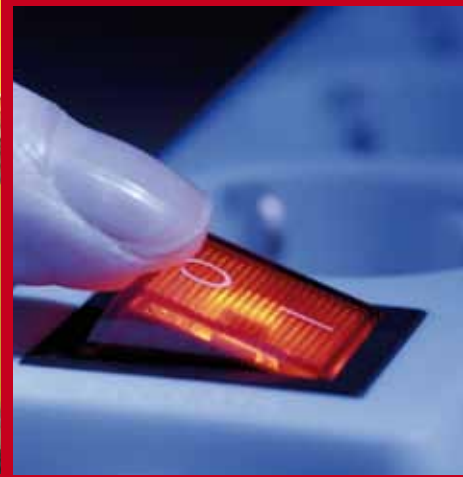




Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

NEW THINKING – NEW ENERGY



Energy Policy Road Map 2020

IMPRINT

IMPRINT

Published by: The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Public Relations Division · 11055 Berlin · Germany
E-Mail: service@bmu.bund.de · Internet: www.bmu.de/english

Editors: Maria Krassuski, Patrick Jochum, Julia Rufin, Hannes Ortmann and Patrick Graichen

Design: design_idee, büro_für_gestaltung, Erfurt
Printing: Silber Druck, Niestetal

Photos: Cover: Brigitte Hiss/BMU
Oberhäuser/BMU
blickwinkel/McPHOTO
Paul Langrock
p. 4: DigitalVision
p. 6: Michael Peuckert/ALIMDI.NET
p. 9: Jens Schicke
p. 13: Paul Langrock
p. 14: Thomas Imo/Photothek.net
p. 17: Uwe Schmid
p. 19: Brigitte Hiss/BMU
p. 20: Brigitte Hiss/BMU
p. 24: Jochen Zick/Keystone
p. 26: Fotex/Camerique
p. 29: A. Pastor/STOCK4B

Date: January 2009
Third Print: 3,000 copies

CONTENTS

I. FOREWORD	4
II. TEN PRINCIPLES FOR A SUSTAINABLE ENERGY SUPPLY	6
1. Ensure supply security	8
2. Boost the economy	10
3. Expand renewable energies	12
4. Phase out nuclear power	14
5. Use coal efficiently	16
6. Build power grids for the future	18
7. Consume electricity more efficiently	20
8. Reduce the fossil heat requirement	22
9. Cut traffic emissions	24
10. Act globally	26
III. BMU SCENARIO FOR A SUSTAINABLE ENERGY SUPPLY IN 2020	28

I. FOREWORD



Dear reader,

As our new century begins we face crucial challenges to humanity: the global appetite for energy is growing all the time, climate change is advancing in strides, and at present the financial crisis and its aftermath are drawing more and more people into their wake. Energy policy will play a pivotal role in how we overcome those challenges.

First of all, the world's growing population needs a lasting and adequate supply of energy and primary resources. The global population is set to expand from six-and-a-half billion today to nine billion in just 50 years. This means a huge increase in demand for finite resources, combined with the associated price rises and price fluctuations. We require an energy policy that responds to these developments and ensures that our energy supply is secure and viable in the long term.

Secondly, we need to provide everybody with enough energy to cater for their needs without destroying the climate and the environment. Burning fossil fuels is a major factor in climate change. Whether in the transport sector, in private households or in power generation, energy from coal and oil is the biggest cause of human-induced global warming. In other



words, effective climate protection is impossible without a sustainable energy policy.

Thirdly, the financial crisis proves that bubbles are only pretty until they burst. To restore the economy on enduring foundations, we need real, sustainable investments. Investing in climate protection is a sustainable programme for growth and in the light of the current economic situation it is indispensable.

The task of energy policy in the contemporary world is to combine environment and climate protection with growth, employment and energy security. The energy policy of the future, therefore, will be an integrated energy policy. The key components of this policy will be an unflagging expansion of renewable energies and a massive boost to energy efficiency.

With its Energy Policy Road Map 2020 the German Environment Ministry is demonstrating how an integrated energy policy can be designed and what such a policy can accomplish. The vision of the future it depicts is doubtless ambitious in some respects. But we can do it.

A handwritten signature in black ink that reads "Sigmar Gabriel". The signature is written in a cursive, slightly stylized font.

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

II. TEN PRINCIPLES FOR A SUSTAINABLE ENERGY SUPPLY

A highly developed economy such as Germany's needs a permanently secure supply of energy. That means always being able to guarantee adequate energy provision, but it also means that Germany must not become dependent on energy imports or high-risk technologies such as nuclear power.

Combating climate change calls for a drastic reduction in emissions of greenhouse gases which damage our climate. We therefore have no choice but to modernise our energy supply. At the same time, because the demand for energy is rising all the time – especially in newly industrialising countries – with all the consequences this entails for prices, energy policy has increasingly become a social issue, too.

With all this in mind, the German government has already set some key targets:

- ▶ By 2020 greenhouse gas emissions must fall to 40% below their 1990 levels. By the end of 2007 Germany had achieved -21.3%.
- ▶ Energy productivity must grow by 3% per annum. That means that in 2020 we must be twice as energy-efficient as we were in 1990.
- ▶ The proportion of renewable energies must steadily increase, specifically:
 - to 50% of primary energy consumption by 2050;
 - from about 9% of final energy consumption to day to 18% by 2020;
 - from about 15% of gross power consumption now to at least 30% by 2020;
 - from about 7% of today's thermal energy requirement to 14% by 2020.

The contribution made by biofuels is to increase by 2020 so as to permit a 7% reduction in greenhouse gas emissions compared to using fossil fuels.

- ▶ The contribution of Combined Heat & Power (CHP) to power generation is to double to 25% by 2020.

Achieving the targets calls for a transition in energy policy. Germany needs state-of-the-art, integrated energy policies. This will require ambitious action in every field of relevance to energy and climate protection, without losing sight of the whole picture.

The Energy Policy Road Map "New Thinking – New Energy" charts the route towards that goal. It illustrates what a sustainable energy supply in 2020 could look like and which measures are needed to achieve it.

With an ambitious strategy for enhancing energy efficiency and a committed expansion of renewable energies, Germany can achieve its climate protection targets, dramatically reduce its dependence on energy imports, and provide a powerful boost to the economy and employment. This does not require prolonging the operating life of nuclear power stations.



Where will we be in 2020? A Road Map for Climate, Energy and Growth

1. We will secure a lasting supply of energy.
2. We will cut our energy costs and create 500,000 new jobs.
3. We will derive over 30% of our electricity from renewable sources.
4. We will phase out nuclear power by 2022.
5. We will generate 40% of our electricity in highly efficient coal-fired power stations.
6. We will establish a nationwide grid operator and expand our power grid efficiently and in accordance with environmental standards.
7. We will reduce our electricity consumption by 11%.
8. We will reduce the fossil heat requirement by at least 25% and double combined heat & power generation to 25%.
9. We will reduce our transport emissions by at least 20%.
10. We will bring international talks on climate protection to a successful conclusion.

However, there is nothing automatic about the progress described in this brochure. It will require decisive political action.

► Electricity

Energy efficiency needs to improve much faster, especially on the demand side. Optimising the overall system of power generation from renewable and fossil energy sources must be driven ahead rapidly. Major factors here are the expansion of renewables and the use of combined heat & power.

► Heat

Renewable energies and combined heat & power will also play a growing role in generating heat. Moreover, total heating requirements can be reduced considerably by measures to enhance efficiency.

► Transport

In the field of transport there is a huge need for action to develop and use more efficient technolo-

gies. The use of sustainable biofuels can also make a significant contribution towards reducing greenhouse gases. An increasing proportion of traffic should be shifted from road to rail.

If we finally succeed in tapping the existing efficiency potential and expanding renewable energies further, we will not only have placed Germany's energy supply on a secure long-term basis, but also protect the climate effectively. The impact of this country's climate and energy policies is not confined to Germany. Close attention is being paid around the world to what Germany is doing to achieve its climate protection targets. Germany plays a pioneering role internationally which is worth preserving.

So where will Germany be in 2020? Of course we can only answer that question hypothetically today. However, the Energy Policy Road Map clearly demonstrates what can be accomplished by ambitious climate and energy policies: greater supply security, fewer harmful greenhouse gases and a strong economy well equipped for the future.

1. We will secure a lasting supply of energy.

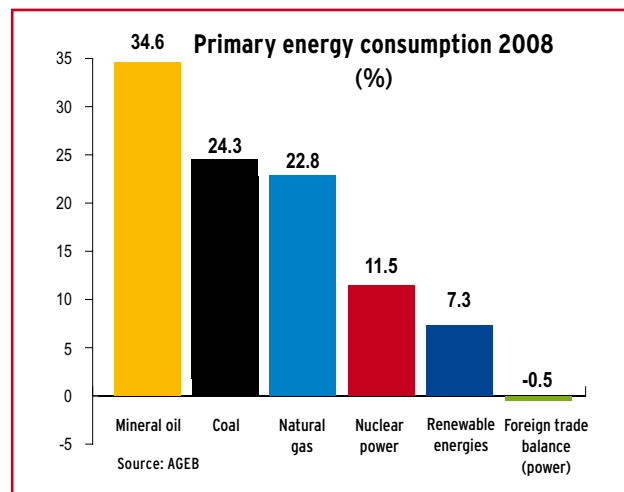
Where are we now?

Germany's energy supply is secure and it will remain secure. But in the next few years the energy mix we use in Germany will have to change in a number of ways. Focussing on fossil fuels, in particular, entails a multitude of problems:

- ▶ Global reserves of oil and gas are decreasing, whereas demand – especially from newly industrialising countries – is increasing all the time. The consequence of rising demand is a long-term rise in prices.
- ▶ Nearly 70% of the fossil energy sources used in Germany is imported. This high level of dependence on imports incurs serious risks, especially in the light of rising energy prices.
- ▶ The use of coal, oil and gas and the resulting CO₂ emissions are a major factor in climate change.

Clearly nuclear power is not the answer to these challenges, because nuclear power is and remains a high-risk technology. Besides, all the uranium fuel has to be imported.

To make sure that Germany's energy supply remains secure in 2020, there is no alternative to expanding renewable energies and increasing our energy efficiency. This dual strategy reduces our dependence on energy imports, protects the climate and makes our supply secure. The Monitoring Report on Energy Supply published by the Federal Ministry of Economics in 2008 demonstrates the long-term security of Germany's power supply despite the phasing out of nuclear power.



