contribution to the shortage of food and feedstuff supply. In case of doubt priority must always be given to food production—food first!

Tank and plate are both possible

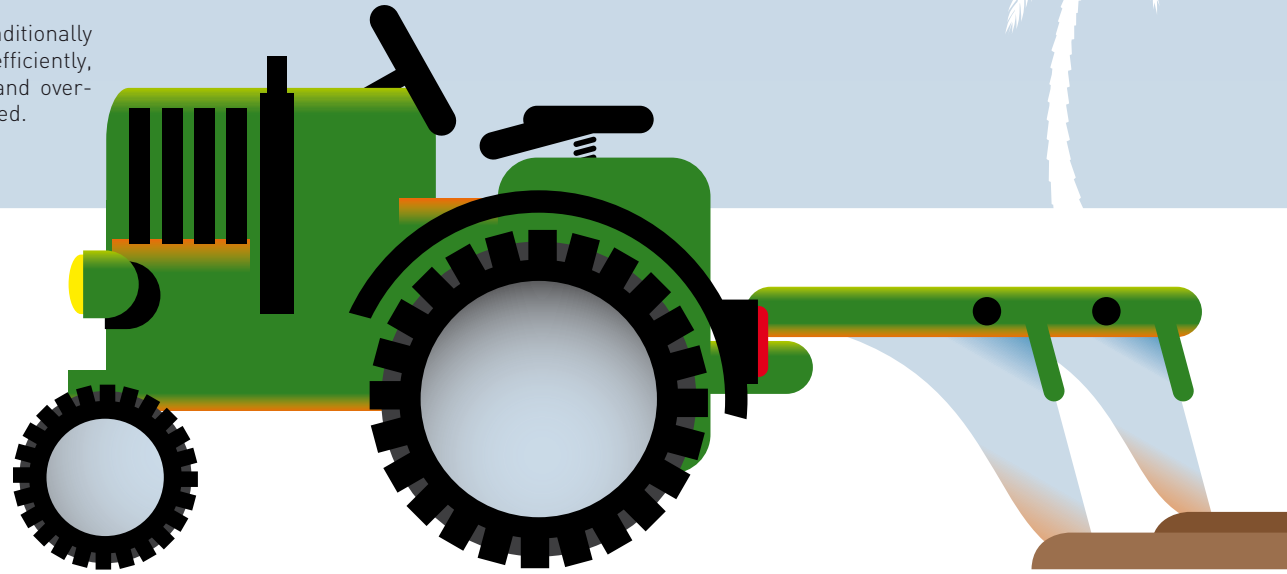
In 2009, only 7.5 % (136 mln tonnes) of the world grain harvest (1.8 bln tonnes, without rice) was used in the production of biofuels. In view of adequate land and biomass potential, there does not have to be any competition between food production and energy use of biomass. We do not have to decide between „tank or plate". We can have both—if existing potential is developed and sustainably used. Hunger on the other hand is above all a poverty problem. It has to do with fair distribution of wealth and does not mean that too little food has been produced.

Bioenergy as an opportunity

Many small farmers in developing countries have given up in the past due to the pressure of low world market prices and the lack of profitability and have migrated to the metropolises. Entry into sustainable use of bioenergy provides the opportunity to reverse the trend:

- The production of electricity, heat and fuels creates a second economic pillar for farmers.
- Dependence on expensive fossil energy sources is reduced.
- In developing countries, bioenergy offers the cost-effective decentralised energy supply which is indispensable for all other social and economic activities.
- In the poorest countries, which traditionally use biomass (e.g. dung, wood) inefficiently, the supply can be modernised and overexploitation of wood can be stopped.

