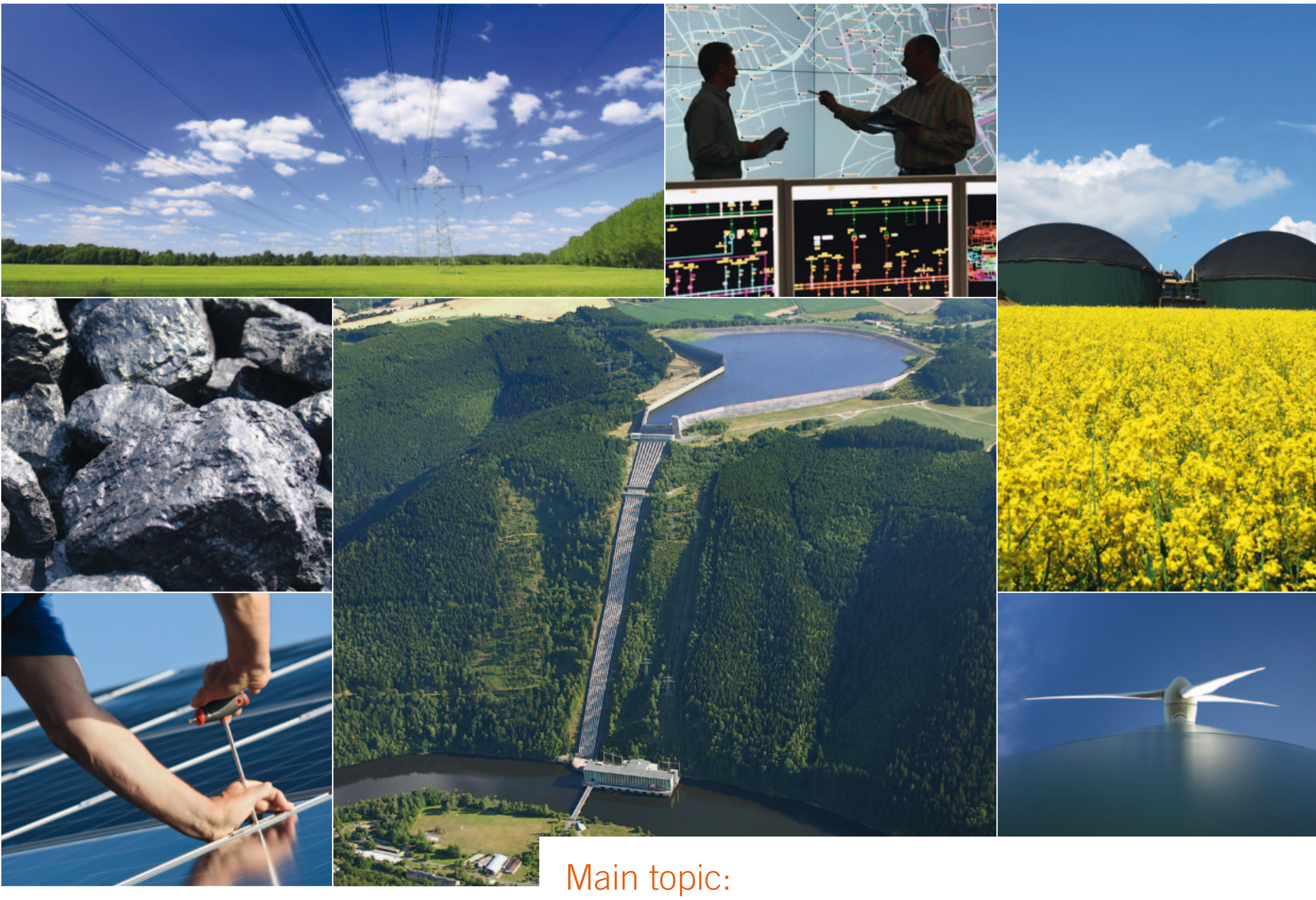
Energy for Germany 2011

Facts, outlook and opinions in a global context



Main topic:

Integration of renewable energies into the power supply system

WORLD ENERGY COUNCIL

Weltenergierat - Deutschland

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Foreword

The dramatic events in Japan, above all the terrible disaster at the nuclear power plant in Fukushima, have provoked deep shock – and not only within the energy industry. This disaster is the precursor to far-reaching and long-term effects in the region. At the same time, the disaster has also prompted a debate around the world on the security of nuclear energy. One thing at least has become clear: in the aftermath of this event, the energy industry cannot simply continue business as usual.

Natural catastrophes on the scale of the one in Fukushima are not a risk in Germany. Nevertheless, the terrible images from Japan have triggered a political earthquake in our country. The first repercussions of the Japanese disaster were seen just a few days afterwards, when the German government imposed a three-month suspension on its decision to extend the lifetime of nuclear reactors and ordered the immediate shutdown of reactors which went into operation before 1980. A few weeks later, a political decision was reached on the future of nuclear energy in Germany: in July 2011, Federal President Christian Wulff signed the Nuclear Power Phase-out Act. Under this act, the operation of nuclear power plants in Germany is to be discontinued step by step by the year 2022. In addition, the 8 of Germany's seventeen nuclear plants which were shut down during the moratorium will remain permanently offline.

The consequences of our national policy decisions will also impact neighboring countries. As a result of its short-notice shutdown of around 8,000 megawatts of easily controllable generating capacity in the base load, Germany has in fact reduced the safety margins of the entire European network to a critical level. Moreover, the price increases already evident today and the further increases to be expected in the long-term also directly impact our European partners. This is reflected in the international criticism voiced over the past few months. As the largest energy market in the center of Europe and closely connected with its neighbors, Germany bears a particular responsibility. Germany's energy policy needs to win over the rest of Europe.

Notwithstanding Germany's decision, the top priority in the operation of nuclear power plants must be the safety of these plants. This is – and was – without doubt. But safety doesn't stop at national borders, especially not in a place as densely populated as Europe. Here, despite its current political reorientation, Germany would be well advised to participate actively in the review and further development of safety requirements and safety facilities at European level. Because even after the events in Japan, it is to be assumed that across Europe nuclear energy will continue to be used for decades to come. Corresponding initiatives are already underway. At the end of May, the European Commission together with the European Nuclear Safety Regulators Group (ENSREG) already defined criteria for a Europe-wide "stress test" for nuclear power plants. Now the Member States must carry out the stress tests based on these criteria by the end of 2011.

The safety aspects are at the forefront of the discussion – and rightly so. But the disaster in Japan has also had effects on the market. There has been a significant increase in demand for LNG (liquefied natural gas) to compensate the widespread outages within Japan's energy supply system. At the moment, the market is able to satisfy this increased demand very well since the USA has now all but ceased import of LNG. One major reason for this is the massive increase in extraction of unconventional natural gas (shale gas) there in recent years. These circumstances and associated effects were also among the central topics at the World Energy Congress in Montreal last September. A detailed presentation of the results of this conference can be found at the back of this publication.

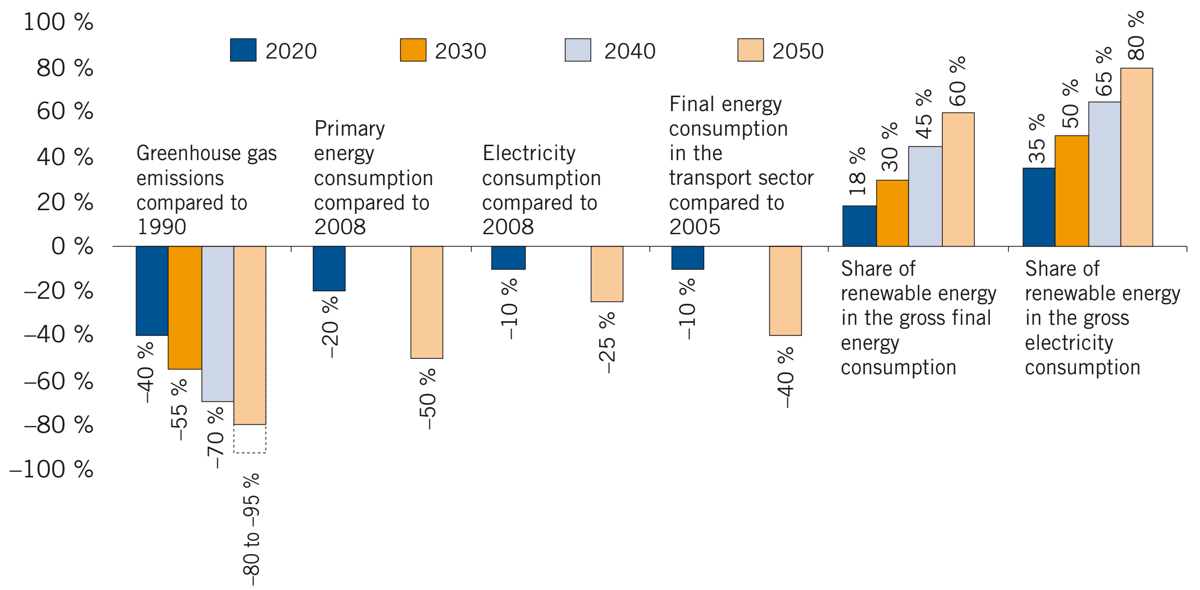
The question as to whether energy policy with a national focus still makes sense at all is becoming ever more justified. Markets are growing together internationally, business flows are increasingly assuming a global focus and demand for energy is increasing rapidly in emerging countries. The German energy supply system in particular, situated in the heart of Europe, will have to take significant account of policy direction at European level. In November 2010, the European Commission clearly defined its priorities with the presentation of its Energy Strategy 2020. This provides a stable foundation and a reliable package of measures for implementation of the energy and climate policy objectives[1] of the European Council by 2020. One specific focus of the European Commission's energy strategy is the systematic application of existing instruments, particularly with regard to completion of the European internal energy market. This is the right approach, particularly in order to avoid market distortions, but consideration should perhaps be given to additional monitoring instruments.

On the way to a sustainable internal European energy market, infrastructure development assumes an essential role. The infrastructure package also presented by the European Commission last November must therefore also be considered a central component of the strategy and one of the most important policy objectives for the coming years. By 2020, the European Commission estimates that investment volume will be approx. one billion Euro; distributed more or less equally between the sector of generation capacities on the one hand and energy networks and storage systems on the other hand. In view of the massive investment needed, especially in the field of energy networks, the critical factors for their successful development are the use of market mechanisms and the creation of attractive investment conditions, including risk-adjusted returns and coordinated or harmonized regulatory conditions. Projects of European interest must also be measured by appropriate criteria. Even in the generation sector, security of investment is essential. The tendency to use energy policy targets to increasingly undermine the market is, in this context, of little benefit. How much market regulation and how much government regulation will there be in future? Companies need clear, long-term prospects here to better understand where developments are leading. Particular challenges will be the simplification and acceleration of approval procedures and the acceptance of infrastructure projects within the population.

The European Council's energy summit at the beginning of February 2011 basically reaffirmed the path laid down by the Energy Strategy 2020 and established benchmarks. The EU heads of state and government agreed on the year 2014 as the target date for completion of the single internal market for electricity and gas, with adequate connection of all Member States to be achieved by 2016. But the delegations – particularly Germany – did find it difficult to think European on the future development of renewable energy, particularly with regard to their gradual entry and integration into the market. Legislative

1 This includes a reduction of greenhouse gas emissions by 20%, increase of the proportion of renewable energies to 20% and a 20% increase in energy efficiency

Objectives of the German Energy Concept, 28 September 2010



Further objectives: duplication of the renovation rate from the current figure of less then 1 % a year to 2 % of the total building stock.

Source: Energy concept of the German federal government proposals on the infrastructure package and the establishment of a long-term outlook up to 2050, which the European Commission is expected to present by the end of 2011, are eagerly anticipated.

The existing national energy strategies, including the German energy concept, will be essential for the development of a European energy road map for 2050. In last September's energy concept, the German government was the first European nation to present a concrete framework for transformation of its energy system into one based primarily on renewable energy sources. This includes reducing primary energy demand by half, reducing greenhouse gas emissions by 80-95%, and increasing the share of renewable energy sources in electricity production to 80% (see illustration). The very ambitious targets for the year 2050 set out in the energy concept are internationally unprecedented. In July 2011, Germany enacted a comprehensive legislative package for its future energy policy. This package aims to accelerate the shift towards a sustainable energy system by 2050 and is the first step to actively implementing the concept. It includes amendments to several energy acts and proposes additional projects that would assist the country with its new energy policy. It also incorporates further development of the legal framework to accelerate the urgently needed and largely delayed grid extensions. The most discussed and probably most far-reaching element in the package is the nuclear energy policy turnaround from lifetime extension to a resolution on accelerated phase-out.[2]

The decision to shut down the nuclear power plants in Germany early will significantly accelerate the pace of transformation again. The technical and economic impacts on the entire energy system and Germany as an industrial base cannot yet be anticipated. In this context there are some important questions to be asked. Does the already extremely ambitious energy plan offer the scope required for such a step? Is it possible to maintain the ambitious goals, particularly the CO_2 target? Where will the funding essential to finance the transformation come from? How can the energy supply be secured without having to rely too heavily on imports? How will the plan to introduce CCS technology in power plants using fossil fuels progress? How soon will the much-needed grid expansion and development and implementation of storage technologies occur? The answers to these important questions will be critical in determining how we succeed in transforming the energy system. As a highly industrialized country, Germany needs an energy policy with long-term sustainability. An important steering element is anchored into the process in the form of the planned monitoring, which is intended to redirect and rebalance in case of aberrations. This applies in particular to the issue of cost advances, security of supply and climate protection.