What have we done so far?

By adopting its Integrated Energy and Climate Programme in August 2007, the German government established a broad, effective framework for modernising and securing Germany's energy supply:

- ▶ The Renewable Energy Sources Act provides for the greater use of renewable sources – water, wind, sun, geothermal and biomass – in power generation.
- ▶ The Combined Heat & Power Act promotes the expansion of cogenerated power and heating and of heating networks. Household energy supply is flanked by a selective funding programme.
- ▶ The amended Energy Industry Act will help to link offshore wind farms to the grid.
- ▶ The Energy Saving Ordinance ensures that new and radically refurbished buildings have a very low energy requirement.

- ▶ The Renewable Energies Heat Act means that new buildings draw more energy from renewable sources.
- ▶ The Market Incentive Programme for Renewable Energies promotes the use of renewable energies in heating supply and introduces measures to improve efficiency in relation to renewable energies.
- ▶ Special rules on access to the gas network make it easier to feed biogas into the natural gas network.
- ▶ Introducing state-of-the-art metering technology is encouraging more flexible power supply.
- ▶ The substantial increase in resources for energy research will add extra momentum to the development of modern energy technologies.

What remains to be done?

The following measures will permit the long-term replacement of nuclear power and power from inefficient conventional power stations:

- ▶ Renewable energies are an essential component in the energy system of the future. The pace for the expansion of renewables must therefore be stepped up. To this end, supportive measures under the Renewable Energy Sources Act must be updated regularly to reflect the state of the art.
- ▶ A massive increase in energy efficiency will reduce the total electricity requirement in Germany. It is essential to tap the huge potential that already exists in this sphere. This will call for new rules, such as an Efficiency Standards Act.
- ▶ There is an urgent need to renew the power station fleet. This is the only way to ensure that enough power is available from highly efficient power stations and that ageing installations that harm the climate can be decommissioned.
- ▶ The grid must be expanded rapidly and grid operation optimised so that electricity can be transmitted across great distances from the future centres of generation in the north and east of Germany to the centres of consumption further south and west. High-voltage direct-current



transmission (HVDC) enables power to be transported over long distances with much smaller losses. Developing an appropriate network infrastructure at European level also creates the scope to offset peaks in generation and consumption.

- ▶ Several factors are necessary to ensure a need-oriented current flow: fossil-fuel power stations that can be operated more flexibly, an optimal combination of electricity generation from different renewable sources, energy storage systems and load management.

What will we have achieved in 2020?

The system has been optimised to guarantee a lasting, secure energy supply without damaging the climate. The government's climate targets have been reached: Germany has cut its greenhouse gas emissions by 40% compared with 1990.

Germany has drastically reduced its dependence on imports. Over 30% of power is now generated from domestic renewable energy sources. The proportion of renewables used for transport and heating has also been steadily increasing.

Parallel to this there has been a dramatic improvement in energy efficiency. Germany has doubled its energy productivity since 1990. The energy costs Germany has saved this way amount to several billion euros. This reduces the strain on both industry and private households.

The phase-out of nuclear power has almost been completed by 2020. Security of supply has not been undermined because expanding renewable energies and enhancing energy efficiency has compensated fully for phasing out nuclear power.

Vision 2030

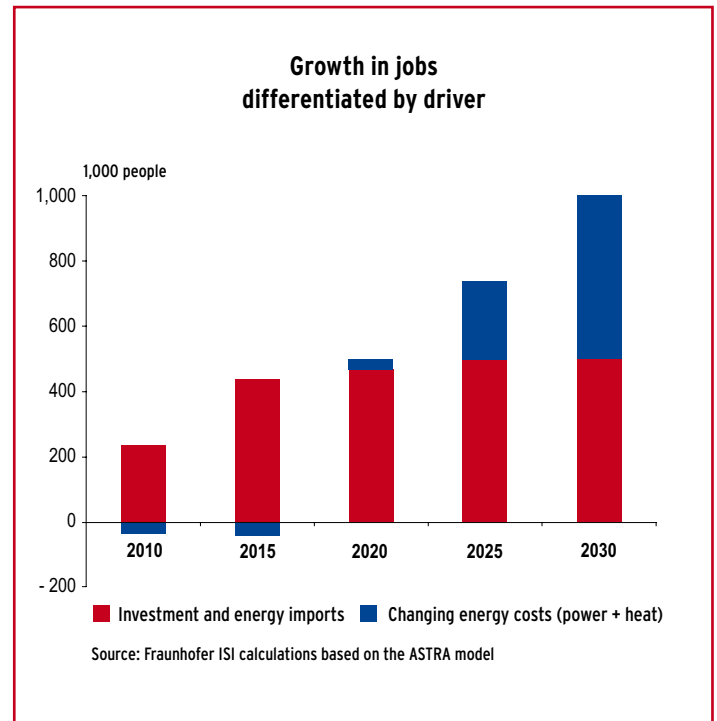
- ▶ Energy supply has been further optimised.
- ▶ Energy productivity has tripled since 1990.
- ▶ 50% of the electricity requirement is supplied by renewables.

2. We will cut our energy costs and create 500,000 new jobs.

Where are we now?

If it had not been clear before, there has been no denying it since “The Economics of Climate Change” was published in 2006 by the British chief economist Sir Nicholas Stern: doing nothing about climate change could prove expensive. Globally, the cost of failing to act could in the long term amount to as much as 20% of GDP. By contrast, an effective climate policy need only absorb 1% of GDP. Besides, the German economy stands to profit substantially from climate protection, because a well designed climate protection policy will drive the development of innovative technologies ahead, thereby enhancing competitiveness and boosting employment.

Green lead markets already account for a volume of about €1,000 billion a year, and by 2020 this figure could more than double. In fact, exporting environmental technologies and services creates and secures jobs in Germany. German companies are top of the export charts in virtually all fields of environmental technology. If things are to stay that way, we must invest now in development and research.



What have we done so far?

Thanks to its active environment policy, Germany has already cut many emissions since 1990 while at the same time creating a large number of jobs in the environment sector. About 1.8 million people work in environment protection today – that’s twice as many as 10 years ago. In 2006 they earned €56 billion from exports of green technologies, making Germany the world’s champion exporter of environmental goods yet again.

Renewable energies in particular have become a significant factor in the German economy in recent years. In 2007 the renewable energy sector achieved a turnover of about €25 billion and employed almost 250,000 people. 150,000 new jobs can be attributed to the Renewable Energy Sources Act alone. The law has also helped to save 57 million tonnes of CO₂.

Industry and the climate also benefit equally from greater energy efficiency. Lower energy consumption furthermore reduces dependence on energy imports. The German government has therefore supported a number of efficiency measures. Since 2001 the CO₂ Building Rehabilitation Programme has been providing funds for the modernisation of energy systems in buildings and for especially energy-efficient new buildings. The “Special Fund for Energy Efficiency in Small and Medium-Sized Enterprises” set up in 2008 helps smaller businesses by providing grants for energy consulting and loans for investments.

The German government has attached particular importance to funding research and technological development to enable Germany to maintain its leadership in environmental technologies in future years.

What remains to be done?

The benefits of an advanced climate and energy policy were examined in a study commissioned by the German Environment Ministry published in November 2008. "Investments for a Climate-Friendly Germany" is the first such analysis of the impact which German climate protection policies are having on growth, employment and economic structure.

The result of the study is clear: the strategy for more renewable energy and greater energy efficiency is not merely cutting energy costs in Germany, but also creating more growth and employment. That is because investing in climate protection stimulates greater demand for domestic environmental goods, while at the same time more money stays within the country instead of flowing abroad to pay for imports of coal, oil and gas. Efficiency measures such as refurbishing buildings are also labour-intensive. All of that means growth and jobs.

Briefly, the study analyses the following effects of an ambitious programme to achieve a 40% reduction of greenhouse gases by 2020:

- ▶ Taken together, the measures result in a reduction in energy imports worth approx. €20 billion a year by 2020 and nearly €35 billion a year by 2030.
- ▶ Thanks to the climate protection package, net investment will increase by more than €30 billion a year. By 2030 average annual gross domestic product will be more than €50 billion greater than in the reference scenario. In other words, the Integrated Energy and Climate Programme and other proposed measures will generate greater macroeconomic growth.
- ▶ At least 500,000 additional jobs will have been created in Germany by 2020. By 2030 this figure could rise to over 800,000.

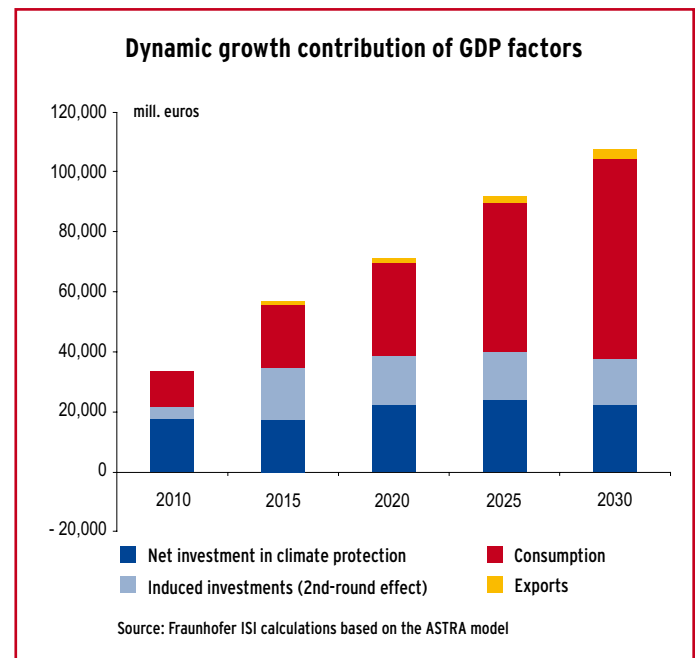
What will we have achieved in 2020?

By consistently expanding renewable energies and doubling energy efficiency, Germany has managed to consolidate its competitive strengths in the international arena even further. But German environment and climate policies have scored some other successes, too:

- ▶ By 2020 climate policy has generated a net increase of 500,000 jobs.
- ▶ As an overall average, the national economy has incurred cost savings of about €40 for every tonne of CO₂ emissions avoided.
- ▶ Each year some €20 billion remain in the country for Germany to use because they have not been spent on energy imports.