Bioenergy is an economic development opportunity for developing countries



Bioenergy leads out of the oil trap and keeps foreign exchange in the country

Fossil fuel share of all imports

Source: WTO International Trade Statistics 2008

The high dependency of many emerging economies and developing countries on imports of fossil fuels together with the oil price rises since the 1970's was one of the decisive factors leading them into debt. The developing countries continue to have to pay the rising world market prices despite increasingly weaker purchasing power. The proportion of expenditure on the import of fossil energy sources in many developing countries therefore rose, in relation to their export income, to over 50 % to 75 %. That means, the low income achieved through the sale of local products on the world market are immediately eaten up again by their oil bill.

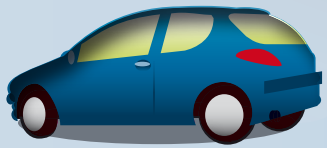
A rise in the crude oil price by 10 US$ per barrel and year leads to an average fall in gross national product of ...

3.0% in the developing countries of Sub-Saharan Africa
1.6% in the highly indebted developing countries
0.8% in the developing countries of South-East Asia
0.4% in the western industrial nations (OECD)

Source: IEA World Energy Outlook 2006

At first glance:

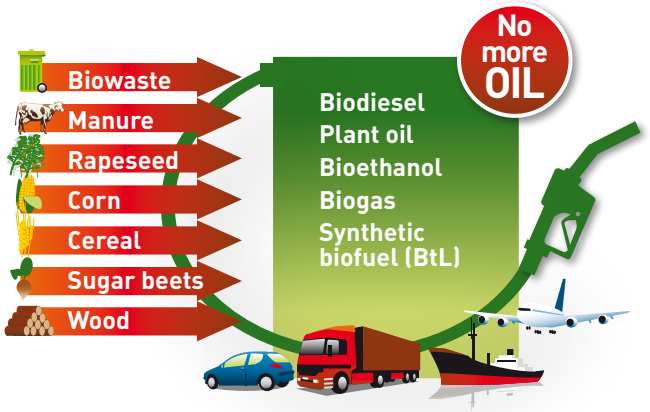
„Biofuel generates more CO2 than it saves.“



The amount of CO2 set free while burning biomass equals the amount of CO2 the plant absorbs while growing. Thus, renewable biomass absorbs the CO2 set free during the industrial process. It's a closed CO2 circuit.

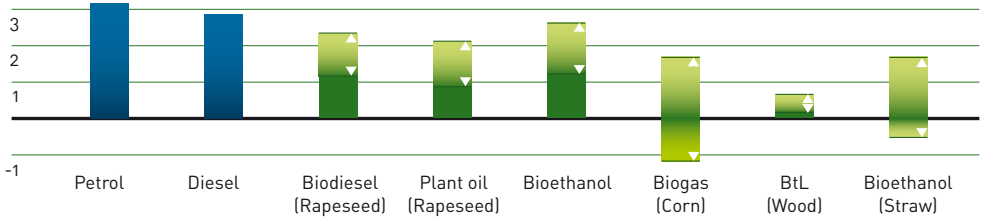
The climate balance of biofuel therefore depends on the amount of energy necessary to cultivate the plant (e.g. fertilization, harvest) and on how complicated transport and processing are (e.g. efficiency and biorefineries). In regard to the climate balance, closed and decentralized circuits are best, especially if home grown energy plants are used efficiently. New biofuel processing (BtL = biomass to liquid) can enhance the energy and climate balance even further.

Plant oil and rape groat will be extracted from rapeseed in the oil mill. In the biodiesel plant, biofuel will then be produced from the plant oil and can be used in cars, trucks, airplanes and ships. While renewable rapeseed absorbs the CO2 set free during the whole process, the by-product rape groat can be used as feedstock. On the other hand, biomass waste such as manure can be utilized again as energy in biogas plants. And biogas plant residues are used as fertilizers for the cultivation of rapeseed. However, external processing energy (e.g. bioenergy) is needed for the farming of rapeseed and for the operation of biodiesel plants.