It is clear that the transformation is already in full swing and will continue to move forward. The proportion of renewable energy sources in Germany's electricity consumption has almost tripled over the past ten years to top 17 % in 2010. The vast majority of this expansion, around 70%, is attributable to the extremely variable power generation from wind and solar energy. By the end of the year 2010, the installed capacity of photovoltaic systems alone in Germany was approximately 17,000 MW. Additionally there is also around 27,000 MW of installed wind energy capacity. And this is a trend that is increasing. This dynamic expansion has brought costs for consumers as a result of the German Renewable Energy Act reallocation fee (EEG surcharge) and the level these costs have now reached (over €12 billion in 2010 alone) is causing considerable criticism and even a fundamental questioning of the acceptability of renewable energy sources. The social implications of the costs for households, which have already been fixed for the next 20 years and which continue to increase dramatically, should not be underestimated. This applies equally to the implications for trade and industry which are subject to international competition. New balanced solutions must be found.

The increased proportion of fluctuating power generation will however also lead to major challenges for its integration into the existing supply system. In the past, power grids were not designed to deal with unequal regional distribution in wind and solar energy supply. At certain times, the transmission reserves seem to be exhausted in certain regions. This is also documented in a monitoring report by the Federal Ministry of Economics and Technology on reliability of supply. Practical issues of conversion, especially relating to future integration of the now mature renewable energy sources, must therefore be addressed and answered now.

2 In the Energy Concept from September 2010, nuclear power was supposed to play the role of a bridging technology to enable achievement of the ambitious climate goals, offer a sufficient level of supply security and provide the financial resources to successfully transform the German energy system. Therefore it was decided, as one important pillar of the energy concept, to extend the lifetime of nuclear power plants from 32 years to approximately 45 years. But a few months later, in the wake of the nuclear disaster in Japanese Fukushima, the German government reversed the lifetime extension already legally enacted. The new legislation from July 2011 provides that by 2022 all German nuclear power plants will be shutdown step by step. This represents an about-face for the utilization of nuclear energy in Germany.

Therefore, this year's issue of "Energy in Germany" focuses specifically on the "integration of renewable energy sources into the electricity supply system." We want to lend new impulses to the political and public debate in Germany and make our contribution to an intelligent turnaround of energy policy. For the enormous challenges before us, I wish us all the necessary courage but also due care and prudence. I hope that this publication will be useful in that respect.

Jürgen Stotz
Berlin, September 2011

Inhaltsverzeichnis

Main topic: Integration of renewable energies into the power supply system*

By Dr. Jürgen Neubarth, e3 consult OG

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* Translation of the summary published in „Energiewirtschaftliche Tagesfragen“, 8/2011, p.8-13. The full article is available in German and has been published in „Energie für Deutschland 2011“.

Whilst, as a reaction to the nuclear disaster at Fukushima, the German government presented an energy policy concept in record time, converting the energy system will be an ongoing task for the coming decades. Within this framework the integration of renewable energy into the power supply system is one of the major challenges for the energy transition. This makes it all the more important to thoroughly analyze and evaluate related aspects. As a basis for discussion, the key issue of "Energy for Germany 2011", provides a detailed overview of these challenges and demonstrates that only a combination of system-related and organizational measures can facilitate efficient integration of renewable energy sources.

Today, at both German and European level, increasing the electricity generated using renewable energies (RE) is regarded as an essential lever towards long-term reduction of greenhouse gas emissions; it is no coincidence that the World Energy Council devotes considerable attention to this topic[1]. According to the objectives of the German government's energy concept, the share of renewable energies used to generate the nation's electricity supply should be 35% by 2020, increasing to 80% by 2050[2]. Because of their considerably greater potentials for expansion when compared to hydropower, biomass and geothermal, it will be wind and solar power that will make the biggest contribution here.

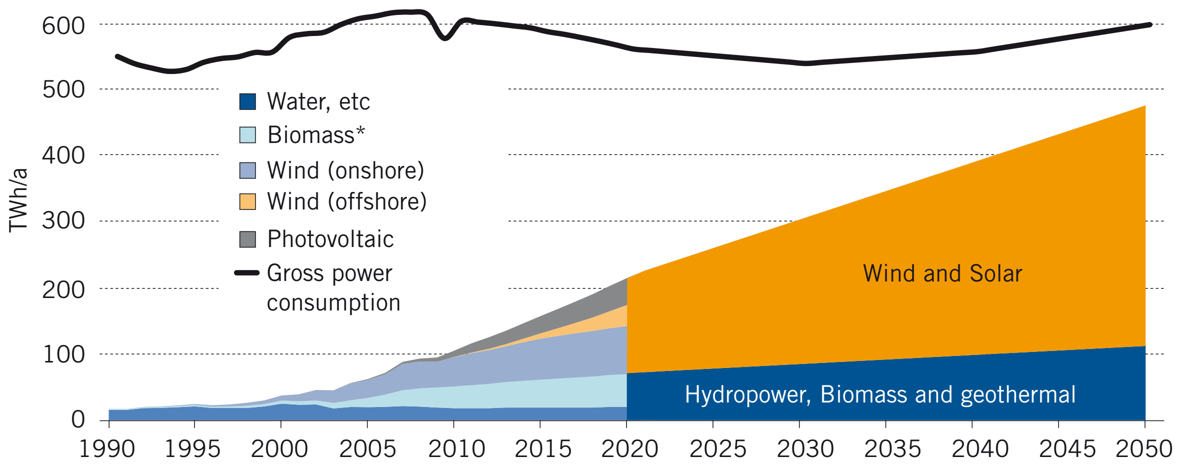
Wind and solar power to lead expansion

Almost 95 % of the 57,000 MW of RE power to be installed by 2020 is to use fluctuating wind and solar energy (Fig. 1). Even after 2020, wind and solar energy will dominate renewable energy expansion, although it is precisely power generation from these two sources that presents the biggest challenges for integrating renewable energies into the existing electricity supply system. In the past, power grids were not designed for unequal regional distribution, as it is the case with power generation from wind and solar energy; also conventional power plants up to now have only had to balance fluctuations on the demand side, not on the supply side.

Fig. 2 shows an example of the fluctuations in power generation using wind energy in Germany for different time intervals. Over the course of hours and days depending on prevailing wind and weather conditions, there can be fluctuations in generation ranging from practically nothing to nearly 85%[6]. Looking at the monthly pattern, there is higher wind power generation during the winter months, but within individual months there can be deviations from the relevant long-term monthly averages by up to +90/-50% and in some years deviations from long-term annual averages may be up to +/-15%[7].

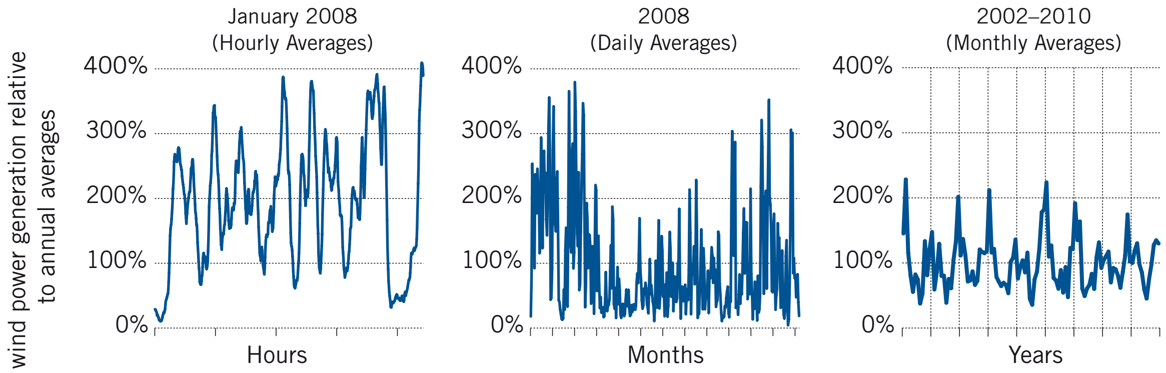
Besides the absolute fluctuation range within a given time interval, the speed with which these power fluctuations occur is also relevant for guaranteeing adequate system stability (known as the "power gradient" or "ramp"). For

Figure 1: Historical and possible future development of gross power consumption and the contribution of renewable energies[2–5]



*incl. sewage and landfill gases and biogenic portions of the waste
Source: BMU, Federal German Government, BMWi, DLR

Figure 2: Fluctuations in wind power generation in Germany



Source: BDEW, TenneT TSO GmbH, Amprion GmbH, 50Hertz Transmission GmbH, EnBW Transportnetze AG

example, it is estimated that for the year 2030 the maximum hourly fluctuation for wind power generation could be up to 25% of the installed capacity – i.e. more than 15,000 MW per hour[8].

Multiple impacts

Since publication of the "dena Grid Study I" in 2005[9], there has been intense discussion of the potential impacts of increasing the proportion of electricity generated from renewable energy sources on the electricity supply (Fig. 3), especially since system conflicts with the existing generation and grid structures could delay the further development of renewable energies. The fluctuating supply of wind and PV power has a direct impact on price formation at the electricity exchanges (so-called "merit order effect"). Consequently, there are also impacts on short-term operational planning of conventional power plants, which must compensate these fluctuations or satisfy the remaining demand (or "residual load") by way of flexible operation. Additional demands on conventional power plants result from the maintenance of an operating reserve to quickly compensate any difference between actual and projected power generation from wind and PV power plants. While renewable energies can therefore influence the operational deployment of conventional power plants in the short term, in the long-term they will

Figure 3: Interactions between renewable energy sources and the power supply system

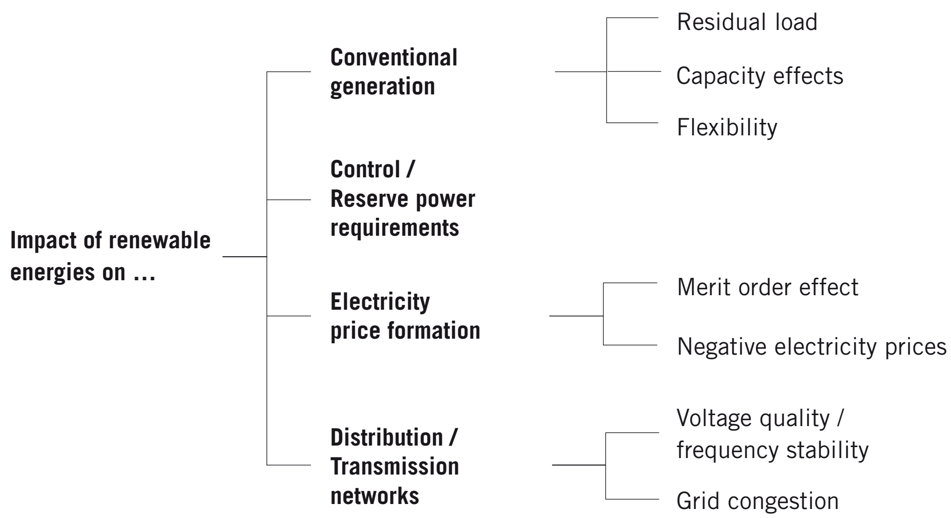


Figure 4: System-related options for the integration of renewable energies

System integration of renewable energies

Generation
- Flexible conventional power plants
- System responsibility for renewable energies

Grid
- Network optimization
- Expansion of existing networks
- New network concepts (supergrids)

Storage
- Central storage systems
- Decentralized storage systems

Consumers
- Demand management
- “New” consumers (e.g. heat pumps, e-mobility)

supersede conventional generating capacity (known as the “capacity effect”).

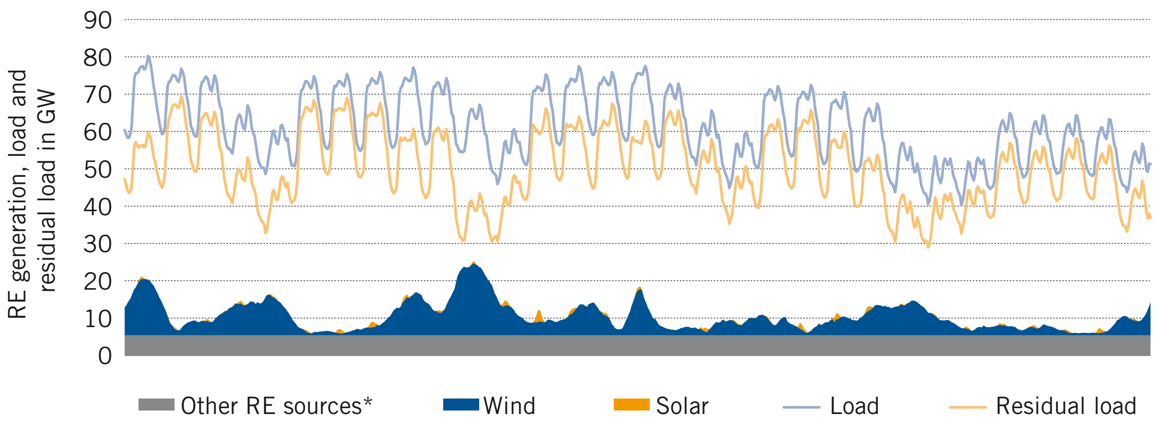
Besides the generation side, the grid itself will be particularly affected by expansion of renewable energy when regional or trans-regional generation surpluses lead to congestion thus forcing conventional power plants (and in some cases RE plants too) to reduce their power generation. A number of additional effects in the distribution and transmission network can occur as a result of the fluctuations in power generation, e.g. in terms of voltage quality and network stability, or as a result of specific technical characteristics of the plants, for example, provision of reactive power.