The global market volume of climate protection technologies has almost doubled since 2008 to over €2,000 billion. Thanks to Germany's drive to introduce and spread climate protection techniques, the sectors concerned have been able to specialise at an early stage in providing innovative technologies to meet this objective and consequently to reinforce their competitive edge in this important export and lead market.

In the wake of the financial crisis in 2008, investing in climate protection proved to be an ideal way of re-igniting the economy.



Vision 2030

- ▶ Climate policy has generated 900,000 new jobs compared with 2008.
- ▶ Savings worth approx. €40 billion have been made in energy imports.
- ▶ Thanks to a range of efficiency measures energy costs have been cut by 20% compared with the business-as-usual scenario.

3. We will derive over 30% of our electricity from renewable sources.

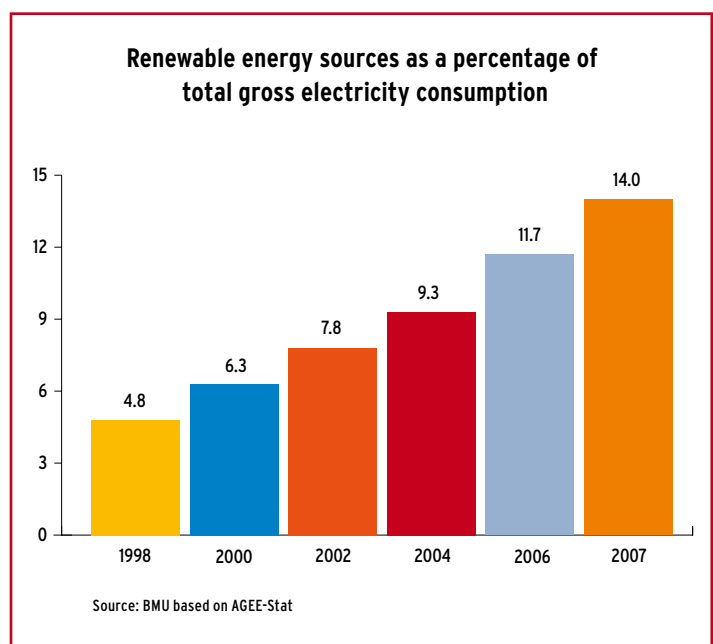
Where are we now?

The renewable energies – hydro, wind, solar, bio-energy and geothermal – have a key role to play in modernising our energy supply. In the Renewable Energy Sources Act (EEG), Germany already has a highly successful instrument for promoting power generation from renewable sources.

Since the adoption of the Electricity Feed Act in 1990 and the EEG in the year 2000, the proportion of the German electricity demand met by renewable energies has grown from year to year. In 2008 it was already around 15%. The total installed capacity to generate power from renewable energy sources has almost tripled since the EEG entered into force in 2000. In 2007 alone, those installations were responsible for cutting emissions by approx. 110 million tonnes CO₂.

The costs incurred by the payments made under the EEG are absorbed by the general electricity rates and amount to approx. 1.2 ct/kWh. These additional costs are offset by considerable benefits to the national economy, because power generation from fossil fuels causes much greater damage to the environment. The costs of this damage, known as external costs, amount to something in the region of 5-8 ct/kWh. From the national perspective, therefore, the economy gains from renewable power. Studies also show the positive impact the EEG has

had on innovation and value creation in Germany, not least in the labour market. About 150,000 new jobs, for example, can be attributed to this legislation. In fact, the Renewable Energy Sources Act has been such a success story that 50 other countries have now introduced similar provisions for feeding power into the national grid and receiving payment in return.



What have we done so far?

On 1 January 2009 the EEG was radically amended to reflect recent developments. New investment incentives were selectively introduced, in particular for bioenergy and wind farming. The notable improvements in photovoltaics permitted a reduction in the rates of payment for this source. After all, one key objective of the EEG is to incentivise cost efficiency and innovation by gradually reducing payments.

The use of biomass to create energy, which has intensified in recent years and which is essentially to be welcomed, has resulted not only in great achievements but also in the emergence of new challenges,

such as competing claims on land and environmental problems induced by the cultivation of biomass crops. Consequently the amended law is encouraging the use of waste and residual substances and also a more efficient utilisation of biomass in CHP installations. Regulations have also been drawn up on sustainability criteria for biomass.

The 2009 Act also improves the incentives for greater use of wind energy. This applies above all to the substitution of old turbines by new, more advanced models (repowering), to the utilisation of wind power plants to stabilise the grid, and to the development of offshore wind farms.

What remains to be done?

Renewables have been expanding successfully in Germany for some years now. By 2020 renewable energies are to account for at least 30% of electricity generation. Nevertheless, some further efforts will be required:

- ▶ The first requirement in the wind sector is to incentivise repowering so that older turbines are replaced by new ones with a greater capacity. Another important field of action is offshore wind farming. In 2020 Germany's offshore wind farms should have achieved an output of about 10,000 MW renewable electricity.
- ▶ Biomass can also make a major contribution to the renewable power supply. However, expansion should only occur where it is sustainable and makes ecological sense.
- ▶ An important milestone for photovoltaics is the so-called grid parity, which is to be achieved by 2015 at the latest. It means that electricity from photovoltaic installations will then cost the same as the final user pays for electricity.

As the input from renewable energies grows, mechanisms must be established to integrate this electricity into the power supply network. This calls both for fossil-fuel power stations to be more flexible in



their output and for the fluctuating sources of renewable energy (notably wind and sun) to respond to demand. To achieve this, plants on the production side should be combined with energy storage and load management. This requires technical solutions as well as a suitable framework.

What will we have achieved in 2020?

In 2020 at least 30% of electricity consumption is met by renewable energies. Moreover, the demand for power has fallen, thanks to efficiency measures, to about 550 TWh/a in total. The key renewable sources are wind energy (15% of the total electricity requirement), bioenergy (8%) and hydroelectricity (4%). Solar power has become competitive to end users and photovoltaics are standard roof installations.

Offshore wind farms have also become a key factor in power generation. They complement the limited land-based locations and perform more hours at full load. The infrastructure required to bring the electricity to shore is in place.

To adapt fluctuating supply to momentary demand, timely investments have been made in both the plant infrastructure and cutting-edge information and communication technologies. Automated control, energy storage and load management, together with grid expansion and optimisation, have established a power system responsive to demand with a high proportion of renewable input. Batteries for electromobility are already playing an important role. The security of our energy supply is guaranteed.

Vision 2030

- ▶ Power from renewable sources can be used in response to demand.
- ▶ Renewable energies meet 50% of the electricity requirement.
- ▶ Power from renewable energies can be fed into the European grid at any time and transmitted across large distances.

4. We will phase out nuclear power by 2022.

Where are we now?

Part of any sustainable energy policy is to dispense with nuclear power. 20 years after Chernobyl, using atomic energy still entails numerous risks:

- ▶ the risk of meltdown with disastrous consequences (maximum credible accident, MCA),
- ▶ the unresolved issue of nuclear waste disposal,
- ▶ the risk that nuclear weapons will spread (proliferation threat),
- ▶ the risk of a terrorist attack on a nuclear power station.

Although Germany meets high safety standards by international comparison, an accident with the severest of consequences cannot be ruled out anywhere, not even in our country.

Besides, radioactive waste from nuclear power stations remains active for millions of years. A dangerous legacy that we are leaving for future generations.

That is why the German government agreed with the energy providers in 2000, after lengthy negotiations, that nuclear power would be phased out systematically, foreseeably by 2022. Germany is well able to do without nuclear power. Supply security will not be undermined. Until the use of nuclear power has been phased out altogether, the atomic supervisory body monitors human and environmental safety as best it can, drawing on the latest scientific and technological findings. This assumes efficient nuclear management in compliance with international standards

What have we done so far?

In 2002 the German parliament sealed the long-term phasing out of nuclear power with an amendment to the Atomic Energy Act. This transposed the agreement between the federal government and the utilities, adopted in 2000, into national legislation.

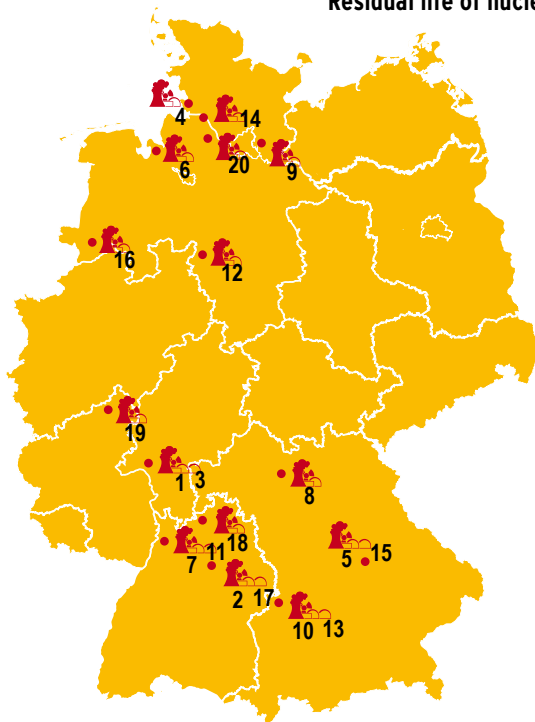
The law defines the residual volumes of power which each nuclear station may still produce. Once these have been achieved, the station will lose its operating licence.

By phasing out nuclear energy, Germany has sent out a clear signal. Dispensing with high-risk nuclear fission technology will make not only Germany a safer place. Germany's phase-out is just as important in the international framework, because the more countries there are operating nuclear technology, the greater the risk of devastating catastrophes will be. There would also be an increasing danger that uranium might fall into the wrong hands and be used for military ends if greater use were to be made of the nuclear option. Germany is playing a pioneering role here. It can demonstrate that even a large industrial nation can achieve economic growth and climate protection without nuclear energy.

Security is the top priority for the remaining nuclear power stations. For this reason, residual operating periods may only be transferred from an older facility to a newer one.