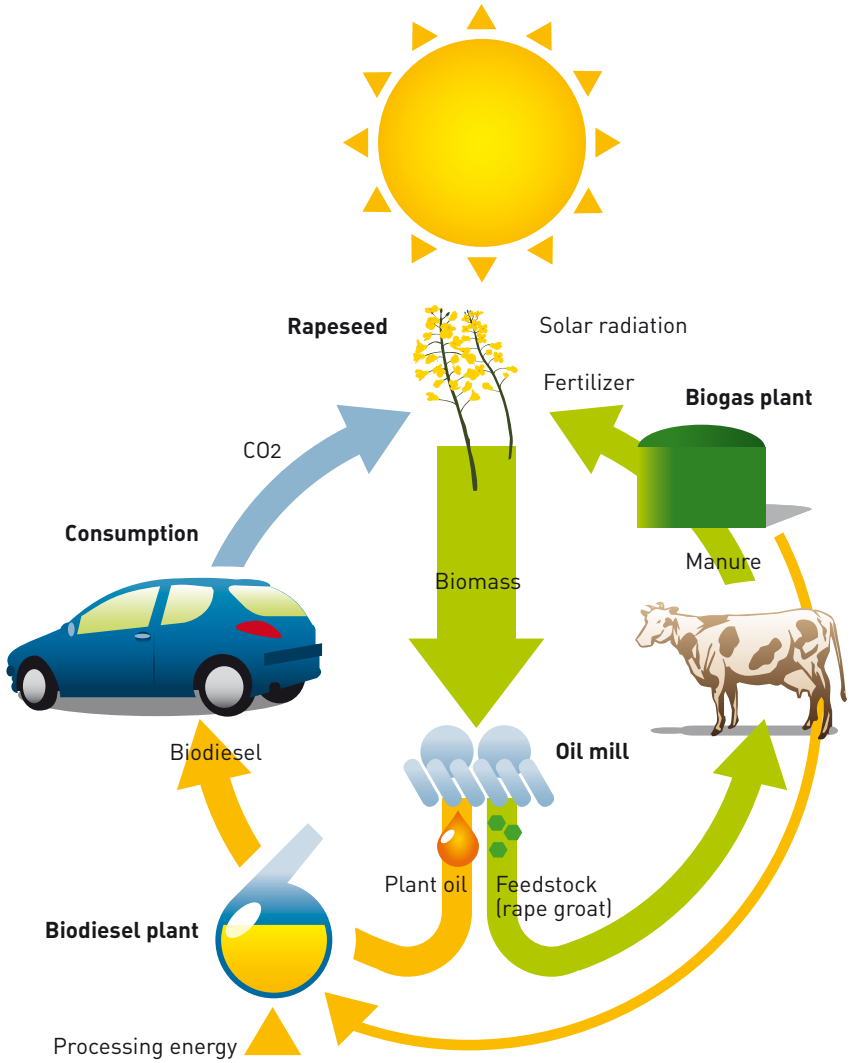
Climate balance of fossile fuels and biofuels

1 kilogramm CO2 = 1 liter fuel*



* inclusive of methane and nitrous oxide. The bandwidth of greenhouse gases depends on the use of side products of the biofuel production and on the cultivation of the energy plants. With today's engines, a car that drives on 100% biodiesel will be able to halve the EU-limit of 120g CO2 output by 66g CO2 output per kilometre (average output of new German-made cars in 2009 are 154g CO2 per kilometre). More economical engines and efficient cars will be able to reduce the CO2 output even further. Source: IE Leipzig, Institute of Applied Ecology, KBA

Biodiesel saves up to 66% CO2



The use of by-products and an efficient cultivation will ensure a better energy balance and can reduce the CO2 output of biofuels drastically. Its comparable with the circuit of biodiesel production.

Facts instead of prejudices

Germany has endless energy. The whole range of renewable energy sources are available to us—from sun, wind and water to biomass and geothermal energy. They cannot be used entirely, but are to be used intelligently. In view of shrinking fossil energy sources, today renewable energy offers reliable solutions for electricity, heat and mobility.