It is already evident today that the existing generation and grid structures are only partly suitable to efficiently integrate the increasing proportion of power generated from renewable energy sources. Accordingly, alongside the expansion of renewable energy sources, the structures of the existing power supply system must be adapted to enable the feed in of the increasing proportion of renewable energies. Fig. 4 gives an overview of the possibilities for system optimization for the integration of renewable energies – these will be described in more detail below.

Flexibility of conventional power plants

In principal, the compensation of load variations and generation outages are not new tasks for conventional power plants. However increased power generation from renewable energies has led to an overall increase in the structural and operational demands on the generating system which has a particularly strong impact on conventional power plants. On the one hand, the demand for conventional generation is shifting significantly from base

Figure 5: Load, power generation from renewable energy sources and residual load in Germany for December 2010



*generating characteristics simplified by assumption of constancy

Source: Source: ENTSO-E, TenneT TSO GmbH, 50 Hertz Transmission GmbH, EnBW Transportnetze AG load to medium and peak load. On the other hand, the dynamics of the residual load are changing within the relevant load ranges, i.e. even in the residual base load, operation for conventional power plants is only possible with frequent start-ups and shutdowns (Fig. 5).

The flexibility of the conventional power plants can be increased in principle by modernization of existing power plants and more flexible operation of nuclear power plants until their final decommissioning. Existing nuclear power plants have the technical potential to operate with the same flexibility as new hard coal power plants. But neither of the technologies comes close to the operating characteristics of new natural gas combined cycle gas turbines (CCGT) plants. In addition to their higher flexibility, combined cycle power plants have the additional advantage that they can potentially also be operated with hydrogen and methane produced synthetically from RE electricity. It is also still unclear whether future power plants working with CO_2-capture and storage (CCS) will be able to provide the comparatively high flexibility of the coal power plant technologies available today.

System responsibility for renewable energies

In addition to compensating generation and load variations, conventional power plants are today also responsible for providing so-called "ancillary services" and supporting the grid in the case of failures, such as short circuits or simultaneous tripping of large-scale generating capacities. However, in future conventional power plants will only be available for providing ancillary services to the extent to which they are required to meet demand. Correspondingly, renewable energies must themselves make a greater contribution to system security.

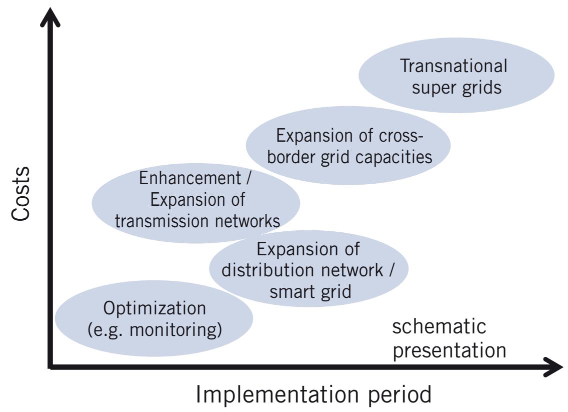
Development over the past 30 years has meant that today wind power plants can also actively influence their effective power output and thus contribute to frequency control (primary control). In addition to frequency control, renewable energies must also increasingly contribute to voltage regulation, mainly because the reactive power needed for this cannot be transported over long distances, but must instead be generated geographically distributed. Additionally, renewable power plants which support the grid in case of failures are a fundamental requirement for the integration of a high proportion of renewable energies. The systems also need to remain capable of isolated operation on the network and of contributing to the restoration of service after major disruptions. This is only possible if the plants are equipped with control and communication technology so that the network operator responsible for the system is able to control their production within a smart grid.

Smart grid complements expansion of the transmission network

However even a smart grid is no substitute for the need for grid expansion in the transmission network since achievement of the government's long-term renewable energy targets will be difficult to implement without utilization of central offshore wind power potential. In order to ensure that the network does not become a "bottleneck" for the further development of renewable energies, there are a range of potential strategies – from optimization of the existing network or expansion of network structures based on AC (alternating current) technologies to development of new network concepts (Fig. 6).

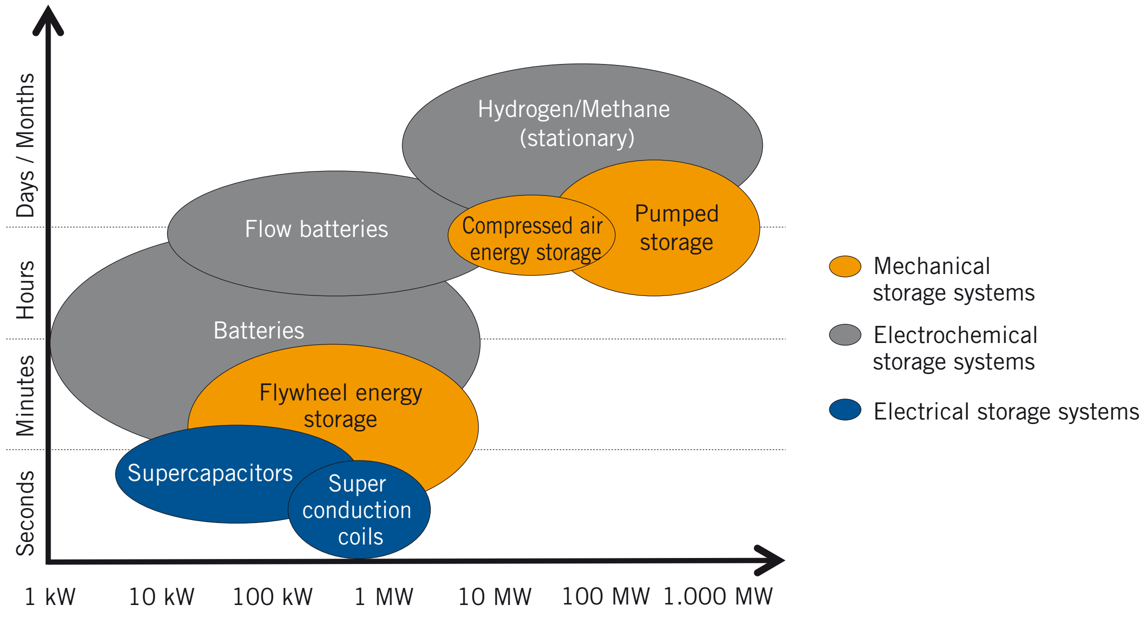
Even if public discussions on network expansion are currently focused heavily on German domestic grids, the necessity for expanding the transmission network does not stop at the border to neighboring countries. Greater involvement of the European electricity grid is especially important to effectively balance fluctuating regional production from wind and solar plants (due to weather conditions). However, as a result of the very high power levels and the great distances over which power must be transmitted, it is questionable whether Europe-wide balancing of power production from renewable energies is even technologically possible at all with the existing AC network. Consequently, new network concepts based on di-

Figure 6: Grid expansion strategies for long-term integration of renewable energies[10]



Source: nach Van Hulle[49]

Figure 7: Classification and applications of electrical energy storage systems[11]



Source: Hanning et al. 59

rect current (DC) are currently being developed which are to be established as an overlay network (so called "supergrid") parallel to expansion of the AC network.

Expansion of additional storage systems

Although expansion of the transmission networks represents a very efficient option for the large-scale balancing of fluctuations in power production from renewable energy sources, complete balancing throughout the network will not be either financially viable or technologically possible. Storage systems can enable flexible compensation of these fluctuations at local, regional and trans-regional levels and can also relief grid congestions.. In addition to pumped storage, over the last 130 years storage technologies have been developed for various power and capacity ranges (Fig. 7).

Pumped storage currently covers more than 99% of the worldwide market for stationary power storage. Just in Germany and the neighboring Alpine countries of Austria and Switzerland there is almost 12,000 MW of pumping power in operation and several more 1,000 MW under construction or at an advanced planning stage. Both pumped storage and compressed air energy storage (CAES), which is still in development, will be used primarily for hourly or daily storage. The use of a weekly or monthly storage systems or seasonal balancing of generation is not economically viable, not least due to the low storage capacities. One technical answer to this however could be the chemical storage of renewable energy electricity as hydrogen or synthetic methane. A major advantage of this is that there is already a nationwide infrastructure in Germany for the storage and distribution of natural gas with storage capacities of approx. 200 TWh[12]. However, this concept is still at a very early research and development stage.

For system integration of renewable energies small decentralized storage facilities connected to the distribution grid can be used alongside large central storage capacities. Possible areas of application for such battery storage facilities, installed in close proximity to the consumer, are in particular network support within the distribution grids. However, the costs are currently still 5 to 10 times those of pumped storage[13].

The consumer as a virtual storage plant

From the perspective of the overall system, additional involvement of the consumer in provision of flexible power reserves has the added advantage that existing technical facilities can be used without the need to build additional conventional power or storage plants, some of which are only operated for a few hours during the year. By way of demand adjustment in response to price signals it is possible to reduce consumption in the case of supply scarcity (e.g. in the case of low power generation from renewable energies) and to increase it accordingly in the case of excess generation.

This intelligent demand management (demand response) is particularly suitable for commercial and industrial consumers where it is possible to achieve a decoupling of electricity consumption and energy service by way of energy and or product storage. Demand response programs were introduced primarily in the U.S. to improve the security of supply after the frequent black-outs and brownouts in the late 1990s and early 2000s. In 2010 in the U.S.A. demand response programs with a potential load reduction of about 53,000 MW (around 7% of annual peak load)[14] were implemented. Depending on the time of year, Germany's overall technical potential is estimated at between 9,500 and 17,000 MW, whereby an additional potential of 17,000 to 25,000 MW would be available in winter via electric storage heaters and heat pumps[15].

Market integration alongside system integration

The existing potential for flexibility – power plants, storage, networks and consumers – can however only be used efficiently if they are actually available to the market. Since existing market desing often take inadequate account of the specific production characteristics of fluctuating power generation from wind and solar energy, further development of the legal and regulatory framework conditions is needed at both German and European level (see inter alia[16]).

In particular the efficient management of grid congestion at the interconnection of national electricity markets as well as liquid intraday markets can contribute to the market integration of renewable energies. What is important in connection with the development of liquid intraday markets is that they do not remain confined to national markets, but rather develop transnationally across the internal European electricity market on the basis of harmonized market rules. In the management of transnational grid congestion, this need is increasingly being met by introduction of what is known as market coupling. However, even market coupling does not optimize the available coupling capacities in real time, which would certainly support integration of the fluctuating and not fully foreseeable generation of power via wind energy and PV systems. Consequently, there is often a need for further development of congestion management from implicit auctions toward a load-based congestion management with intraday market coupling.

Market-based promotion of renewable energy sources

Intraday trading and congestion management help optimize Europe-wide compensation of fluctuating power generation and implementation of flexible power stations, storage systems or load management, but they do not necessarily lead to a more demand-orientated generation of renewable energies and thus to better integration into the electricity market. In order to achieve these effects, it is not only necessary to adapt the existing system to the fluctuating power supply from renewable energies, but also to create incentives to produce RE power based on electricity demand and thus regulate "green electricity with green electricity." Here the 2012 amendment to the German Renewable Energy Sources Act [EEG] is a step in the right direction with its introduction of an optional market premium model creating an incentive particularly for operators of variable RE plants to shift generation to the hours with the highest electricity prices – namely hours with high demand and/or lower production from wind and solar energy.

From energy market to capacity market?

The gradual adjustments of the existing market design described here can significantly support integration of renewable energies in the short and medium term. But in the longer term the existing market structures may not provide the necessary incentives for fundamental further development of the existing system of production beyond these adjustment measures. This may be the case in particular if the present market design of electricity pricing based on marginal costs does not offer sufficient incentive for investment in flexible power plants and storage systems. One proposed approach to solve this "investment dilemma" is what are known as capacity markets in which – in addition to the energy price based on marginal costs (€/MWh) – an additional power fee (€/MW) is charged for a time period established in advance for generation or storage capacity or for switchable load[18].

Due to their complex design, the implementation of capacity markets does however require careful analysis of the framework conditions of the energy market and energy policy and above all Europe-wide coordination. With this in mind, the German government also concludes in its energy concept concerning capacity markets that "the scientific debate is still in its infancy and therefore all relevant questions and proposals for a sustainable market design should be developed in a comprehensive research project."

Complete package integration rather than individual measures

Both the individual system-related features and the options for further development of the market design should never be considered in isolation from one another. Rather, they must be seen as part of an overall portfolio of essential measures for the integration of renewable energies into our power supply system. An overall assessment of all the available options has yet to be made but is urgently required to ensure efficient integration of renewable energies from an overall economic viewpoint.

In addition, there must be a fundamental change in the current approval process for energy sector infrastructure projects which are essential for the efficient integration of renewable energy sources and thus for implementation of the renewable energy golas in Germany. Without these accompanying measures there is a high risk that system conflicts with the existing generation and network structures will thwart the ambitious renewable energy goals in the power sector and thus steer the energy revolution into a dead end.