Residual life of nuclear power stations in Germany



Nuclear power station	active until ¹⁾
1 Biblis A (PWR)	2010
2 Neckarwestheim 1 (PWR)	2010
3 Biblis B (PWR)	2010
4 Brunsbüttel (BWR)	2012
5 Isar 1 (BWR)	2011
6 Unterweser (PWR)	2012
7 Philippsburg 1 (BWR)	2012
8 Grafenrheinfeld (PWR)	2014
9 Krümmel (BWR)	2019
10 Gundremmingen B (BWR)	2015
11 Philippsburg 2 (PWR)	2018
12 Grohnde (PWR)	2018
13 Gundemmingen C (BWR)	2016
14 Brokdorf (PWR)	2019
15 Isar 2 (PWR)	2020
16 Emsland (PWR)	2020
17 Neckarwestheim 2 (PWR)	2022
Nuclear power station decommissioned	
18 Obrigheim (PWR)	
19 Mühlheim-Karlich (PWR)	
20 Stade (PWR)	

PWR: Pressurised water reactor

BWR: Boiling water reactor

1) assuming no output transfers and no lengthy downtime for individual stations

Source: BMU

What remains to be done?

The phase-out must not be reversed, and nor will it. The federal government and the utilities have reached an agreement on how the phase-out will take place, and that agreement stands. Calls by nuclear power station operators to prolong the residual life of their facilities must not be heeded, because continuing to operate these stations once they have been fully written off serves only one end: extraordinary profits for operators at the cost of consumers.

Besides, it would be irresponsible to carry on producing even more highly radioactive waste.

The waste which will still arise until the planned phase-out has been completed must be stored as safely as possible in a final repository. This means identifying and exploring the safest location for nuclear waste in Germany. The site at Gorleben should be compared with other locations in a nationwide selection procedure based on defined criteria.

Bureaucratic structures and complicated decision-making procedures within the German nuclear regulator need to be reformed and communication processes, some of which are inadequate, improved.

What will we have achieved in 2020?

The nuclear phase-out decided in 2000 is almost complete. There are only three nuclear power stations left on the grid: Isar 2, Emsland and Neckarwestheim 2. These will also be shut down in the foreseeable future.

Phasing out nuclear power has not had a negative impact on either power supply security or the price of electricity. Quite the reverse. Consistent implementation of the phase-out strategy has been a major factor in the rapid modernisation of energy provision. The German energy sector has made timely investments in long-term solutions – renewable energies and energy efficiency. The energy supply is now more flexible and more decentralised.

Germany's nuclear regulator has been restructured, making it leaner and more effective. This helped to ensure that all nuclear power stations continued to operate safely until they were shut down.

As for final storage, a transparent decision-making procedure was held to identify and examine alternatives to Gorleben. Following broad consultation with public stakeholders and the communities concerned, the choice of final repository fell on the site which offers the greatest security. Planning procedures are underway in compliance with nuclear legislation.

Vision 2030

► Germany is free of nuclear power.

5. We will generate 40% of our electricity in highly efficient coal-fired power stations.

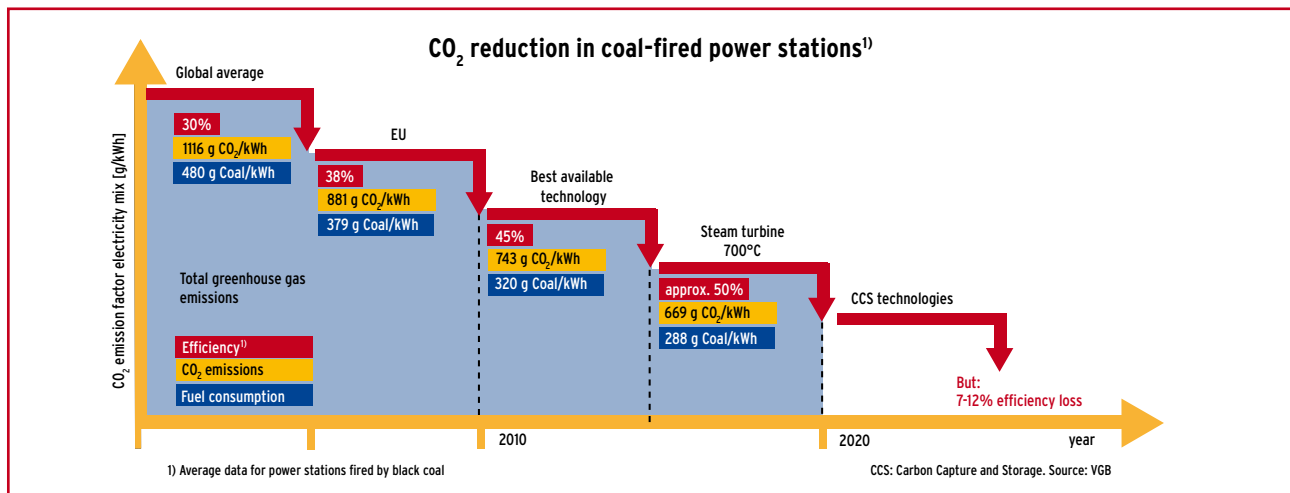
Where are we now?

Fossil-fuel power stations generate the lion's share of electricity in Germany. Even if there are ambitious efforts underway to expand renewable energies and enhance energy efficiency, this will remain the case for some time to come. In order to meet the 40% target for climate protection in spite of this fact, Germany urgently needs to replace older, less efficient power stations with modern, highly efficient installations. The percentage of combined heat & power stations in particular will have to increase so that fossil fuels can be used to maximum effect. This means developing additional heat sinks.

In 2005 emissions from fossil power stations had only declined by 4% compared with 1990. There is still a long way to go to reach the 40% target by 2020. The power market in Germany is still dominated by old

facilities whose book value has been fully written down. By contrast, state-of-the-art power stations display much higher levels of efficiency, even today. Moreover, many of these older power stations will be reaching the end of their mathematical service life in the years between 2010 and 2020. To prevent these old installations from being operated longer rather than being replaced by newer, more advanced facilities, there needs to be an investment drive in the renewal of the fossil-fuelled power station fleet.

Emissions trading is already sending out a clear price signal to encourage the shutdown of old stations with higher emissions and their replacement by newer, more efficient ones. As emission allowances are in increasingly short supply, there are strong incentives for increasing the efficiency of the power generation system as a whole.



What have we done so far?

The emissions trading launched in 2005 sets a clear cap on CO₂ emissions from industry and the power sector. This ensures that the ambitious climate protection targets will be achieved. From 2013 onwards, all CO₂ emission allowances in the electricity sector will be fully auctioned. The cap on available emission allowances will decline by 1.74% a year from 2013. By 2020 this will result in a 21% cut compared with 2005. This target will be raised if Europe commits to an ambitious climate protection target under an international agreement.

From 2009 the new Combined Heat & Power (CHP) Act will promote the construction and modernisation of highly efficient CHP installations, and this time it will include the power used by operators themselves. Grants are available to expand heat networks. The target is to double the percentage of power generated by CHP to 25% by the year 2020.

Carbon capture and storage (CCS) could prove to be an important option for future CO₂ mitigation. By 2020 CCS technology should be safe, efficient, environmentally friendly and commercially available. The German government is therefore supporting research and development in this field.

What remains to be done?

One of the greatest hurdles to new investment in power stations at present is uncertainty about future nuclear policy. As long as investors cannot be sure that the political community will not reverse the phase-out of nuclear energy, they will only make modest investments. New power stations fired by fossil fuel cannot compete with old, amortised nuclear power stations whose residual service life has been extended. That is another reason for pursuing the nuclear phase-out with determination.

Power station operators need a clear framework and investment security. Only then can old, inefficient power stations be replaced as quickly as possible by highly efficient state-of-the-art facilities, with a rapid increase in the proportion of CHP installations. It follows that the maximum value of certificates available in emissions trading must be reduced quickly to the permissible level following the expected conclusion of an international agreement at the Climate Change Conference in Copenhagen in December 2009.



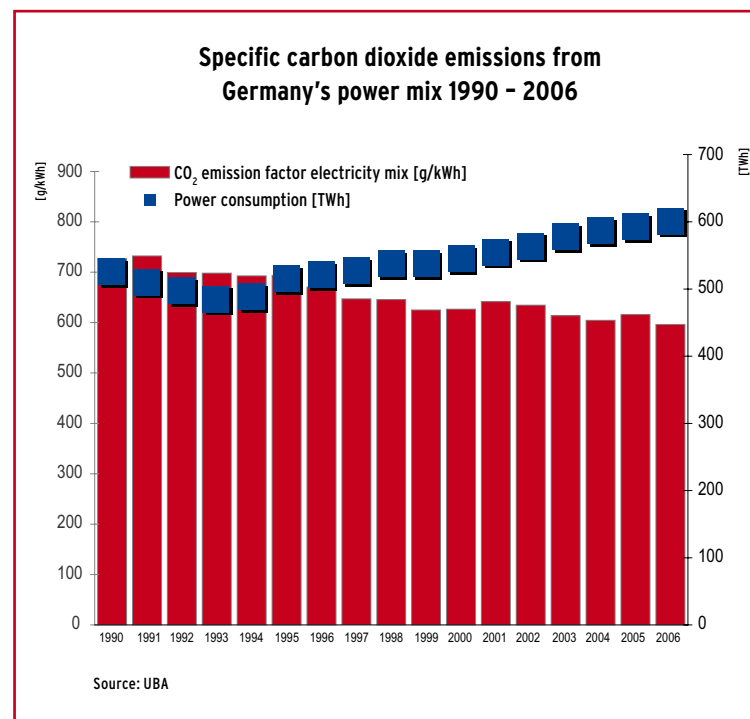
For CCS technology to be made available as a mitigation option as soon as possible, research and development need to be driven forward without delay. Above all, CCS demonstration projects must be launched on a commercial scale.

What will we have achieved in 2020?

In 2020 emissions from power generation have fallen dramatically. Apart from the expansion of renewable energies and improvements to energy efficiency, another core factor in the reduction of emissions in Germany has been the renewal of the coal-fired power station fleet.

The price signal from emissions trading has contributed decisively to the closure of inefficient old stations and their replacement by efficient new ones. Moreover, many power stations are operated on the basis of combined heat & power. Highly efficient coal-fired power stations now account for 40% of power generation.

Techniques for carbon capture and storage have been broadly tested and improved. In Germany three CCS demo facilities are now operating. Retrofitting highly efficient coal-fired power stations with CCS technology presents no problems.