The diverse possibilities for utilising renewable energy sources are only just being developed in Germany. Nevertheless, their development is a worldwide unique success story which shows how protection against climate damage and expensive fuel imports is possible.

Renewable electricity

In 2009, renewable energy covered around 16 % of German electricity requirements. It therefore exceeded the political target of 12.5 %, planned by the European Union for 2010, three years ahead of schedule. Up until the mid-1990s, old hydroelectric power stations were virtually the only source of renewable electricity in Germany. Since then electricity generation from renewable energy has more than tripled. The Federal Government's development target is a 30 % share of electricity consumption in 2020. According to industry's estimates, renewable energy's share of electricity consumption is expected to be 47 % by 2020.

Renewable heat

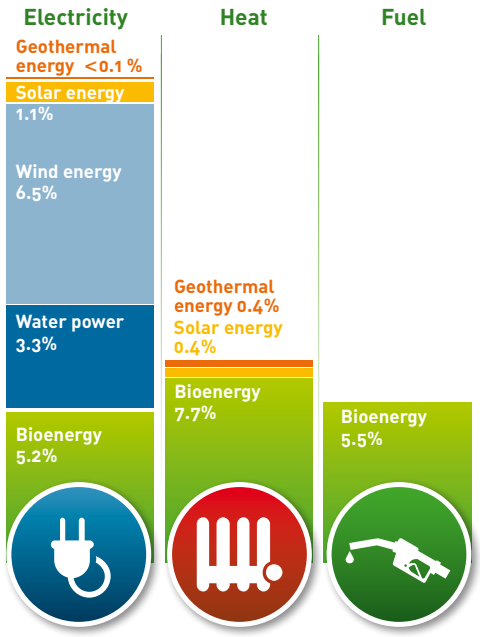
The heat requirement in Germany is also increasingly being covered by renewable energy (share in 2009: 8.4 %). To date, renewable heat comes mainly from bioenergy in the form of wood. Apart from heating with wood pellets, solar heating systems as well as geothermal heat pumps offer cost-effective heat sources. With rising heating oil and natural gas prices, increased utilisation is to be expected. The Federal Government's development target is a 14 % share of heat consumption in 2020. The pilot study of the Federal Ministry for the Environment considers an increase in share to 50 % to be possible by 2050.

Renewable mobility

People and goods can be moved on land, water and in the air with renewable energy. In less than ten years, renewable energy's share of fuel consumption has risen from zero to 5.5 % in 2009. To date this contribution has almost exclusively been supplied by biofuels, which can be used in the combustion engines of cars and trucks, railways, ships and airplanes.

In future, electric mobility will account for an increasing share: Electricity from renewable energy drives clean and efficient electric motors in cars and motorbikes, in buses and railways. By 2050, renewable energy's share in the traffic sector could rise to 50 % according to the pilot study of the Federal Ministry for the Environment.

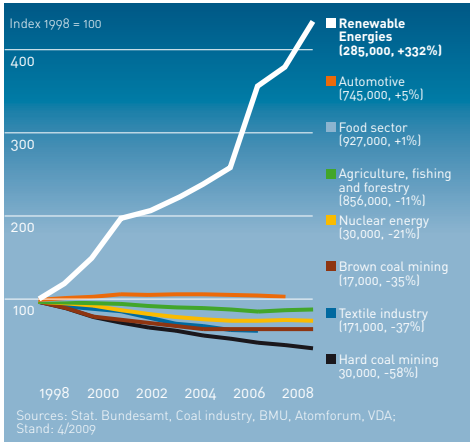
Renewable energy sources' share of electricity, heat and fuel consumption 2009



Renewable energy - an employment driver

Renewable energy creates employment. At the end of 2009, approximately 300,500 people in Germany were employed in planning and designing, installing and operating plant and systems. The number of jobs has quadrupled since 1999 and rose by 22,500 in 2009 alone. Due to the worldwide increasing demand for renewable energy, the industry expects to employ more than 500,000 people in Germany by 2020. Most will work directly for the export of plant and machinery to fulfil the increasing demand for German renewable energy technology abroad. The industry will benefit from the years of successful development on the domestic market, which has made it a worldwide technology leader. Around 60 % of the companies complain of too few or inadequately trained employees, according to a study by the Wissenschaftsladen (WiLa) Bonn.