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Energy in Germany

2

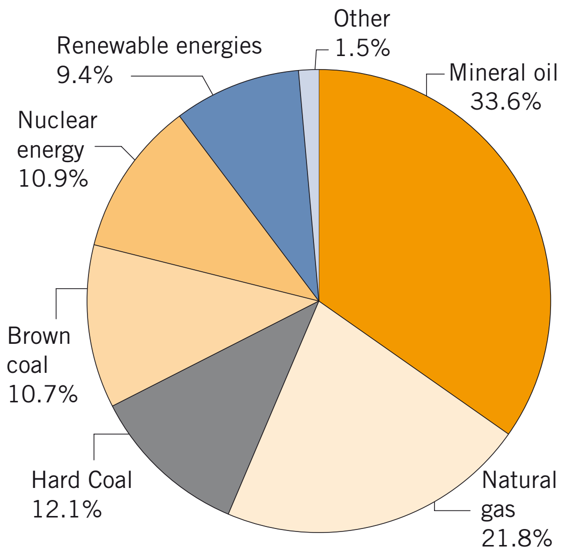
2.1 Facts & Figures

Key data for Germany's energy market

In 2010, Germany consumed 479.6 million TCE of energy. This means that Germany is the seventh largest energy market in the world after China, USA, Russia, India, Japan and Canada. Germany has an annual per capita consumption of 5.9 TCE of energy. This figure is more than twice the global average, but half the energy usage of the United States. If one relates these figures to the number of goods and services produced, then it is clear that Germany uses energy very efficiently. So in 2010, energy consumption in Germany amounted to about 192 kg of coal equivalent per € 1,000 gross domestic product. The global average for this specific type of energy consumption is twice as high. Between 1990 and 2010, the overall energy efficiency of the economy – measured in terms of primary energy consumption per unit of real gross domestic product with annual average rates of about 1.6% – improved by 1.8 % after adjustment for inventory and temperature effects.

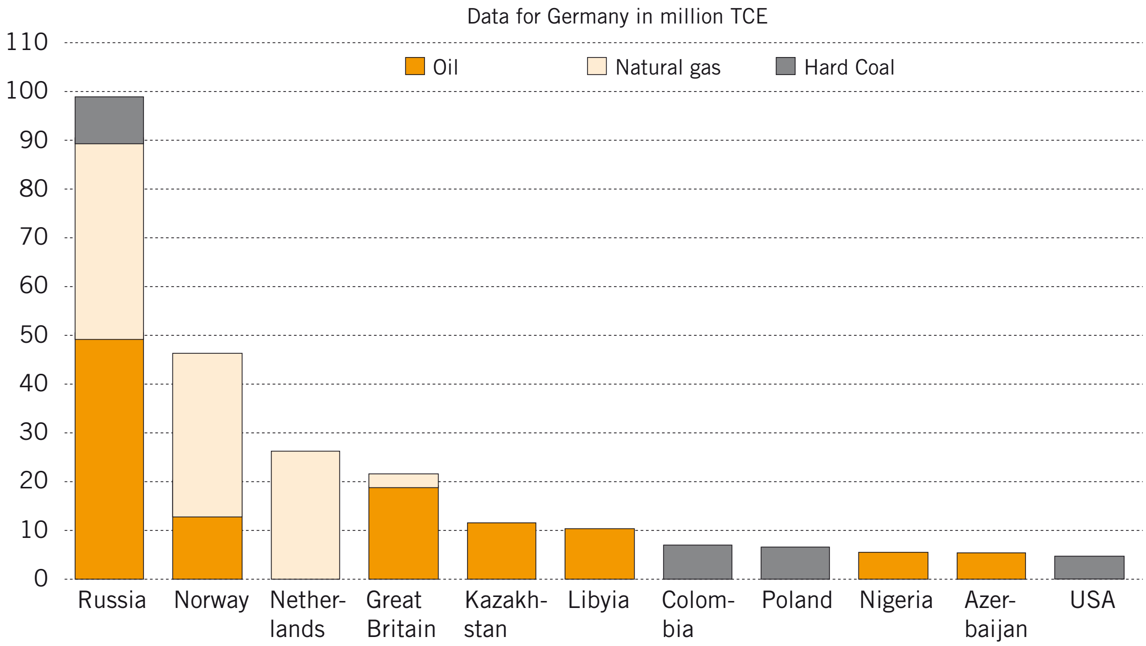
Germany's own energy reserves are limited mainly to coal. Its share of global oil and gas reserves is marginal. So Germany is forced to rely heavily on imports for these energy sources.

Figure 2.1: Primary energy consumption according to energy sources in Germany, 2010
Total: 479.6 million TCE



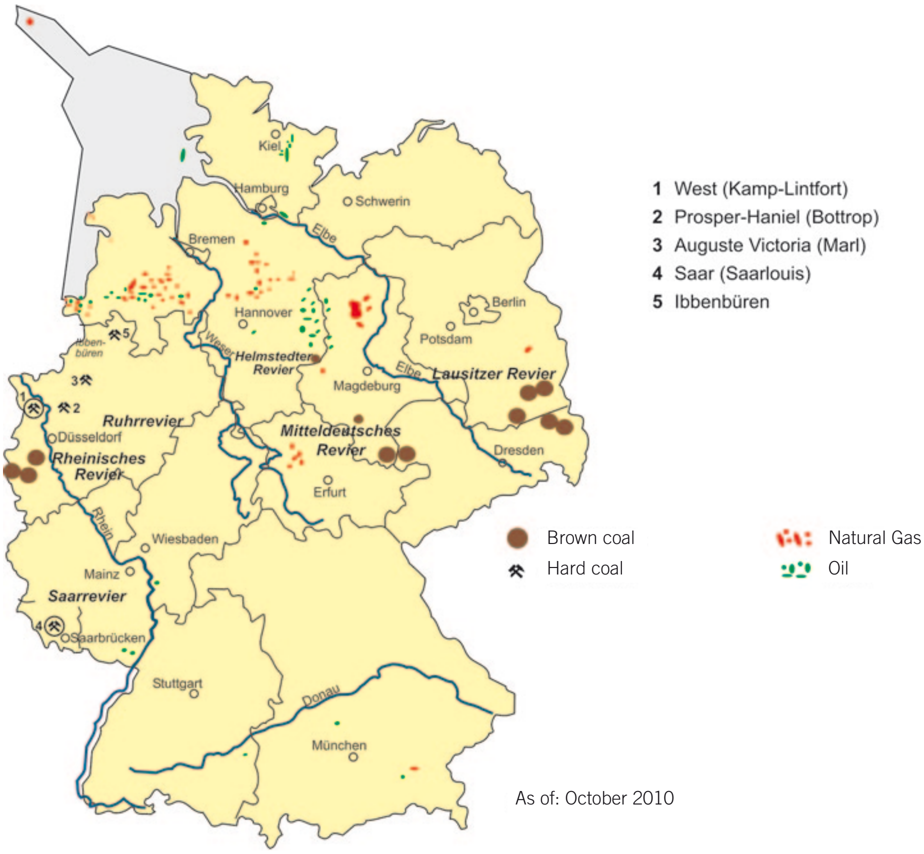
Source: Arbeitsgemeinschaft Energiebilanzen 2/2010 (Working Group on Energy Balances)

Figure 2.2: Suppliers of EnergyResources, 2010



Source: H.-W. Schiffer (calculations based on ACFA) (Bundesamt für Wirtschaft und Ausfuhrkontrolle)

Figure 2.3: Key Areas of energy production



Source: H.-W. Schiffer, Energiemarkt Deutschland (Germany Energy Market)

In 2010, 40% of energy consumption was covered by domestic energy (including nuclear energy, which is classified as domestic energy due to the large supplies of uranium within the country). Coal contributed 65.5 million TCE or 35% of total domestic energy production in 2010 (189.6 million TCE); of this 52.3 million TCE resulted from brown coal and 13.2 million TCE from hard coal. Next comes nuclear energy with 52.3 million TCE, natural gas with 13.7 million TCE, mineral oil with 3.7 million TCE, renewable energy with 45.0 million TCE and other energy with 9.3 million TCE.

Imported energy accounts for 60% of energy consumption. Energy imports are spread over a diverse range of sources and countries of origin. Germany's most important foreign energy supplier is the Russian Federation. Natural gas, crude oil and hard coal imports from Russia accounted for almost one-third of Germany's total energy resource imports in 2010. Russia is followed by Norway, the Netherlands, Great Britain, Kazakhstan and Libya. Germany imports natural gas from the Netherlands, oil from Kazakhstan and Libya and both natural gas and crude oil from Norway and Great Britain. Germany's most important hard coal suppliers in 2010 were Russia, Colombia, Poland, USA, Australia and South Africa.

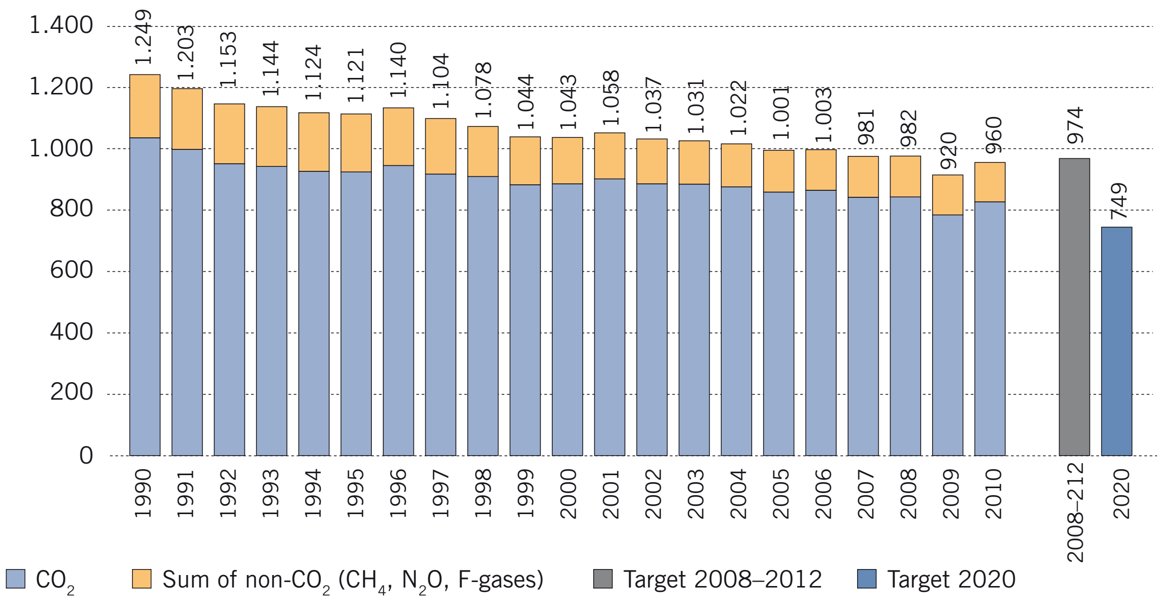
The foreign exchange costs for energy imports in 2010 amounted to approximately € 74.9 billion (net). Oil imports made up the largest share of net imports with € 50.5 billion. The second largest share of imports was natural gas with € 20.2 billion. Coal accounted for € 4.5 billion and uranium € 0.8 billion. In the case of electricity, Germany achieved a positive export balance of € 1.1 billion in 2010.

CO_2 emissions

According to calculations by the Federal Environment Agency (UBA), greenhouse gas emissions rose slightly in 2010. With overall emissions of 960 million tons, Germany remains below the Kyoto target of 974 million tons. However, compared to the previous year greenhouse gas emissions increased by a total of 40 million tons or 4.3%.

The commitments under the Kyoto Protocol of 1997 refer to a total of six greenhouse gases. These are – in addition to carbon dioxide (CO_2) – methane (CH_4), nitrous oxide

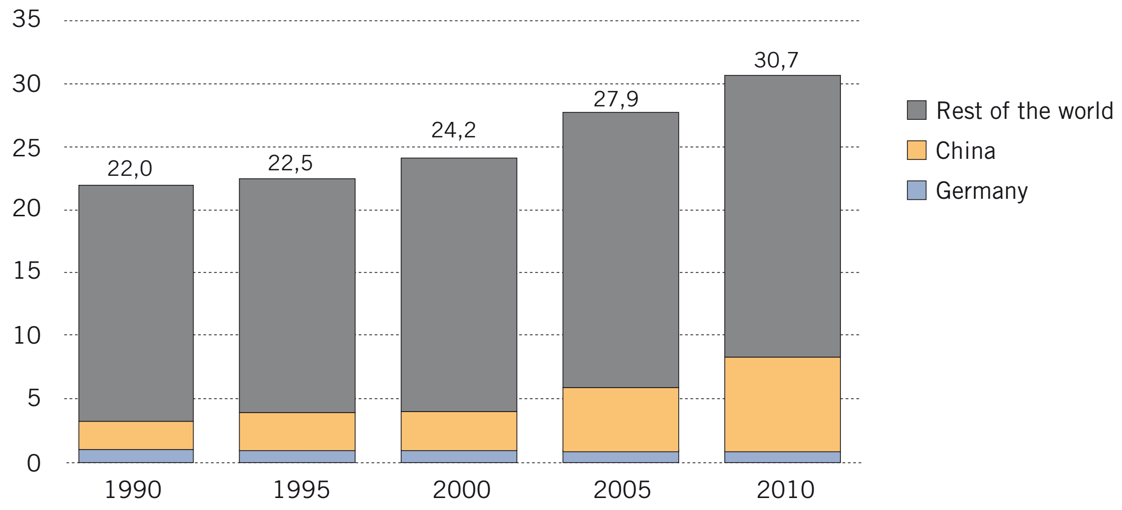
Figure 2.4: Emissions of the six greenhouse gases in Germany, specified in the KyotoProtocol (in million tons CO_2-equivalent, without CO_2 from LULUCF[1])



1 LULUCF= Land Use, Land-Use Change and Foresty

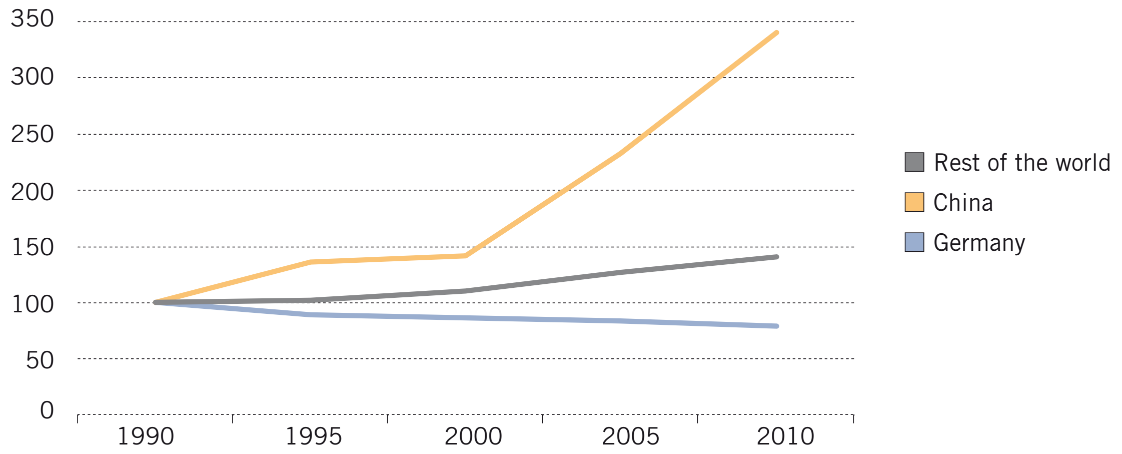
Source: Calculations from Federal Environmental Agency (Umweltbundesamt)

Figure 2.5: Development of global CO_2 emissions (in billion tons)



Source: H.-J. Ziesing ET 09/2010 (from1990 to 2009); own estimate (for 2010).