Vision 2030

- ▶ The share of coal-fired power stations based on combined heat & power has continued to rise.
- ▶ There is a worldwide emissions trading scheme linked to emissions trading in Europe.
- ▶ Half the coal-fired power stations are equipped with CCS technology.

6. We will establish a nationwide grid operator and expand our power grid efficiently and in accordance with environmental standards.

Where are we now?

The transmission grid belongs to Germany’s four biggest power producers. Currently each company runs its own network business, but several network operators would like to sell their network. The overall length of the transmission grid – the electricity “highway” – is almost 60,000 km.

The grid urgently requires expansion, otherwise electricity from the planned new power stations and wind farms in the north and east of Germany will not be able to reach consumers. In high winds it is already the case that power generated by wind turbines cannot be transmitted. The German Energy Agency has calculated that the grid needs to grow

850 km by 2015. It is already clear that this schedule cannot be met. The interconnections with neighbouring states in Europe are also inadequate for the purposes of smooth electricity trading. If the grid cannot be upgraded in time to reflect demand, climate protection targets are at risk and so is Germany’s ability to function as an industrial base.

The grid operators have announced investments in the transmission network worth over €6 billion. This is more than the current value of the grid, estimated to be €4 billion. If networks are to be sold, a well-endowed purchaser will need to be found.

What have we done so far?

The German government has agreed on a draft for a Grid Expansion Act. This Act should offer solutions to the problem of tardy grid expansion – many projects are taking longer than ten years. First of all grid operation must be improved. That will enable more current to be transmitted. The Bill seeks to simplify procedures and allows the use of new, environmentally friendly technologies. Cables near residential areas can be laid underground. As a first step, the Act provides for a number of pilot projects.

To transport electricity long distances without much loss, it makes sense to use high-voltage direct-current transmission (HVDC). Other countries are already using this innovative technology beneficially. The Power Grid Expansion Act will permit the construction of HVDC lines in Germany.



What remains to be done?

An efficient, demand-responsive power grid is an essential precondition for integrating electricity from renewable energies and new power stations and for untroubled trading. The infrastructure that is required for a secure, commercial, sustainable energy supply must be made available in good time. An innovation strategy for the networks means:

- ▶ introducing new network technologies without delay,
- ▶ providing innovative HVDC transmission from north to south in the form of underground cables,
- ▶ laying conventional cables underground, too, in sensitive areas and close to residential zones.

Interconnections with neighbouring countries must also be developed to enable electricity trading to function within the EU.

There is also great potential in network business, however. The sale of transmission grids presents an opportunity to establish a nationwide grid operator. A “German grid company” running the grid would be able to create an efficient, uniform structure. Operating costs could be reduced considerably. Because the network infrastructure is of such crucial importance, a public stake in this “German grid



company” is essential. The federal government has a responsibility for decisions relating to grid expansion in the interests of secure, efficient energy supply. To this end, the state must hold at least 25.1% of the shares. The future owner of the transmission network must be neutral – the European Commission requires this, too – and must treat everyone using the grid fairly and equally. This is vital if competition in the energy market is to prosper.

What will we have achieved in 2020?

As new power stations have been built in the coastal region and wind farms offshore, power generation has shifted further towards the north and east of Germany. The electricity is transported to the south of the country via two HVDC lines in the form of underground cables. The existing overhead network has been expanded to complement this. Wherever concern for local residents or landscapes dictated, this was also laid underground.

Network operation as a whole has been enhanced by appropriate technologies. The grid can absorb electricity from renewable energies and new, efficient fossil-fuel power stations and it serves as a marketplace for the European power trading.

Offshore wind farms in the North Sea are connected to wind farms in neighbouring countries via HVDC lines. New grid technologies, but also new technologies for managing energy consumption, have been implemented to positive effect. The “smart grid” permits flexible power flows in response to demand.

A “German grid company” owned by private investors and the state operates the German grid. Essential and strategic decisions cannot be taken without a public voice. Equal importance is attached in this respect to security, efficiency, consumer friendliness, and protection of the environment and climate.

Vision 2030

- ▶ A smart European grid fully absorbs wind and solar energy.
- ▶ Solar power can be imported into the EU from Africa via innovative European HVDC cables.
- ▶ Smart grids help to save energy during both production and consumption.

7. We will reduce our electricity consumption by 11%.

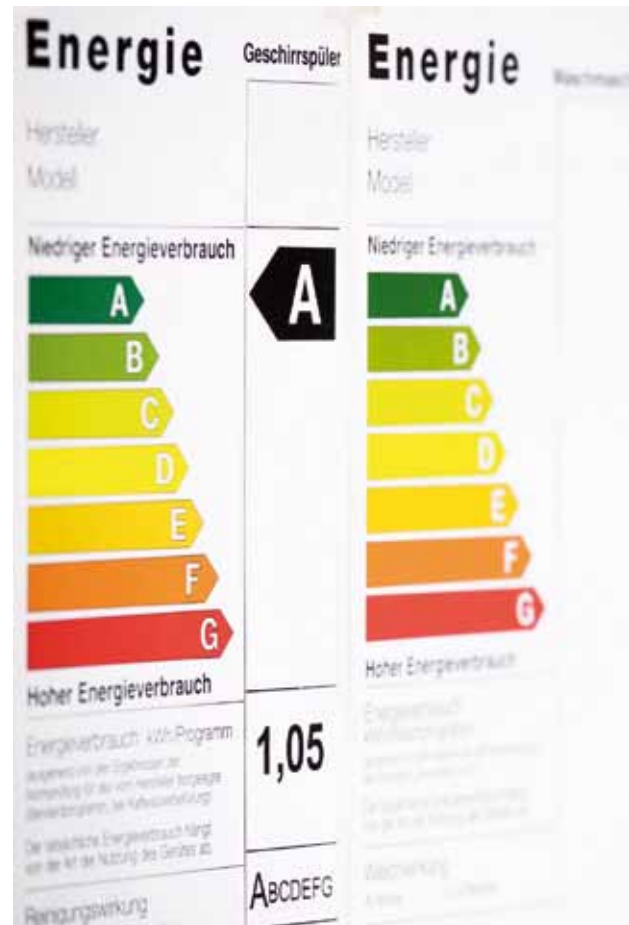
Where are we now?

Although electricity “only” accounts for a fifth of final energy consumption, it causes almost half the energy-related emissions of greenhouse gases. That is because about three times as much primary energy is required to generate power. It follows that reducing power consumption is a key factor in achieving Germany’s targets for climate protection and overall system efficiency.

At present, however, our consumption of electricity is continuing to rise. We must reverse that trend. All the studies show that there is huge potential for saving electricity, for example:

- ▶ in the electrical cross-sector technologies used in manufacturing (e.g. electric engines),
- ▶ in refrigeration and air conditioning,
- ▶ by replacing old household appliances (especially refrigerators), redesigning lighting and not using stand-by options unnecessarily,
- ▶ in information and communication technology,
- ▶ by installing state-of-the-art meters,
- ▶ in pumps and by replacing night storage heaters and electrical water heating.

Drawing on a study by the Wuppertal Institute for Climate, Environment and Energy (commissioned by the energy utility E.ON), the Federal Environment Agency has calculated that approximately 110 billion kilowatt hours of electricity a year could be saved by 2015 only by making full use of existing profitable options for cutting electricity consumption. That is 20% of all the power we currently



generate. The climate would not be alone in profiting greatly from this substantial reduction in consumption. Consumer electricity bills would be about €10 billion lower. So it does pay to prevent climate change!

What have we done so far?

Studies on behalf of the German government in the run-up to the Energy Summit in 2007 calculated the measures that would be needed to cut power consumption by 2020 to a level 11% below that of 2005. Some important steps have already been taken as part of the Integrated Energy and Climate Programme. Opening the electricity meter-reading business to competition established a key condition for time-sensitive measurement of electricity consumption. The legal basis for this was laid by

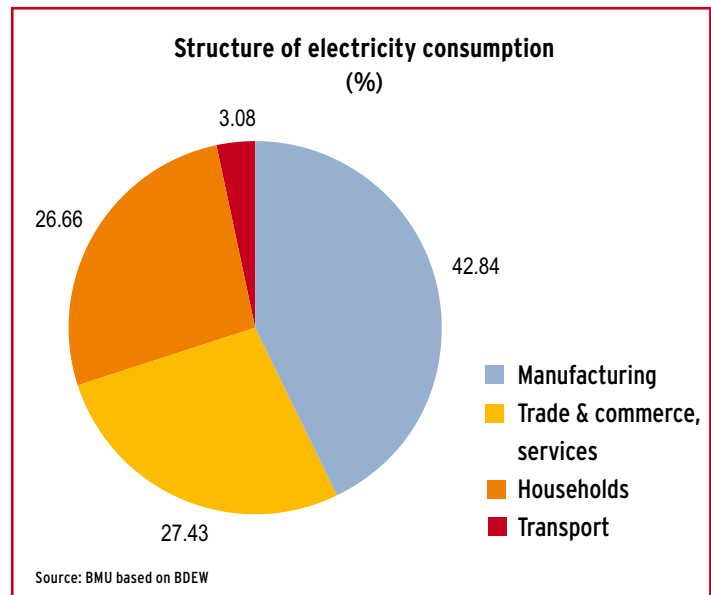
amending the Energy Industry Act and adopting a Regulation on Meter Access. Furthermore, energy utilities will be obliged to offer variable load-dependent prices from 2011.

The German government has been campaigning within the European Union for the Ecodesign Directive to include ambitious, dynamic efficiency standards for electrical appliances using the top runner principle. It also champions an improved, expanded labelling scheme for energy consumption.

What remains to be done?

Despite the action that has already been taken, there is still huge potential for improving energy efficiency. Tapping that potential at long last will require the same kind of dynamic approach that we already find in the field of renewable energies. To drive this development forward, we will need a combination of instruments: labelling, consultancy, funding and ambitious standards:

- ▶ Low-income households are hit especially hard by high energy prices. They in particular need advice and financial support to carry out efficiency measures.
- ▶ The market share of domestic appliances which can claim high energy efficiency must increase drastically. This calls in part for clear labelling which displays the life-cycle costs of these appliances, and in part for minimum efficiency standards which are updated dynamically along the lines of the top runner approach. Appliances that do not meet the minimum standards will be excluded from the market.
- ▶ To speed up the formation of a dynamic market for appliances with top energy efficiency ratings, private and commercial consumers require consultancy that is precisely attuned to their needs and support in acquiring the best available models.
- ▶ There is also a need for an Efficiency Act which requires and rewards gains in energy efficiency by companies and consumers. Investment grants and



advantageous depreciation rules for efficiency investments could contribute to companies investing more in highly efficient technologies.