Development of jobs in the renewable energy sector in comparison to other industries 1998-2008



Local advantage

Numerous local authorities and regions, especially in rural areas, are making the development of energy supply through domestic renewable energy the centre of their economic development. Everyone can participate in the decentralised development of renewable energy, e.g. with public wind farms or solar systems. In this way, local citizens, communities, farmers as well as small and medium-sized enterprises promote regional added value: Installation, maintenance and operation of renewable energy systems are mostly carried out by local businesses, e.g. tradesmen and technicians as well as agriculture and forestry. A stronger self-generated supply with renewable energy reduces dependency on fossil fuel imports and their rising prices. Local authorities and municipal utilities, as users of renewable energy, can effectively reduce costs, e.g. through solar heating systems for their swimming pools or through harvesting the energy of biowastes in biogas plants. Instead of paying energy bills to Russian natural gas corporations and Arabian oil sheikhs the energy expenditure then remains in the region. If local synergies are created and cycles closed, renewable energy is an important driver of economic development.

More information:
www.kommunal-erneuerbar.de

Facts & figures 2009/2010

Wind energy in Germany 2009

Installed total capacity:	25,777 MW
New installed capacity:	1,880 MW
Generated quantity of electricity:	37.8 bln kWh
Share of electricity consumption:	6.5 %
CO2 avoidance:	30.2 mln t
Jobs:	approx. 87,100

Hydroelectric power in Germany 2009

Installed total capacity:	4,760 MW
Generated quantity of electricity:	19 bln kWh
Share of electricity consumption:	3.3 %
CO2 avoidance:	16.9 mln t
Jobs:	approx. 9,000

Bioenergy in Germany 2009

Installed total capacity (electricity):	5,889 MW
Generated quantity of electricity (incl. biogenic waste):	30.5 bln kWh
Share of electricity consumption:	5.2 %
CO2 avoidance:	23.1 mln t
Generated quantity of heat:	100.8 bln kWh
Share of heat consumption:	7.7 %
CO2 avoidance:	28.2 mln t
Biofuel utilisation:	3.8 mln t
of which:	
Biodiesel	2.5 mln t
Vegetable oil	0.1 mln t
Bioethanol	0.9 mln t
Share of fuel consumption:	5.5 %
CO2 avoidance:	4.8 mln t
Jobs:	approx. 109,000

Solar energy in Germany 2009

Installed capacity (electricity):	9.800 MW
New installed capacity (electricity):	3,923 MW
Generated quantity of electricity:	6.2 bln kWh
Share of electricity consumption:	1.1 %
CO2 avoidance:	3.9 mln t
Installed total output (heat):	9,000 MW
New installed output (heat):	1,100 MW
Generated quantity of heat:	4.8 – 6* bln kWh
Share of heat consumption:	0.4 %
CO2 avoidance:	1.1 mln t
Jobs:	approx. 80,000

* Information from the German Solar Industry Association (BSW-Solar)

Geothermal energy in Germany 2009

Installed total capacity (heat):	approx 2,500 MW*
Generated quantity of heat:	5 bln kWh
Share of heat consumption:	0.4 %
Installed total capacity (electricity):	6.6-8 MW*
Generated quantity of electricity:	19 mln kWh
Share of electricity consumption:	< 0.1 %
Jobs:	9,300 - 12,000*

* Information from the German Geothermal Association (GtV)