Figure 2.6: Development of CO_2 emissions (index 1990 = 100)



Source: H.-J. Ziesing ET 09/2010 (from1990 to 2009); own estimate (for 2010).

(N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

Since 1990, the emissions of all six greenhouse gases listed have been reduced by 23.1%. This means that Germany is on track to meets its obligations under the Kyoto Protocol and EU Burden Sharing (-21% in the period from 1990 to 2008/12). The development of overall German greenhouse gas emissions during the period from 1990 to 2010 is shown in Figure 2.4.

Energy taxes and other charges

The German Federal Government raised € 46.0 billion from the imposition of excise taxes (mineral oil and electricity tax) on energy in 2010. This represents almost two-thirds of Germany's total net energy imports. In 2010, mineral oils accounted for € 37.2 billion or about 81% of the energy consumption tax revenue. Natural gas and electricity contributed € 2.6 and € 6.2 billion respectively to the total revenue.

Consumption taxes represent a varying portion of the product prices. A mineral oil tax of 65.45 cent/liter is imposed on petrol. The equivalent tax on diesel (also sulfur-free goods) is 47.04 cent/liter. Taking account of value added tax too (since January 1, 2007: 19%), the calculated tax proportion of product price in 2010 was 62% (petrol super) and 54% (diesel).

Additionally, the following consumption tax rates apply:

- For LPG € 180.32 per 1,000 kg until December 31, 2018 and € 409.00 per 1,000 kg from January 1, 2019.
- For natural gas € 13.90 per MWh until December, 31 2018 and € 31.80 per MWh from January 1, 2019.

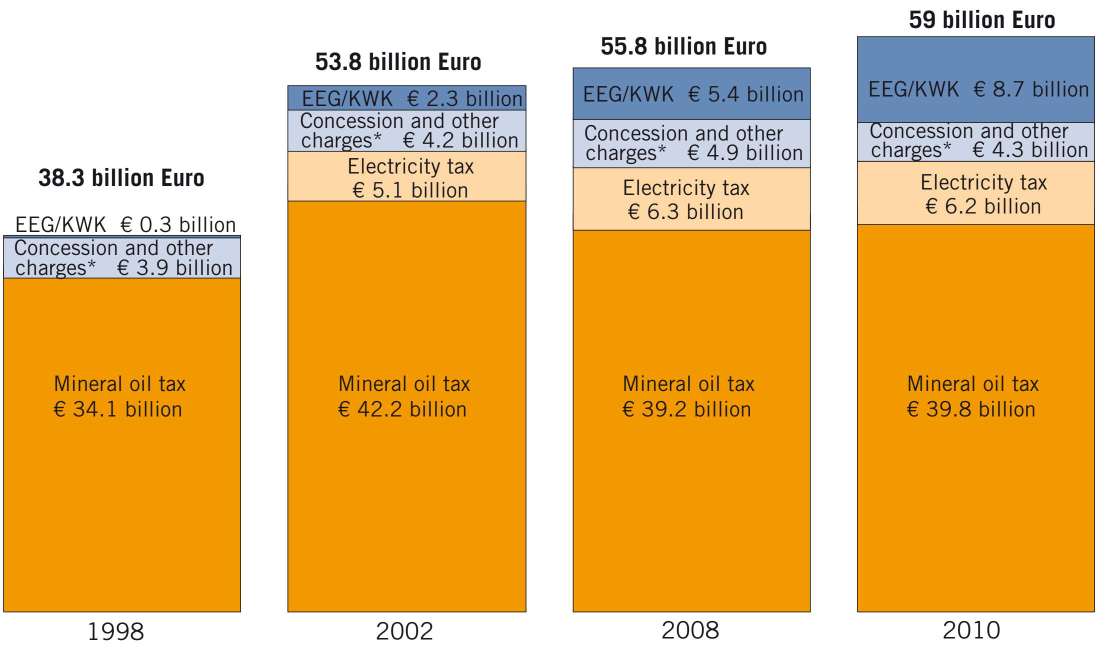
There are lower tax rates on energy consumption for heating than for motor fuel. These are :

- Light fuel oil: 6.135 cent/liter; for goods with a sulfur content of more than 50 mg/kg as of January 1, 2009: 7.635 cent/liter
- Heavy fuel oil: € 25 per 1,000 kg.
- LPG: € 60.60 per 1,000 kg.
- Natural gas and other gaseous hydrocarbons: € 5.50 per MWh.

For light fuel oil, the tax proportion (consumption taxes and VAT) – measured according to the price to private households – in 2010 was 28%. For natural gas the proportion of taxes and charges on the price to household customers in 2010 was 30 % taking account of the concession charges and proportional extraction royalties.

Coal is taxed at a rate of € 0.33 per GJ. Use of coal as an alternative energy source for the generation of electricity is – like, for instance, the use of natural gas for electricity generation – exempt from energy tax. Coal used to heat households was also not taxed up to December 31, 2010.

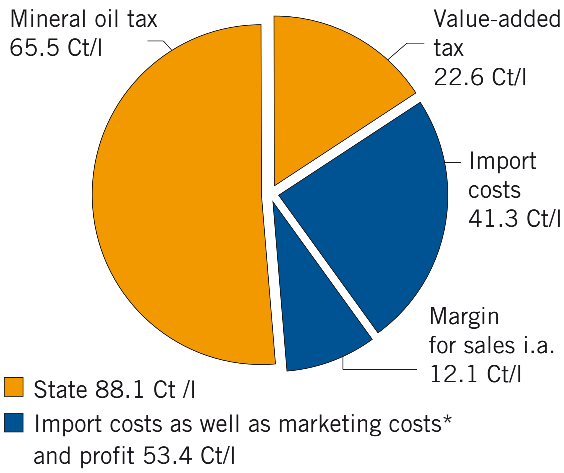
Figure 2.7: Energy tax and charges in Germany



* Numbers are partly estimated, according to: concession duties of €3.3 billion/year, subsidy levies on natural gas and oil: 1998 €0.14 billion, 2002: €0.4 billion, 2008: €1.22 billion, 2009: €0,85 billion and 2010: €0.69 billion including value of petroleum stockpile duty: €0.5 billion per year during the years from 1998 and 2002, €0.35 billion in the business year 2007/08, €0.37 billion in the business year 2008/09 r and €0.36 billion Euro in the business year 2009/10 fiscal year(excluding VAT)

Source: Federal Finance Ministry (Bundesminister der Finanzen) and estimates of the German Association of Energy and Water Industries (BDEW)

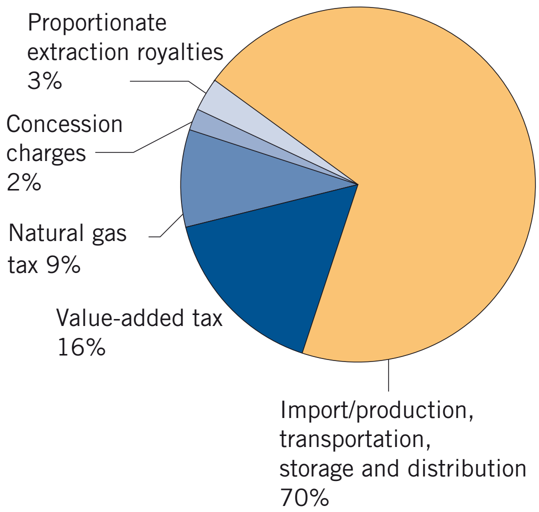
Figure 2.8: Petrol price in 2010: State's share of 62%
Average price of super unleaded: 141.5 Ct/l



* marketing costs (interior transport, warehousing, stockpiling required by law, administration, sales and marketing as well as costs for adding of organic components) and profit, as of February 2011

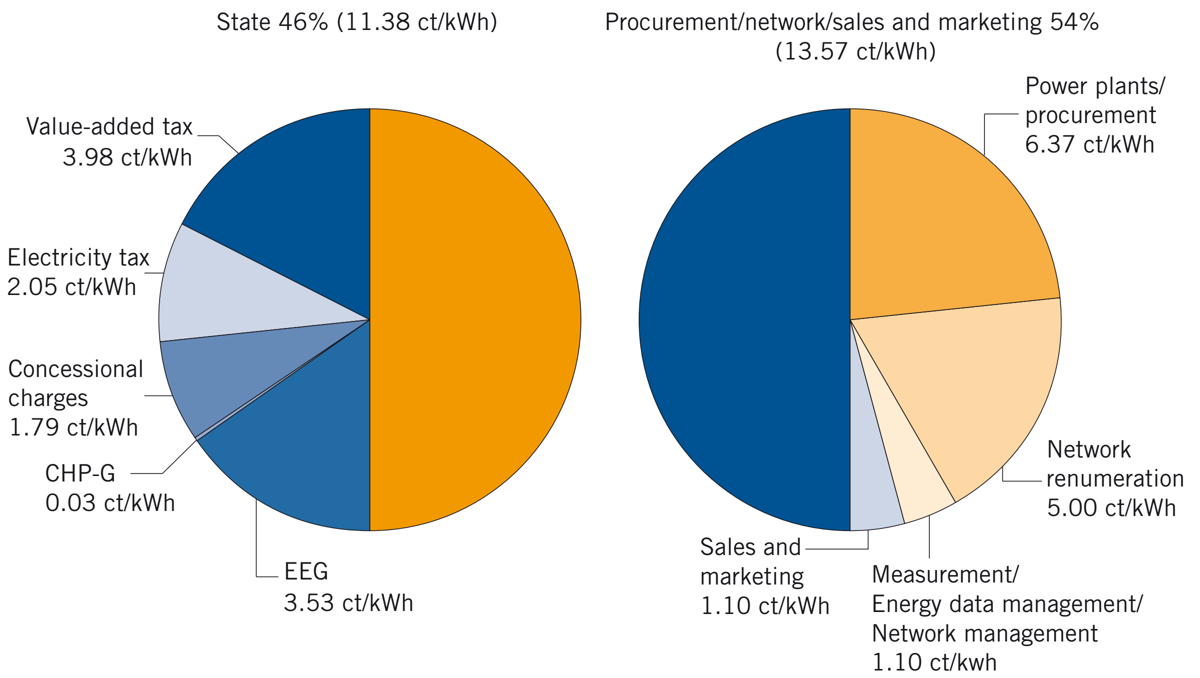
Source: German Petroleum Industry Association (Mineralölwirtschaftsverband)

Figure 2.9: Composition of natural gas prices for private households beginning 2010
Taxes and charges: approx. 30%



Source: BDEW; Status: 2010

Figure 2.10: Composition of household electricity price in 2011 (24.95 cents/kWh)



Source: BDEW – as of: 01/2011

Under the Nuclear Fuel Rod Tax Law (Kernbrennstoffsteuergesetz) from December 8, 2010, nuclear fuelused for the commercial generation of electricity is subject to nuclear fuel rod tax from January 1, 2011 (until 2016). The tax on one gram of plutonium 239, plutonium 241, uranium 233 and uranium 235 is € 145. This represents a tax burden on electricity produced on the basis of nuclear energy of €15.50 per MWh.

The price of electricity, the average of which in 2010 for private households with an annual consumption of 3,500 kWh is estimated at 23.69 cent per kWh, is made up as follows according to the German Association of Energy and Water Industries (BDEW, as of March 2011). All figures quoted in cent/kWh:

- Production/transportation/ distribution: 13.89 (2011: 13.57)
- Concession charges: 1.79 (2011: 1.79)
- Renewable Energy Sources Act (EEG): 2.05 (2011: 3.53)
- Combined Heat and Power Act (KWK-G): 0.13 (2011: 0.03)
- Electricity tax: 2.05 (2011: 2.05)
- Value-added tax: 3.78 (2011: 3.98)

Thus, the government-induced portion of the price of household electricity in 2010 was 41%. In 2011, this portion is increased to about 46% due to the EEG surcharge increasing to 3.530 ct/kWh. This is based on a household electricity price of 24.95 ct/kWh.