- ▶ The additional revenues from emissions trading from 2013 should be used to set up an Efficiency Fund worth €1 billion a year. This would finance measures for saving electricity in public, private and commercial environments, such as the modernisation of municipal street lighting.

What will we have achieved in 2020?

Germany is the most energy-efficient country in the world. Electricity is no longer wasted. Consumers have evolved from passive customers to active co-architects of energy use. The nationwide use of smart meters enables domestic appliances to be timed to run during periods when electricity consumption is low. Thanks to variable load-dependent pricing, this has a direct effect on people's wallets.

Industry and business have adopted active load management, helping considerably to optimise the overall system. Energy management systems are now an integral, indispensable part of corporate management. Electricity suppliers have swum with

the tide and broadened their offers. Innovative energy services set the tone in the contemporary market. Green electricity options, customer advice and bonus schemes figure in the standard repertoire of every power company.

Power consumption has become a more important factor in purchases of electrical appliances, and households overwhelmingly use the most energy-efficient models available. As a result, the range of highly efficient appliances on offer is constantly increasing. The public sector only buys energy-efficient top runners. In addition to this, most of the electricity it purchases is green. Taken as a whole, this has meant that power consumption in 2020 has fallen by 11% to just under 550 TWh a year.

Vision 2030

- ▶ The electricity requirement has fallen another 10%.
- ▶ 90% of household appliances fall within the category of best available energy efficiency.
- ▶ Germany is market leader for energy-efficient technologies.

8. We will reduce the fossil heat requirement by at least 25% and double combined heat & power generation to 25%.

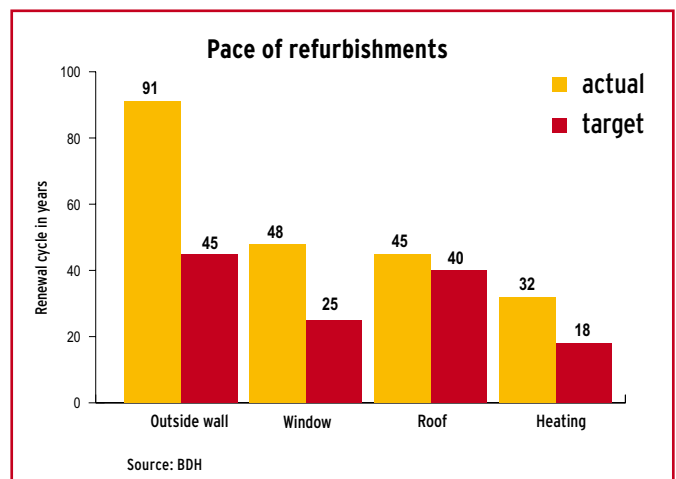
Where are we now?

The market for heat accounts for more than half of Germany’s final energy demand. But although there is huge potential here for saving energy, improving energy efficiency and using more renewable sources, not enough attention has hitherto been paid to the heat market. That needs to change fast.

Natural gas and oil are currently the principal fuels used to generate heat. Combined heat & power (CHP) consequently has an important role to play in the heat market. In CHP facilities the waste heat arising from power generation is drawn off and used to provide commercial premises and households with warmth. This enhances the efficiency of the energy input from 40% to as much as 90%. It saves fuel and reduces environmental pollution. The German government has therefore set a target for stepping up the annual percentage of electricity that is generated by CHP facilities, doubling it to 25% of total output by 2020. Renewables, especially bioenergy and solar, currently account for approx. 7% of the heat produced. That figure will be increased to 14% by 2020.

The need for action is just as urgent on the demand side. 50% of thermal output is used for space heating and approx. 35% for process heat in industry.

There is tremendous potential to cut consumption in both areas. The present thermal insulation regulations for buildings are designed to achieve steady improvements in the standard of insulation for both existing and new buildings, but there is nevertheless a considerable backlog in restructuring and refurbishment, even though saving energy normally makes sound sense economically. There are no statutory regulations to govern process heat as yet. Here, too, the potential savings are substantial.



What have we done so far?

There are various ways of cutting the consumption of fossil fuels when producing heat. One is to reduce the thermal requirement as a whole. A key instrument in accomplishing this is the Energy Saving Ordinance, which lays down energy standards for buildings. In 2009 these standards are to be tightened by an average of 30%. In a second stage a leap of similar magnitude will be made by 2012.

Another approach is to make heat generation more efficient and expand the use of renewable energies. Since 1 January 2009 the Renewable Energies Heat Act has been calling for the use of renewable energies in new buildings. Specific requirements have been defined for each renewable source, depending

on the choice. For example, if solar heating is to be installed, the panels must be a certain size. This law will also help to drive the expansion of CHP technology in order to cut greenhouse gas emissions, because heat from CHP plants also qualifies under the statutory requirement to use renewable energy sources.

The recently amended CHP Act promotes the construction of new CHP installations and the modernisation of older ones. It also stimulates the construction and expansion of heat networks, which are essential to stepping up the use of cogeneration technologies. The law is flanked by two funding schemes, the Market Incentive Programme and Mini-CHP, which grant additional financial support for network expansion and CHP plants.

What remains to be done?

Further measures are needed to reduce the demand for fossil heating. Our existing building stock, in particular, offers great potential for inexpensive savings using technologies that are already in place. That makes it so important to step up the pace dramatically in the refurbishment of old buildings and double the rate of energy upgrades. It is high time to overcome the backlog in restructuring and refurbishment.

To this end, funding schemes such as the CO₂ Building Rehabilitation Programme need to pursue their objectives at a vigorous pace. There must be greater motivation for landlords to invest in measures to upgrade energy efficiency. This calls for new approaches to financing.

What will we have achieved in 2020?

By doubling the pace of building modernisation and making greater use of renewable energies, the fossil heat requirement has been reduced by 25%. Landlords are motivated to keep energy costs to a minimum by investing in building stock and heating technology. The rate of energy upgrades has skyrocketed as a result. Heating supply in new buildings is largely independent of fossil fuels. It is standard practice to use renewables.

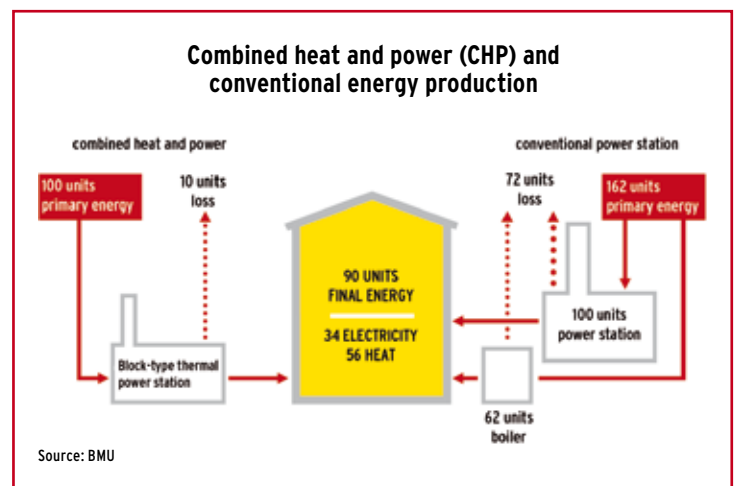
A quarter of the total electricity requirement is now met from CHP units. About half the cogenerated heat can be used all year round for industrial purposes. The other half is distributed to about 10-15 million households via heating networks. Intelligent arrangements, centralised heat storage and the exploitation of thermal inertia in the networks and in the buildings to be heated have permitted substantial efficiency gains for cogenerators.

The CHP market can only grow to the extent proposed if there are enough heat sinks for it to service. Three areas for action will therefore prove crucial in expanding cogeneration:

- ▶ CHP-fed district heating networks
- ▶ an expansion in decentralised energy supply with mini-CHP and micro-CHP
- ▶ industrial cogeneration.

Expanding district heating networks is vital if we are to make greater use of combined heat & power. In areas where district heating is not a viable option, it makes sense to install small, decentralised cogeneration units. There is also major potential in the industrial sphere. Wherever there is a local need for process heat, installing combined heat & power is particularly easy and efficient.

Quite apart from the cost situation, a new environmental awareness now inspires investors, architects, building service planners and developers. Installations that make good use of waste heat, such as CHP, or that are fuelled by renewable energies are now a matter of course. Everyone appreciates the greater comfort of a well insulated building.



Vision 2030

- ▶ New buildings have not required fossil fuels for the last 10 years.
- ▶ Decentralised heat generators with no electricity output are no longer built. All new fossil-fired power stations produce combined heat & power.
- ▶ Non-insulated buildings and draughty windows are relics of a bygone age.

9. We will reduce our transport emissions by at least 20%.

Where are we now?

About 20% of greenhouse gas emissions in Germany originate from the transport sector, which is therefore a major factor in climate change. It follows that transport will also have to make a robust contribution to achieving national targets for climate protection by reducing that impact.

The market for cars in Germany has already been witnessing a modest but all the more significant shift in recent years. The majority of new registrations are for vehicles in the small and middle-sized categories, where consumption has fallen considerably. Today, purchasing decisions are mainly based on fuel economy rather than horsepower.

Various technical innovations and the promotion of biofuels have led to a decline in transport emissions since 1999. And yet there is hardly any other sector where energy is put to such inefficient use. Only about 30% of the energy input translates into engine performance. Moreover, private cars and road



freight are still dominant features of German life and passenger miles in air travel are constantly on the rise.

What have we done so far?

The Integrated Energy and Climate Programme adopted by the German government also injects important momentum into the transport sector to achieve the national 40% reduction target.

For example, road tax for new cars is to be based on CO₂ emissions rather than engine capacity, creating a major incentive to buy vehicles with low greenhouse gas emissions. At the same time, the wider differentiation in HGV road tolls will increase the desired impact on fuel performance: efficient trucks with lower emissions will be noticeably cheaper to run than those which generate higher levels of pollution.