Prospects

Planned investments 2005-2020: 235 bln euro

By comparison: announced investments of the conventional power suppliers in new power stations by 2020: around 40 bln euro

	2009	Forecast 2020
CO2 avoidance:	109 mln tonnes	250 mln tonnes
Jobs:	300,500	500,000
Energy import savings:	6.4 bln euro	20 bln euro
Export volume :	12 bln euro	80 bln euro

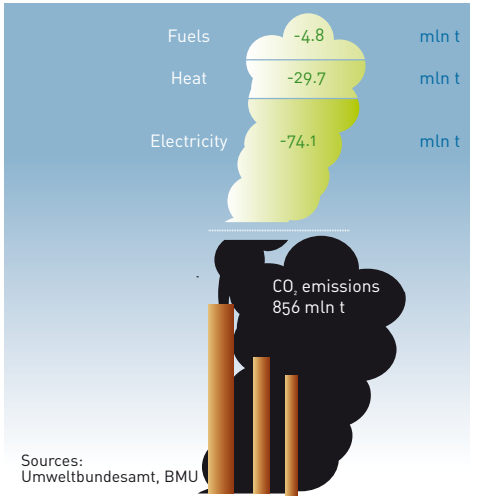
Sources: Industry data, BMU

Renewable energy sources are climate protectors

Use of renewable energy sources instead of oil, coal and natural gas is the most important way to achieve the reduction targets for greenhouse gases which are harmful for the climate. In 2009 alone, renewable energy sources avoided CO2 emissions totalling 109 mln tonnes. 55 mln tonnes CO2 saving alone was achieved as an effect of the Renewable Energy Sources Act (EEG), whose objective is to increase renewable energy's share of the electricity supply.

If the development potential in the electricity, heat and mobility sector continues to be tapped in a well-directed way and if by 2050 at least 50 % of the energy required in Germany is covered by renewable energy, around 448 mln tonnes CO2 emissions can be avoided annually. This already corresponds to around 45 % of the CO2 emissions currently caused by total energy production in Germany. If it is assumed that energy savings and efficiency measures will substantially cut energy requirements by 2050, the contribution made by renewable energy to CO2 avoidance will increase the electricity share of renewable energies.

109 mln tonnes CO2 avoided by renewable energy in Germany 2007



Sources:
Umweltbundesamt, BMU

Abbreviations

Atomforum - German Atomic Forum
BEE - German Renewable Energy Federation
BAFA - The Federal Office of Economics and Export Control
BMU - Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMWi - Federal Ministry of Economics and Technology
DLR - German Aerospace Centre
IFEU - Institute for Energy and Environmental Research
MWME NRW - Ministry for Economics, Medium-sized businesses and Energy of North Rhine-Westphalia
Deutsche Umwelthilfe - German Environmental Aid
Stat. Bundesamt - Federal Statistical Office
VDA - German Association of the Automotive Industry
Umweltbundesamt - Federal Environmental Agency

Imprint

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Fotos

p. 5	Stock Exchange sxc
p. 9	**Stock Expert**
p. 21	iStock photo
p. 23	BSW, Stock Exchange sxc Montage: BBGK
p. 25	Stock Exchange sxc, Montage BBGK
p. 29	iStock photo
p. 31	Wikimedia
p. 33	**Stock Exchange sxc**
p. 37	**Stock Exchange sxc**
p. 43	**Stock Exchange sxc (9); Stock Expert (1)**

The full picture of renewable energy matters

The Renewable Energies Agency (Agentur für Erneuerbare Energien) is funded by renewable energy companies and associations and supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry of Food, Agriculture and Consumer Protection.

Its task is to inform about the opportunities and advantages of a sustainable energy supply based on renewable energy - from climate protection to a secure energy supply through to jobs, economic development and innovations. The Agency for Renewable Energies works on a cross-party and cross-society basis.

Renewable Energies Agency

www.renewables-in-germany.com