Reduced rates are applicable for the manufacturing industry and for agriculture.

Mineral oil

Crude oil imports form the basis of provision, as only 2 % of demand can be covered by domestic sources. Crude oil imports in 2010 amounted to 93.3 million tons. Additionally, imports of mineral oil products contributed 35.8 million tons to cover demand.

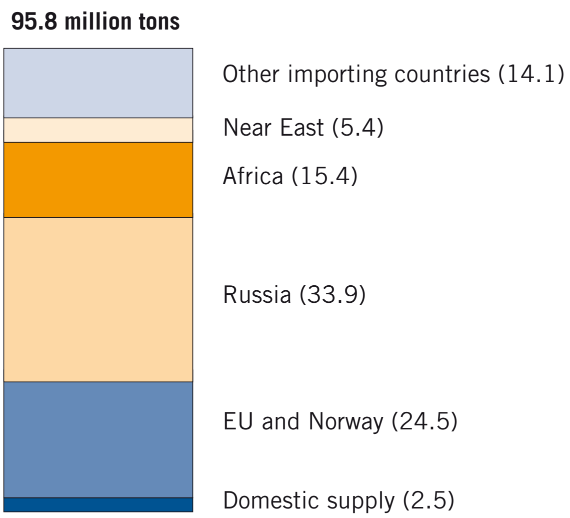
Imports of crude oil in 2010 originated to 26% from Western and Central Europe (essentially from the North Sea), 49% came from Eastern Europe/Asia, 17% from Africa, 6% from the Near East and 2% from America. OPEC's share amounted to 18%.

Crude oil distillation capacity in 2010 amounted to 117.6 million tons per annum.

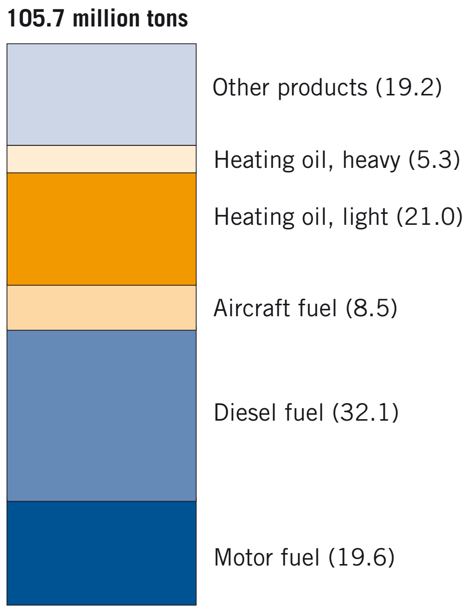
Domestic sales of mineral oil products reached approximately 105.7 million tons in 2010. The main products are above all fuels used in road traffic (petrol: 19.6 million tons; diesel: 32.1 million tons), light fuel oil used primarily for the space heating market (21.0 million tons), naphtha used predominantly in the chemical industry (16.6 million tons), aviation fuel (8.5 million tons) and heavy fuel oil (5.3 million tons).

For the eleventh consecutive year, the sale of petrol dropped in 2010. This was due to structural factors, such as a reduction in the stock of cars with petrol motors and the increasing proportion of vehicles with more fuel-efficient engines. In contrast, the recovering economy and the continued rise in the stock of cars with diesel engines have led to an increase in demand for diesel for the fifth consecutive year. Sales of light fuel oil remained more or less constant compared to the previous year. As was the case in the previous two years, the demand for aviation fuel was down slightly in 2010. The decrease was in part due to air traffic stoppages during May 2010 as a result of the Icelandic volcano Eyjafialla, as well as the early onset of winter in late 2010. Over the last ten years, heavy fuel oil has been increasingly replaced by other energy sources on the heating market. Non-energy use accounted for about 70% of consumption in 2010. Demand for naphtha increased significantly in 2010 as a result of increased demand from the chemical industry due to improved economic conditions.

Figure 2.11: Crude oil supply by origin in 2010 (in million tons)



Domestic sales of mineral oil products in 2010 (in million tons)



Source: Federal Authority for Economy and Export Inspection (Bundesamt für Wirtschaft und Ausfuhrkontrolle)

Natural gas

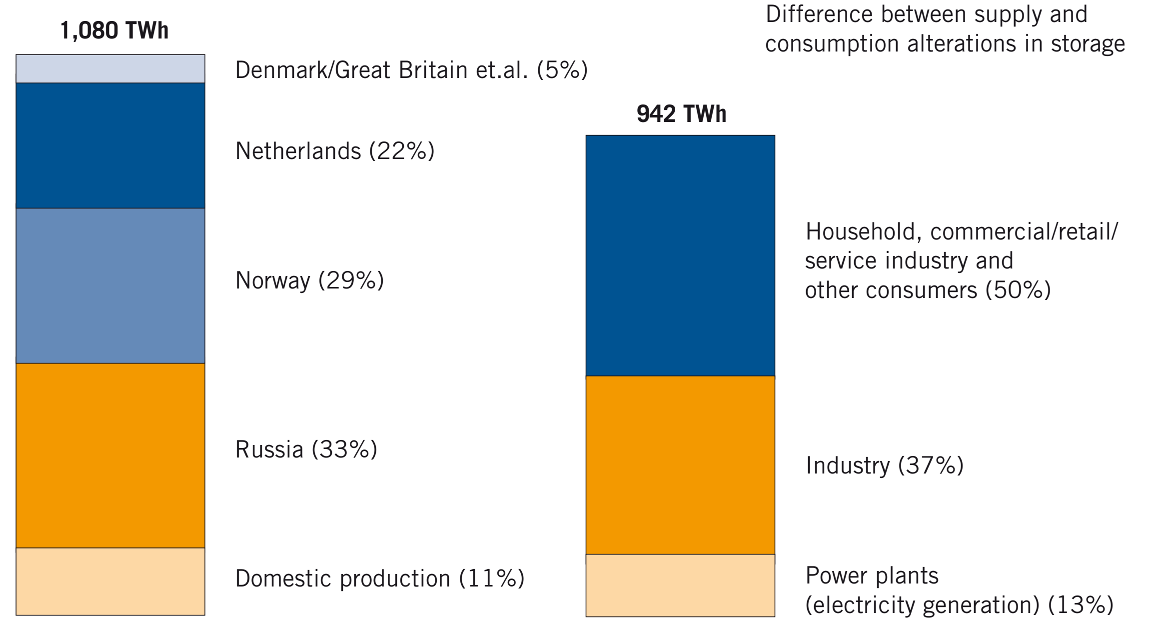
Today, natural gas covers about 22% of the total primary energy demand in Germany. In 2010, natural gas consumption amounted to approximately 942 TWh or 104 million TCE. The household and small-scale consumption sector together with other consumers accounted for 50% of the total natural gas consumption. This is in part due to the high number of gas-heated homes. By the end of 2010, 49% of all homes used natural gas heating. Industry accounted for 37% of natural gas consumption and power plants used 13%.

Germany's natural gas supply comes from a diverse range of sources. In 2010, 11% of the natural gas supply came from domestic production and 89% was imported from various sources: 33% from Russia, 29 % from the Norwegian North Sea, 22% from the Netherlands and 5 % from Great Britain and Denmark. Overall, about two-thirds of total natural gas volumes were from sources in Western Europe. Purchases of natural gas from abroad are predominantly based on long-term contracts between the suppliers and a range of import companies operating within the German market.

In the future, Germany's natural gas supply will increasingly be based on imports. With its long-term supply policy, the German gas industry has already contractually secured considerable quantities of gas from current supplier countries for the coming decades and thus made provision to secure gas supplies for the future. Corresponding import contracts have been concluded, some extending up to 2035. Given the growing importance of liquid trading markets in Europe and increasing competition on the gas market, there is a fundamental and urgent need to adapt supply conditions in the context of long-term supply contracts with major foreign producers of natural gas.

Integrated within the European transportation systems, there is an extensive pipeline network with a total length of almost 450,000 km for the transportation and distribution of natural gas. The infrastructure includes a number of underground storage facilities with a maximum available capacity of over 20 billion m^3.

Figure 2.12: Natural gas supplies in 2010 (in TWh) — **Natural gas consumption in 2010** (in TWh)



Source: BDEW

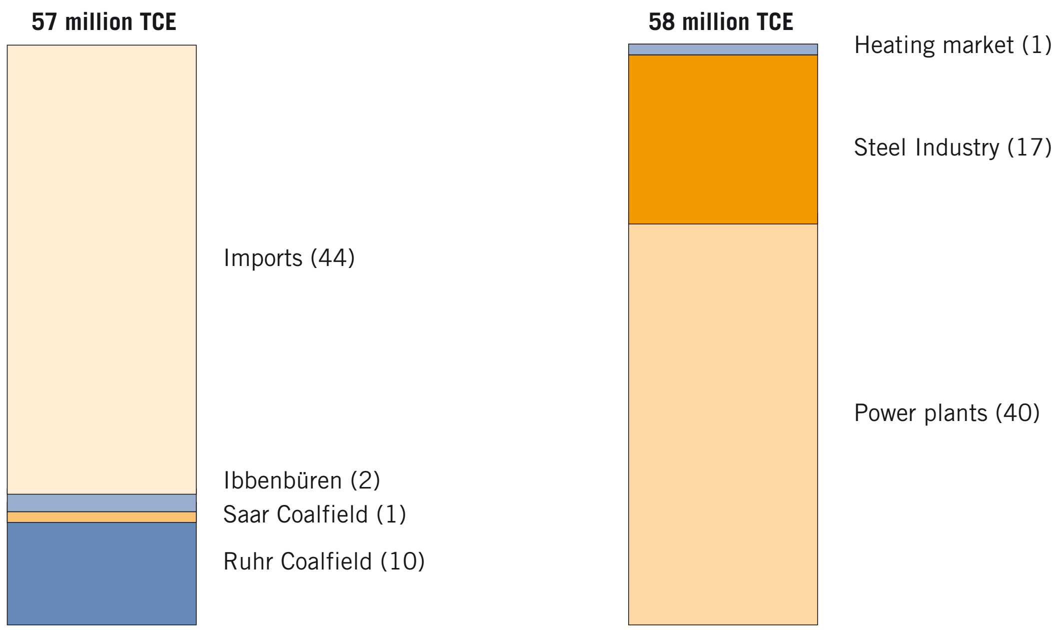
Hard Coal

Germany mined 13.2 million TCE of hard coal in 2010. Of this 74.4% was mined from coalfields in the Ruhr area, 10.3% from the Saar area and 15.3% from Ibbenbüren. Imports of hard coal covered about 76% of total hard coal consumption in 2010. 90% of the imports came from six supply countries, namely Russia, Colombia, Poland, USA, Australia and South Africa.

The volume of Germany's entire hard coal market in 2010 was 57.8 million TCE. Consumption of hard coal was distributed as follows: 39.7 million TCE by power plants, 16.6 million TCE by the steel industry and 1.5 million TCE by the heating market. Due mainly to the geological conditions, German hard coal production cannot compete with the production costs of coal deposits overseas. In the course of the Hard Coal Mining Financing Act on ending subsidized German hard coal mining by the end of 2018, which came into force on December 28, 2007, the adaptation process continued as planned in 2010. Consequently, employment in this market continued to decline in 2010. Thus, the number of employees in the hard coal mining industry decreased by 11.4% from 27,317 on December 31, 2009 to 24,207 on December 31, 2010. Mining productivity in 2010 – expressed as usable extraction per man and underground shift – was 6,092 kg in 2010. At European level, operational aid is permitted by European Council Regulation. A proposal by the European Commission from July 2010 suggested imposition of a time limit on aid to the hard coal industry to 2014. With widespread public support across party lines, Germany and other mining countries have achieved a viable amendment to the Commission's first proposal. According to the Council Decision which entered into force on January 1, 2011, operational aid will continue until the end of 2018, so that the German legal framework is also safeguarded at European level.

Figure 2.13: Hard coal supply in 2010
(in million TCE)

Hard coal consumption in 2010
(in million TCE)



Source: Federation of German coal industry (Gesamtverband des deutschen Steinkohlenbergbaus) (GVSt)

Brown Coal

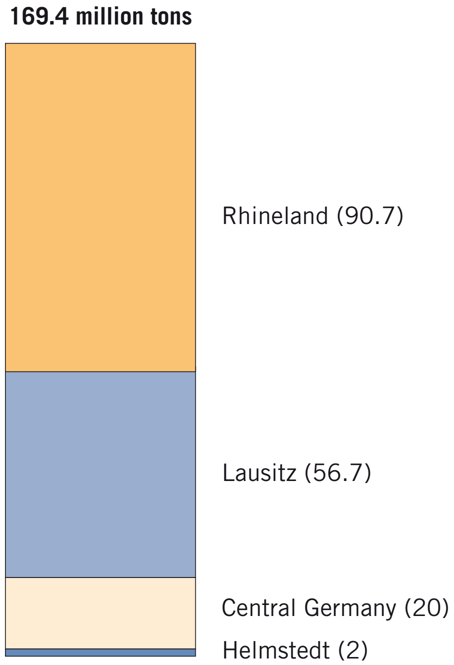
In 2010 approximately 169.4 million tons of brown coal – which corresponds to 52.3 million TCE. – were produced in Germany exclusively by surface mining. Imports totaled 0.1 million TCE. Thus, the proportion of domestic production was 99%.