Europe has, for the first time, imposed a compulsory cap on CO₂ emissions from new vehicles of 130 grams CO₂ per kilometre in 2012; a further 10 grams are to be saved by additional measures (including biofuels). It is also planned to ratchet the target up to 95g from 2020. This has created a very significant

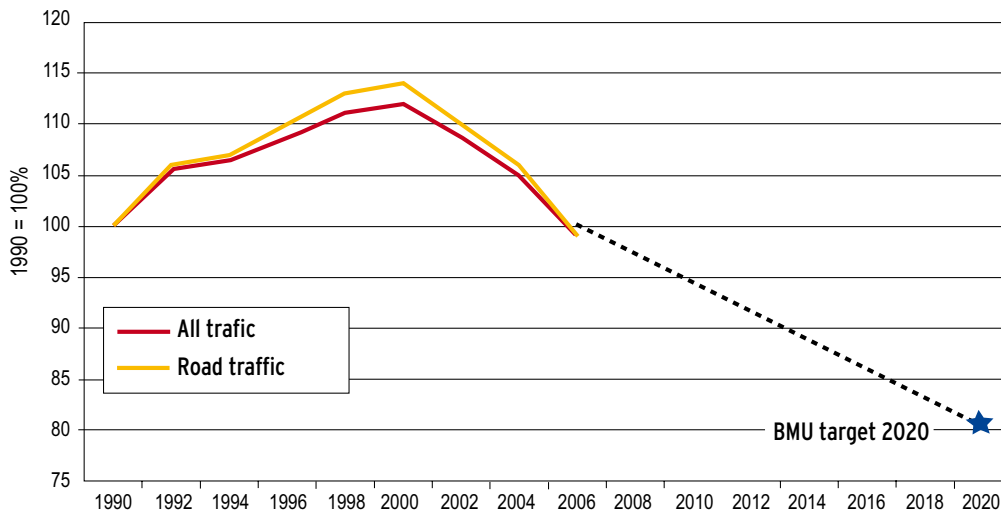
instrument for reducing climate gases in the transport sector, with an ambitious long-term objective for 2020 that will require greater engine efficiency.

The new German Biofuel Quota Act builds on the use of regenerative fuels in order to reduce greenhouse gases by 7% in 2020 compared with the use of fossil fuels. Regulations in the form of an ordinance will ensure that biofuels meet minimum requirements for greenhouse gas emissions.

To encourage electrical vehicles in conjunction with renewable energies, the German government has decided to draw up a National Development Plan for Electromobility. It will also support the greater use of greener modes of transport such as rail and inland waterways. Under the master plan, the federal government is making €115 million a year available for freight and logistics to expand appropriate routes.

Aviation is to be included in the present European emissions trading scheme following a decision by the Council of the European Union.

Relative changes in direct CO₂ emissions from transport (%)



Source: BMU

What remains to be done?

In response to rising energy prices, faster climate change and growing traffic problems, transport policy must evolve into a policy for sustainable mobility. Mobility needs to be ensured for everyone in the country. Active traffic management will include encouraging cleaner vehicles and linking them into an efficient public transport system.

Like other sectors, transport needs a broad programme of action:

- ▶ Amend the regulations on labelling energy performance: people buying new cars require better information about fuel consumption.
- ▶ Limit the tax breaks for luxurious company cars: this will create an incentive to opt for efficient models when purchasing cars for the company.
- ▶ Promote innovative technologies such as electromobility powered by renewable energies, which is almost emission-free.
- ▶ Reduce taxes on local public transport: local public networks should be exempted from electricity tax, and the advantage must be passed on in full to users.
- ▶ Introduce a speed limit on the German motorways: this will directly reduce CO₂ emissions and influence the structure of new vehicle fleets. It will also reduce accidents.

What will we have achieved in 2020?

Although the volume of traffic has continued to rise, emissions of greenhouse gases from the transport sector have fallen by over 20% compared with 2005. To achieve this, the German government has been promoting more efficient technologies with lower emissions, while at the same time far more traffic has shifted from the roads to water and rail. Interfaces and hubs to connect these different modes have been strategically developed.

Combustion engines are 20% more efficient thanks to new technological advances and improvements. Energy-efficient components (such as tyres with low rolling resistance) have also resulted in much lower consumption. Renewable energies are helping to cut emissions from transport, not only in the form of biofuels, but by means of vehicles run on electricity. There are already well over a million electrical vehicles on German roads which run on power from renewable sources. This helps to iron out fluctuations in wind and solar energy.

Vision 2030

- ▶ Thanks to efficient technologies and electric vehicles, greenhouse gas emissions in passenger transport have fallen substantially.
- ▶ Freight miles have nevertheless increased considerably.
- ▶ In the transport sector as a whole, emissions of greenhouse gases have declined by at least 30% compared with 2005.

10. We will bring international climate negotiations to a successful conclusion.

Where are we now?

The world has reached a crossroads in climate change. According to the 4th Assessment Report by the Inter-

governmental Panel on Climate Change (IPCC), the Earth has warmed by 0.74 °C over the last century, faster than at any time in the last 1000 years, and the pace of warming continues to increase.

Most of this change can be attributed to human influence, above all burning fossil fuels such as coal, gas and oil, which emit large quantities of harmful greenhouse gases. As industrialisation spreads across what we call the newly industrialising countries, the speed at which emissions grow could increase considerably. The World Energy Outlook 2008 recently showed that if action to reverse the trend is not taken now, global emissions of greenhouse gases will rise 45% by 2030. If this happens, by 2100 the Earth may be as much as 6.4 °C warmer than before the industrial age, with devastating consequences for our ecosystem: storms, heavy rain and floods would increase and sea level would rise by up to one metre across the globe. To stop that prediction coming true, effective action must be taken at once – and it must be global.



What have we done so far?

The foundations for global action to combat climate change were first laid in 1992 when the Framework Convention on Climate Change was signed in Rio de Janeiro. The aim was to stabilise the concentration of greenhouse gases at a level that would prevent interference with the climate system.

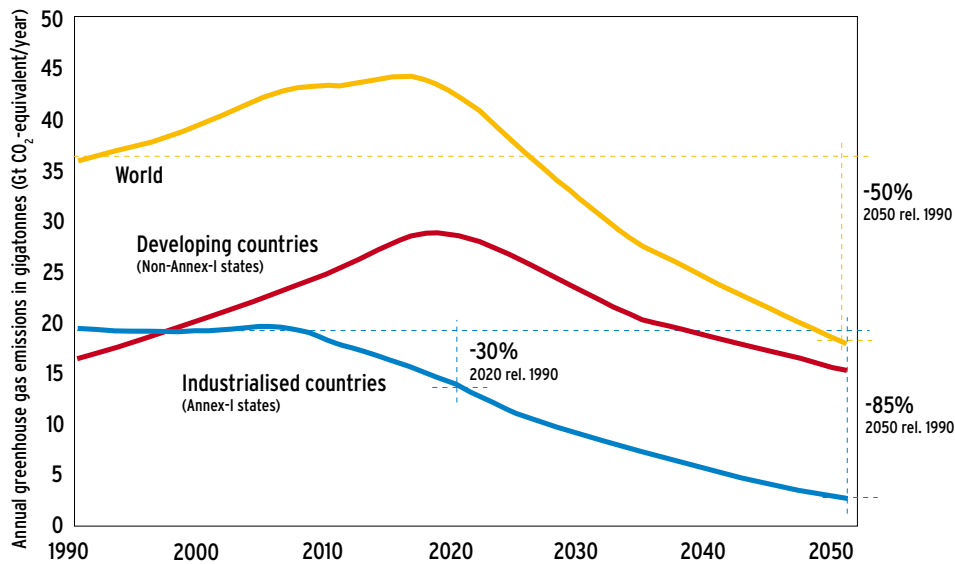
In 1997, at the third Conference of the Parties in Japan, the Kyoto Protocol was signed. This was the first time that industrialised nations, as the main contributors to climate change, made legally binding commitments to cut their greenhouse gas emissions. So far 183 countries, accounting for 63.7% of greenhouse gas emissions, have signed up to the Protocol.

The main increase in greenhouse gases in the next few years is expected in newly industrialising

countries, where climate protection is often not a priority and tends to be perceived as a hurdle to development.

The industrialised nations have a historical responsibility to set a good example in this field and to demonstrate that climate protection and economic development go hand in hand. Recognising this, the EU has already adopted concrete measures to combat global warming. In 2007, under Germany's EU presidency, the 27 Member States resolved to cut CO₂ emissions to 30% below 1990 levels by the year 2020 if a global agreement is reached, and in any case by at least 20%. Renewable energies are to be expanded to meet 20% of total final energy consumption in the EU and efficiency is also to increase 20% by 2020. Since 2005 emissions trading in the EU has set a cap on CO₂ emissions in the power sector and in industry.

Required fall in greenhouse gas emissions



What remains to be done?

All states will need to make an appropriate contribution if climate change is to be countered effectively. A new climate agreement will have to be agreed in Copenhagen in 2009 for the period after 2012, when the first commitment period under the Kyoto Protocol comes to an end. It will have to set a long-term objective for reducing global emissions by at least 50% by 2050. It needs to cover all major emitters and commit industrialised nations to the target for 2020 of reducing emissions to levels between 25% and 40% lower than in 1990.

The newly industrialising countries must make an appropriate contribution to cutting greenhouse gases. Their emissions need to be well below business-as-usual levels. The industrialised nations must provide the developing countries with financial and technological support in greening their economies.

Furthermore, the poorest countries, and those hit hardest by climate change, need assistance in adapting to global warming. Clean Development Mechanism projects, where industrialised states promote greenhouse gas mitigation in less developed countries, will continue to help disseminate climate-friendly technologies.

What will we have achieved in 2020?

The follow-up agreement to the Copenhagen Climate Agreement is entering into force. All major emitters of greenhouse gases fall within its scope and it sets binding targets for emission reductions up until 2030. It has proven possible to reverse the global trend in emissions.

The industrialised nations continue to honour their responsibilities towards less developed countries in

the field of climate protection. The European Union has set a good example and cut its greenhouse gas emissions to 30% below 1990 levels by 2020, and in Germany's case 40%.

A global emissions trading scheme has been established, creating incentives for vital technical innovations to cut greenhouse gases. By auctioning allowances, financial flows are generated that serve in particular to pay for adaptation, forest preservation and technology in the developing countries.

Vision 2030

- ▶ Global emissions of greenhouse gases have fallen to at least 20% below 1990 levels.
- ▶ There is an international climate protection agreement, where all the major countries have made ambitious mitigation commitments.
- ▶ Germany has managed to reduce its emissions by over 50% compared to 1990.