German brown coal mining is concentrated in four regions: the Rhine area west of Cologne, the Lausitz coalfields to the north-east of Dresden, the Middle German coalfields around Leipzig and the Helmstedt coalfields in Lower Saxony. In 2010, 53.6% of the total mining production came from the Rhineland area, 33.4% from Lausitz, 11.8% from the Middle German region, and 1.2% from Helmstedt.

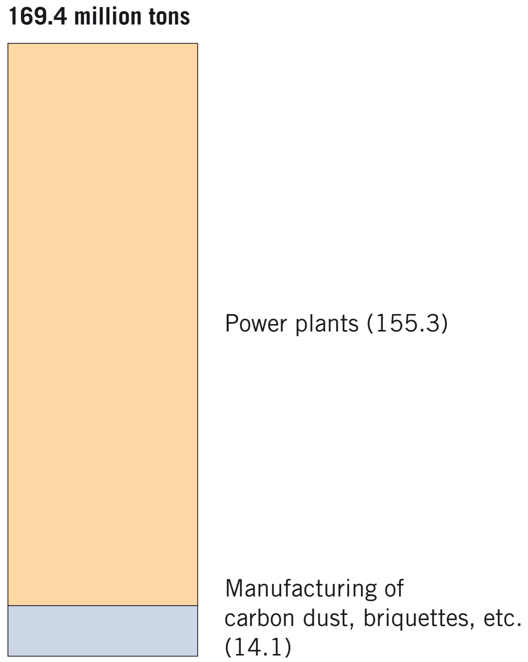
Brown coal's primary use is in base load power generation. In 2010, around 155 million tons of brown coal was used in power plants and from this 147.0 TWh of electricity was generated. This corresponds to 23.7% of overall gross electricity production in Germany. On December 31, 2010, installed gross generating capacity amounted to 22,178 MW.

In 2010, just over 14 million tons of brown coal were used in brown coal mining factories for the production of briquettes, coal dust, fluidized bed lignite and coke. These products are used in the domestic heating market and for industrial processes. Brown coal coke is used for waste gas and waste water purification.

Figure 2.14: Brown coal production 2010
(in million tons)



Brown coal use in 2010
(in million tons)



Source: DEBRIV

Electricity

Total gross electricity generation in 2010 amounted to 621.0 TWh. Of this amount, 92% was created by energy producers' power plants (including those operated by third parties) and 8% from industrial power plants.

After deducting the power plants' own consumption of 37.5 TWh, this results in a net electricity generation for 2010 of 583.5 TWh. Electricity generation by energy source in 2010 was as follows: nuclear power 22.8%, brown coal 23.1%, hard coal 18.3%, natural gas 14.0%, renewable energy sources 17.1%, and fuel oil and other energy sources 4.7%. The German electricity supply is thus based upon the following five pillars; nuclear energy, brown coal, hard coal, natural gas and renewable energies.

The net bottleneck capacity of all power plants in Germany amounted to 165,859 MW on December 31, 2010. Of this, 53,944 MW fell to renewable energy sources, 27,867 MW to hard coal, 20,490 MW to nuclear energy, 20,358 MW to brown coal, 25,500 MW to natural gas, and 17,700 to other energy sources (including pumped storage power plants).

Production at German locations was further supplemented by imported electrical energy of 42.0 TWh. Exports of 59.0 TWh resulted once again in an excess of exports over imports. Germany is the hub of European power trading.

Gross electricity consumption reached 604.0 TWh with grid losses of only 4.5%, which is very low in comparison to European averages.

In 2010, the net electricity consumption of 530.0 TWh (without grid losses and power consumed by the power plants themselves) was distributed as follows: 46% consumed by industry, 27% by private households, 24% by trade and commerce, public facilities and agriculture, and 3% by transport.

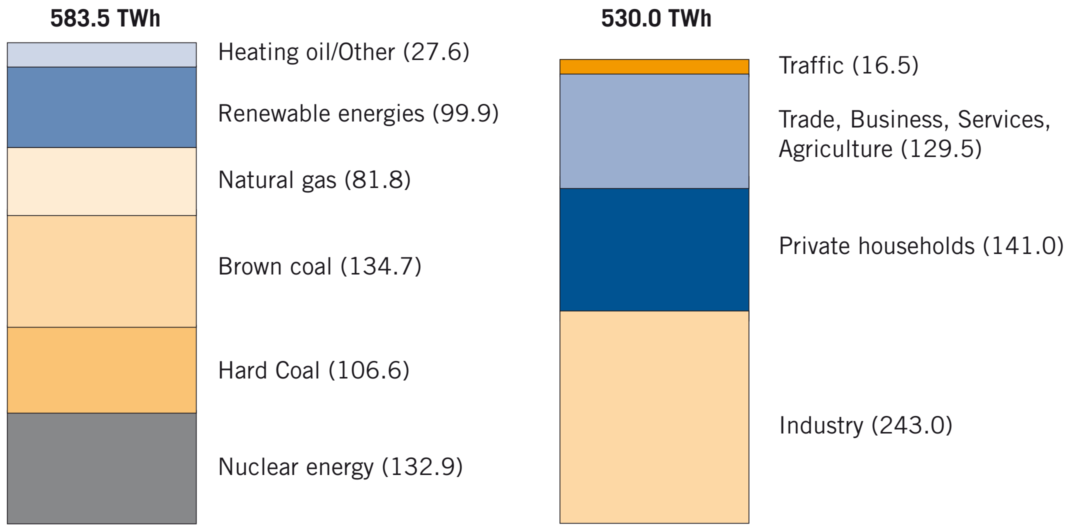
It is expected that consumption will remain relatively stable in the future. In 2010 net electricity consumption was 212 kWh per € 1,000 of gross domestic product. As electricity is increasingly being used more efficiently, power demand intensity continues to decline.

Renewable energies

Renewable energies contributed 9.4% to covering primary energy consumption in 2010. The most important sector using renewable energy is the electricity industry.

In 2010, electricity utility providers and private power plant operators produced 102.3 TWh of electricity (gross) from renewable energy sources. This represents 16.9%

Figure 2.15: Net electricity generation in 2010 (in TWh) — **Net electricity consumption in 2010** (in TWh)



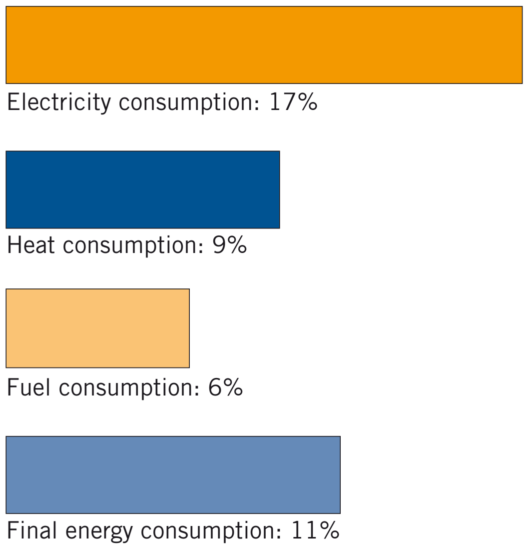
Source: BDEW

of the total electricity supply in Germany. An amount of 36.5 TWh was generated by wind power, 19.7 TWh from hydro power (without pumped storage) classified as regenerative, 28.5 TWh was generated from biomass, 5.6 TWh from refuse and other renewable energies and 12.0 TWh was generated from photovoltaic energy.

Net generation from all installed plants amounted to approximately 53,944 MW as of December 31, 2010. Installations using renewable energy accounted for one-third of the total installed power plant capacity in Germany. Wind generation accounted for 27,214 MW and photovoltaic energy for 16,500 MW: hydro power (excluding pumped storage power plants) generated about 5,330 MW, biomass 4,890 MW, and geothermal energy generated 10 MW.

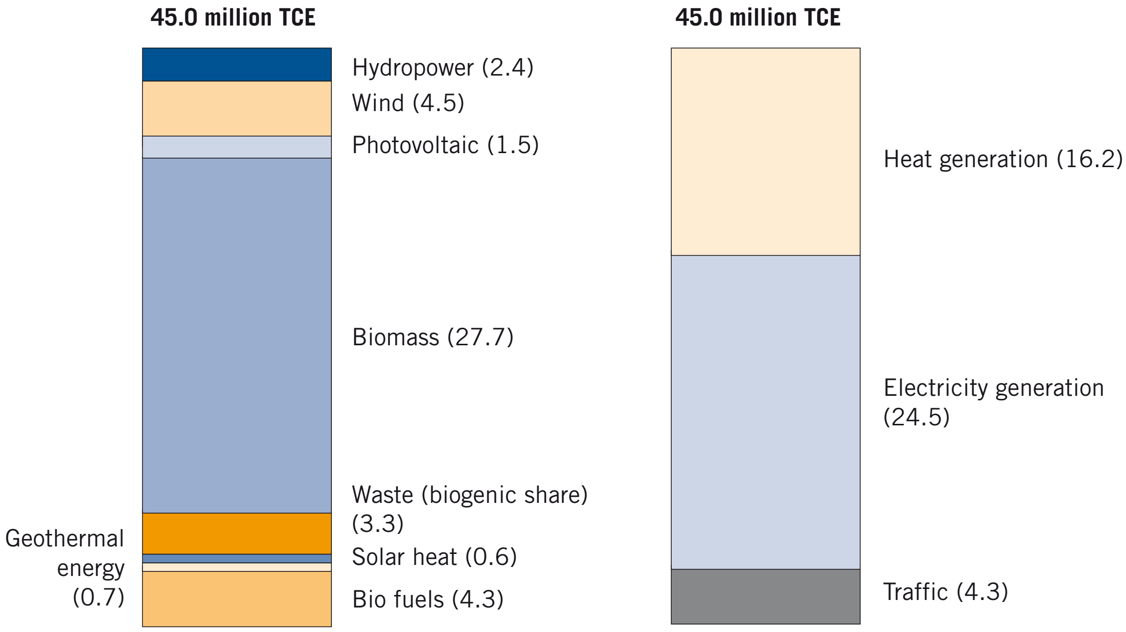
The decisive factor for the increased use of renewable energies over recent years in the generation of electricity is the German law on the prioritization of renewable energies, the Renewable Energy Sources Act (EEG). According to this law, the grid operator must pay the producer of electricity fed in from EEG plants the minimum tariff set out in the Act.

Figure 2.17: Market share of renewable energies in 2010 (in %)



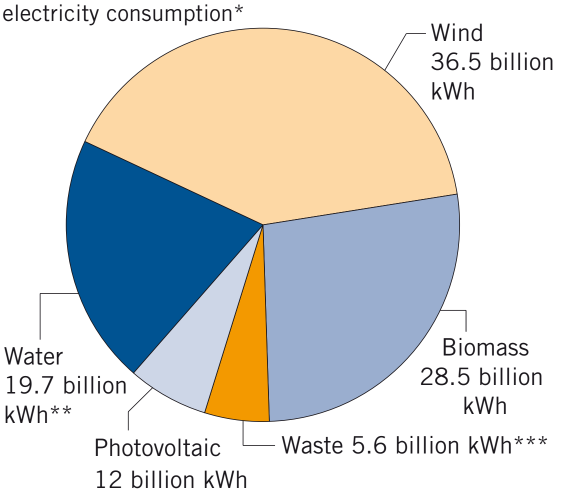
Source: BDEW

Figure 2.16: Volume in 2010 (in million TCE) — **Consumption in 2010** (in million TCE)



Source: AG energy balances as well as Working Group on Renewable Energy Sources Statistics (AG Energiebilanzen and Arbeitsgruppe Erneuerbare-Statistik) (AGEE-Stat)

Figure 2.18: Electricity generation from renewable energy sources in Germany, 2010



* 604.0 TWh
** pumped storage without calculating natural inflow
*** Including other renewable energies

Source: BDEW, February 2011

Total fees for EEG power feeds amounted to €12.365 billion in 2010. The 79.106 TWh of EEG power feeds in 2010 results in a calculated average tariff of 15.631 cent per kWh. EEG power feeds are lower than the total contribution of renewable energy to electricity supply. Reasons for this include: the feed-in of hydroelectricity is basically only subsidized under the EEG for plants up to 5 MW capacity (as of August 1, 2004, however, power which is increased by at least 15% is also subsidized for the portion of plants with over 5 MW capacity). Electricity from refuse, which is classified as regenerative, is not covered by the EEG. On the other hand, electricity generated by coal mine gas is subsidized under the EEG although coal mine gas is not a renewable energy source.

In 2010, the contribution of renewable energies to the satisfaction of heating needs amounted to 132.3 TWh. This means that renewable energies held a market share of around 9 % in the heating sector in 2010. Distribution according to individual energy sources in 2010 can be presented as follows: bioenergy 121.5 TWh, solar thermal energy 5.3 TWh and geothermal energy 5.5 TWh.

Biofuel production increased to 35.0 TWh in 2010, thereby achieving a 5.7% market share for fuel consumption. Of total biofuel production, 77% came from biodiesel, 2% from vegetable oil and 21% from bioethanol.