III. BMU SCENARIO FOR A SUSTAINABLE ENERGY SUPPLY IN 2020

BMU scenario for a sustainable energy supply in 2020

An integrated energy policy for our current age cannot confine itself to isolated measures in different fields, but must always keep the bigger picture in mind. The interplay between the electricity, heat and transport sectors must be taken into account and incorporated in the ongoing development of the energy system. Electromobility is a case in point: electrical vehicles stand to play a valuable part in offsetting the fluctuating generation of power from wind and solar energy. At the same time, protecting the climate makes it essential to meet additional demand for electricity from renewable sources of energy. In this way, electromobility and renewables complement and stimulate each other.

Mutual dependence between the various sectors affects the way the targets set by the German government can be reached. Improving energy efficiency plays a key role here, because a substantial decrease in energy consumption is vital to achieving the targets for both the reduction in greenhouse gas emissions and the increased use of renewable energies within the overall energy portfolio.

Consequently, the above measures in the different sectors all help to optimise the overall system, too. The integrated approach is important, because it combines supply and demand factors. On the one hand, energy must be used efficiently, and on the other, the energy supply must be structured in such a way that it reflects a mix of both renewables and efficient, flexible conventional sources of energy. And throughout this process every sector will be required to take resolute action.

If every measure is consistently implemented, the sustainable energy supply of 2020 should present the following picture:¹

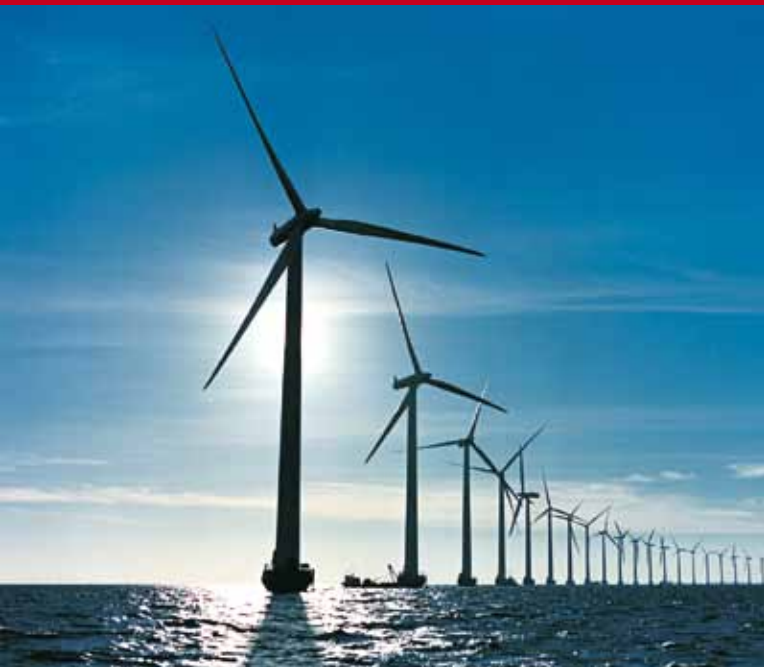
EFFICIENCY

Energy consumption will decline, despite growth in all sectors, as a result of substantial gains in energy efficiency.

- ▶ The **electricity requirement** will decrease by 11%. Gross electricity consumption can be reduced from 618 TWh today (2007) to less than 550 TWh by 2020, a reduction of nearly 11%. This is still far from exhausting the technical and commercial reduction potential of 110 TWh.
- ▶ The fossil **heat requirement** will fall by at least 25%. There is broad consensus that the greatest potential for savings lies in the market for heat. By 2020 the demand for heat is expected to fall to 20% less than in 2005. Combined with an increased use of renewable energies in the supply of heat, this means that the fossil heat requirement will decline 25% by 2020.
- ▶ The energy requirement for **transport** will decrease by at least 20%. There is hardly a sector where energy is used so inefficiently at present as in transport. By 2020 the energy requirement can be reduced by at least 20% thanks to more efficient technologies and a greater use of environment-friendly modes of transport.

All things considered, doubling energy productivity will result in a decline in primary energy consumption of 13% compared with 2007 (from 13,842 PJ to about 12,000 PJ). By 2030 primary energy consumption can be cut to a good 10,000 PJ (28% down on 2007).

¹ The BMU scenario is based on the RE Expansion Scenario described in the Prognos/EWI Report for the Energy Summit in 2007, adapted to current trends in the field of renewable energies with the aid of the Renewable Energies Lead Study 2008. Account was taken of the fact that, due to present coal/gas prices, additional coal-fired power stations are likely to be built faster than Prognos/EWI predicted. However, this adjustment has been made with the proviso that the target of cutting greenhouse gas emissions by 2020 to a level 40% lower than 1990 is nonetheless achieved.



ENERGY MIX

The share of renewables in the energy mix will continually increase. In the power sector in particular, the use of fossil fuels and nuclear power will decrease accordingly. Nevertheless, fossil fuels will of necessity continue to be the biggest factor in the energy supply.

- ▶ The proportion of **renewable energies** will grow.

Renewable energies will be expanded in line with German government objectives, meeting about 33% of power consumption and about 14% of the heat supply by 2020. This means that the contribution of renewables to meeting total final energy consumption is on track to reach the EU's renewable energy target for Germany of 18%. Expansion will continue to gain momentum after this.

Wind energy plays a key role in achieving the targets for expansion. According to the 2008 Lead Study by the Federal Environment Ministry, power generation from wind will increase from just under 40TWh (= 40 billion kWh) in 2007 to more than twice as much (nearly 90 TWh) in 2020 and over 140 TWh in 2030. From about 2025 onwards, offshore generation will exceed land-based output.

- ▶ The **nuclear phase-out** will not be reversed.

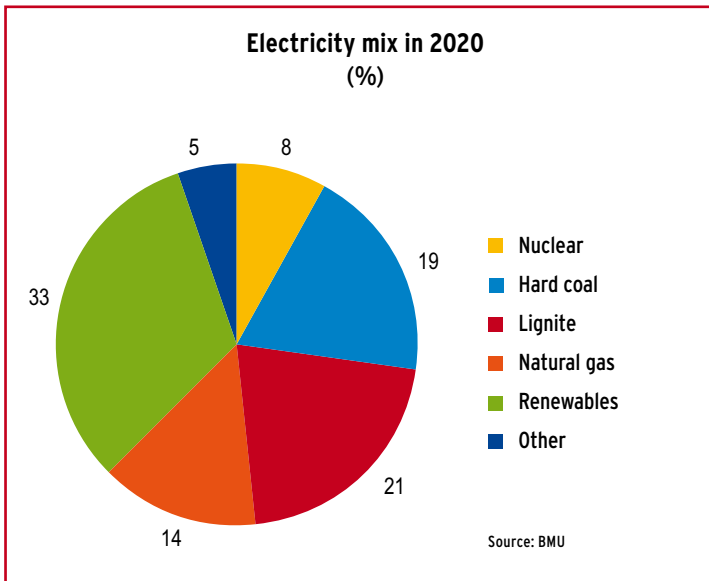
Longer operating lives for inflexible nuclear power stations, which are almost incapable of responding to demand, would undermine essential progress towards a supplier and more decentralised energy supply. Longer service would delay substitution investments in long-term solutions – renewable energies and energy efficiency – and take on board the high security risks involved.

- ▶ The **coal factor** remains important.

Hard coal and lignite will remain important fossil fuels for power generation (approx. 40% in the electricity mix for 2020). This highlights the need to do all we can to use fossil fuels as efficiently as possible. A vital role is played here by the aim of generating 25% of our electricity in combined heat & power installations.

- ▶ The **role of natural gas** will change.

By 2020 the share of natural gas in power generation will increase from the current 12% to about 14%. This is necessary, partly to maintain a flexible complement to the fluctuating output from wind and solar energy and to achieve the targets for expanding cogeneration. On the other hand, the use of natural gas in heat generation will decline considerably in the long run. That is because the overall heat requirement will fall and the contribution from renewables will rise. In net terms, therefore, gas consumption will not increase in Germany.



SUPPLY SECURITY, GROWTH AND CLIMATE PROTECTION

The BMU scenario for a sustainable energy supply shows: A lastingly secure and climate-friendly energy supply without risky nuclear technology is possible. By enhancing energy efficiency, expanding renewable energies and building new, state-of-the-art power stations fired by coal and natural gas, nuclear energy can be fully compensated as it is phased out.

Moreover, the German government's objective of reducing greenhouse gas emissions to levels 40% below 1990 by the year 2020 can be met by consistently pursuing a dual strategy of efficiency and renewables. The caps on emissions imposed by emissions trading ensure that these ambitious targets to protect the climate can be upheld.

Energy efficiency and renewable energies are significant innovation drivers. One example of an innovative idea with plenty of potential is the development of solar thermal power stations. In these installations, sunlight is concentrated by mirrors to generate high temperatures (over 400 °C). The solar heat produced in the process can then be used, as in a conventional power station, to generate steam and ultimately electricity. When combined with heat storage, solar thermal power stations can deliver electricity round the clock. As with many other technologies in the fields of renewable energy, coal- and gas-fired power stations and energy efficiency, Germany is world leader, and intends to remain so.

If we in Germany invest now in greater energy efficiency and renewable energies, the industries concerned can consolidate their competitive international credentials in this important lead and export market. Wind energy illustrates impressively that it is strategically smart to push the technologies of the future. Today, the early support devoted to this technology is creating many jobs in Germany, and in terms of exports it has been a winner, because German companies account for about a third of the global market in wind power.

The Road Map Energy Policy 2020 shows that this dual strategy of enhancing energy efficiency combined with expanding renewable energies reaps economic and ecological rewards. It protects the climate, boosts the creation of value in the domestic economy, generates new jobs and builds a stronger future for Germany's competitive position in the global markets for key technologies. That is why Germany needs an ambitious integrated climate and energy policy.

PUBLICATION ORDER:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Postfach 30 03 61
53183 Bonn
Germany
Tel.: +49 228 99 305-33 55
Fax: +49 228 99 305-33 56
Email: bmu@broschuerenversand.de
Website: www.bmu.de/english

This publication is part of the public relations work of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. It is distributed free of charge and is not intended for sale. Printed on recycled paper.