Table 2.1: Structure of power volumes in accordance with the EEG since 2000

	2000	2002	2004	2006	2008	2009	2010
Total final consumption [GWh]	**344,663.4**	**465,346.4**	**487,626.9**	**495,203.0**	**493,505.8**	**466,054.7**	**485,000**
Privileged end consumption[2)] [GWh]	–	–	36,865.3	70,160.9	77,990.5	65,022.7	75,000
EEG-remunerated total amount of electricity[3)] [GWh]	**10,391.0**	**24,969.9**	**38,511.2**	**51,545.2**	**71,147.9**	**75,053.4**	**80,527**
Hydropower, gases[4)] [GWh]	4,114.0	6,579.3	4,616.1	4,923.9	4,981.5	4,877.2	5,000
Gases[4)] [GWh]	2,588.6	2,789.2	2,208.2	2,019.5	2,000		
Biomass [GWh]	586.0	2,442.0	5,241.0	10,901.6	18,947.0	22,979.9	25,000
Geothermal energy [GWh]	–	–	0.2	0.4	17.6	18.8	27
Wind power [GWh]	5,662.0	15,786.2	25,508.8	30,709.9	40,573.7	38,579.7	36,500
Solar radiation energy [GWh]	29.0	162.4	556.5	2,220.3	4,419.8	6,578.3	12,000
Average compensation [ct/kWh]	**8.50**	**8.91**	**9.29**	**10.88**	**12.25**	**13.95**	**15.3**
Total Remuneration[5)] [billion EUR]	**0.88**	**2.23**	**3.61**	**5.81**	**9.02**	**10.78**	**12.70**
EEG differential costs[6)] [billion EUR]	**0.9**	**1.7**	**2.4**	**3.3**	**4.7**	**5.3**	**8.8**

1) Short Financial Year: 01.04.-31.12.2000
2) According to the special compensation scheme (§ 11 and 16 EEG) for privileged final consumers (since July 2003)
3) Further VDN corrections (2002 to 2009) are not included here, because the additional supplies for previous years in accordance with audit test certificates cannot be allocated to energy sources..
4) In 2004 landfill gas, sewage gas and mine gas was listed separately for the first time.
5) Compensation paid to EEG-system operator (before deduction of avoided network usage charges)
6) EEG differential costs, taking into account the avoided network charges

Sources: EEG annual statements, information platform of the German transmission system operators, http://www.eeg-kwk.net; Data for 2010: Estimate based on AGEE-Stat data; source: Engineering office for new energy sources (IFNs), as of March 2011, figures are provisional pending publication of annual accounts of the EEG-TSO; published as Table 9 in: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Renewable Energies 201, as of: 14th March 2011

2.2 Integration of bio-natural gas into the energy system

Bio-natural gas is a renewable energy source and is created by the treatment of biogas. Feeding bio-natural gas into the natural gas network enables utilization of gas independent of location and at flexible times. Integrating bio-gas into the energy system requires relatively little modification of the technical infrastructure and it can be mixed with natural gas in any proportion. For this reason, bio-natural gas can be used with highly efficient natural gas technologies, for instance, for separate or combined heat and power production and also as a fuel. If bio-natural gas is used for the production of electrical operating reserve this can also support integration of wind and solar power into the energy system. Against this backdrop, the German Government has called for an increase in the generation and feed-in of bio-natural gas to 6 billion m^3 p. a. by 2020 and to 10 billion m^3 p. a. by 2030, which corresponds to approx. 6% and 10% respectively of current natural gas consumption in Germany and the government has also emphasized the importance of bio-natural gas in their latest Energy Concept[1].

Biogas treatment to produce bio-natural gas

Biogas is produced from a wide range of organic substances (manure, household organic waste, etc.) and renewable resources (such as corn or grass silage). Conversion of these raw materials is done in fermentation vessels or fermenters by way of microbial metabolic processes. In Germany, biogas is currently used mainly to generate electricity directly at the plant location. But more versatile and often more efficient use can be made of biogas after it is treated to become bio-natural gas. Treating biogas to produce bio-natural gas basically requires the separation of carbon dioxide and hydrogen sulfide, as well as gas drying. Numerous technologies are available for this, enabling treatment which is site-specific, energy-efficient and cost-effective.

Feed-in and transportation of bio-natural gas

Before being fed into the gas network, bio-natural gas can, if necessary, be adapted to the relevant gas composition by the addition of liquid gas or air. This ensures both an accurate calculation of the gas used by the consumer and maximum compatibility with all the appliances used by consumers. Bio-natural gas can be fed into natural gas distribution or transportation networks.

The throughput of many natural gas distribution networks is large enough to be able to accommodate the gas volumes produced at any time of the year or day, even by high-output bio-natural gas plants. Where this is not the case, in the long-term a system would need to be installed to re-pressurize the bio-natural gas into a gas pipeline with a higher pressure rating, and this system operated at times of low gas consumption. However, the German gas transportation network is already today constructed so that the inclusion of even large amounts of bio-natural gas, is possible at almost every location.

By the end of 2010, the input of bio-natural gas into the natural gas network in Germany increased to around 300 million m 3 p. a. This represents approximately 5% of the goal declared by the Federal Government for 2020. The main reason for this is the poor development of demand for bio-natural gas[2].

Existing storage facilities can be used

In principle, all the existing natural gas storage facilities could also be used for the storage of bio-natural gas. Furthermore, the large capacity of the natural gas pipeline network represents a significant buffer for bio-natural gas, thus increasing the flexible availability of this energy source.

Many fields of application

Since bio-natural gas's chemistry is practically identical to conventional natural gas, it can be used with existing technologies for the generation of heat and electricity. It is particularly efficient at cogeneration, for example in combined heat and power plants. Therefore, the energy industry has been pressing ahead the development of combined heat and power right down to the smallest, remote power system – the micro-CHP[3].

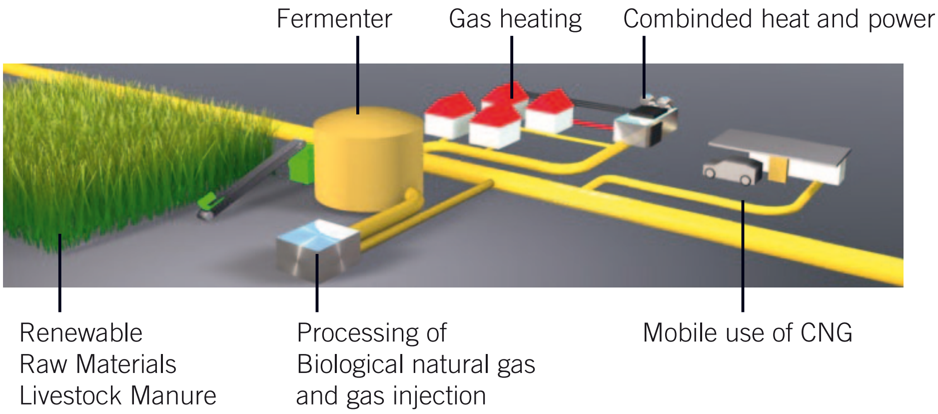
The use of natural gas and bio-natural gas in motor vehicles can not only contribute to reducing emissions of

1 Energy Concept for an environmentally friendly, reliable and affordable energy supply from September, 28 2010, published by the Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

2 Overview: Biomethane in the CHP and heating markets, German Energy Agency (dena), June 2010

3 Michael Koschowitz and Stephan Ramesohl, Mikro-KWK auf dem Weg vom Labor zur Markteinführung (Micro-CHP on the way from lab to market), in GWF Gas Erdgas, November 2010

Figure 2.19: Production, transportation and use of biological natural gas



Source: E.ON Ruhrgas AG

greenhouse gases but also those of particulate and nitrogen oxide. Bio-natural gas can be used in every motor vehicle powered by natural gas, combined in any proportion. Natural gas already enables a reduction of greenhouse gas emissions by around 24% on a comparable petrol engine, depending on the type of vehicle. Use of pure bio-natural gas could reduce greenhouse gas emissions by up to 97%[4]. As more and more natural gas fuel pumps allow vehicles to fill up with a proportion of bio-natural gas, the already comparatively low greenhouse emissions of natural gas vehicles can be reduced still further by mixing in bio-natural gas.

Another possibility is the use of bio-natural gas to generate electrical operating reserve. Fluctuations in the feed-in of electrical work from wind power and photovoltaic plants could be compensated, e.g. by use of rapid-start gas turbine or CHP plants operated using bio-natural gas. Since, as described above, the storage functionality of the gas network and many existing gas storage facilities can be used for bio-natural gas, the integration of bio-natural gas into such a power plant network is preferable to direct generation of electricity from bio-natural gas at the specific locations of bio-natural gas plants.

Outlook: New bio-natural gas technologies and the need for political support

The technology for producing bio-natural gas is constantly evolving and new feedstocks being evaluated. Current work includes the optimization of agitators and feed systems and implementation of the first fermenters for the exclusive fermentation of sugar beet, or grass silage. New processing technologies, e.g. membrane processing[5] are intended to increase both energy and cost efficiency.

Up to now, it has not been possible to use woody materials for bio-natural gas production. However, modified concepts for coal and waste processing enable use of waste materials such as forestry wood residues or landscaping materials, in thermo-chemical gasification. At temperatures of 800°C or more, the molecular bonds of the feedstocks are broken and metal catalysts are used to produce methane, or e.g. liquid fuel. The production of methane, known as bioSNG (substitute/synthetic natural gas), can be achieved with relatively little technical effort and high energy use. Investment in this technology however requires long-term and reliable biomass costs and product prices.

Stable markets for bio-natural gas or bioSNG are an important factor for the further expansion of bio-natural gas feed-in. These can be created or improved by an appropriate political framework. A market incentive could be created by opening up the heating market by way of the amendment to the Renewable Energy Sources Heating Act already announced in the German government's Energy Concept. But legal incentives to provide electrical operating reserve generated by bio-natural gas could also lead to an expansion of bio-natural gas feed-ins and a meaningful supplement to renewable energies[6].

4 CONCAWE, Well-to-Wheels analysis of future automotive fuels and powertrains in the European context, 2007

5 In principle, the separation of gas components using semi-permeable membranes enables the deposition of multiple gas components in a single step.

6 Opinion of the Biogas Council (Biogasrat e.V.) on the EEG reform, September 29, 2010

2.3 Unconventional natural gas in Germany

Occurrence of unconventional natural gas

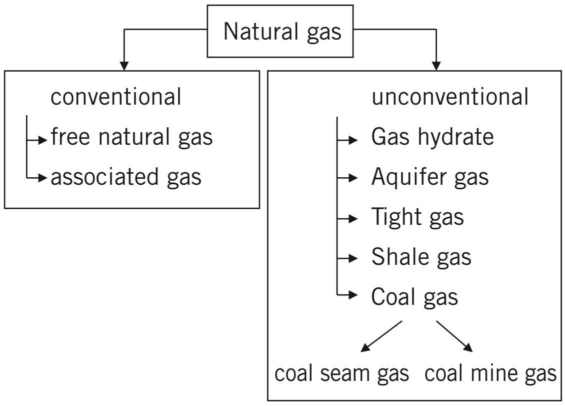
Germany has substantial deposits of unconventional natural gas which have up to now only been used on a small scale. There is no qualitative difference between conventional and unconventional natural gas. Both consist predominantly of methane. What is not conventional however are the sites of unconventional natural gas deposits. While conventional natural gas is concentrated in highly permeable rock, unconventional natural gas is trapped underground. It is either dissolved in water, bound to solids or located in low permeability rock. Conventional natural gas can be reached through a well and flows to the borehole without additional technological effort. Normally, unconventional natural gas must first be mobilized through technological measures.

Unconventional deposits are distinguished into the categories of aquifer gas (gas dissolved in groundwater), shale gas, coal gas, natural gas in gas hydrates and in dense rock known as ‘tight gas’ (see Figure 4.20). Except for natural gas hydrate, all these types of unconventional deposits are known in Germany. Due to the major technological effort required for its extraction, there is no prospect of an economically viable use of aquifer gas in energy production in the foreseeable future. Tight gas has been produced successfully in Germany since the 1990s. Thus, today its inventory and production statistics are no longer reported as an unconventional resource. In the case of coal gas, a distinction is made between coal mine gas in active or abandoned mines and coal seam gas found in undisturbed coal seams (Figure 4.20). At the moment it is coal seam gas and shale gas which are the focus of particular interest in Germany.

Development of coal seam gas and shale gas

Coal seam gas and shale gas describe types of natural gas which never migrated out of the so-called source rock after generation. This gas remained at its source in the coal or shale. Unlike conventional deposits, shale gas and coal seam gas have a low exploration risk, as even in Germany the extent of these rock formations is typically very large. Since however the gas content and properties of the rocks themselves can vary greatly, the main challenge lies in technological development of the economically viable regions for these deposits. Only technologies that are known and well-proven for other types of deposits are used, but these technologies must be optimized and adapted for the specific situation in the coal or shale. Today horizontal drilling and hydraulic fracking are essential elements in the production of shale and coal seam

Figure 2.20: Classification of natural gas deposits



Source: BGR

gas. During horizontal directional drilling the wells are deflected to within the gas-bearing layer. This increases the contact area between the well and the reservoir. Then fracking with highly pressurized water creates pathways through the low permeability shale or coal to allow gas to flow into the well.

Coal gas and shale gas production worldwide

For many years, the exploration and extraction of shale gas and coal seam gas has been conducted in various regions of the world. In China, Australia, Canada and particularly in the USA large quantities of coal seam gas are already produced. For the past 10 years, Germany has also seen a marked increase in the use of coal mine gas, which is primarily used locally in the Ruhr area for the operation of combined heat and power plants.

In the USA, the production of shale gas has developed at a phenomenal rate since the late 1990s. After the extraction of conventional natural gas declined significantly in the USA, there was a boom firstly in coal seam gas and then in the last few years in shale gas too. For 2009, the US Energy Information Administration (EIA) reported a shale gas production for the USA of 88 billion m^3 and production of coal seam gas in the amount of 54 billion m^3. The combination of these two is around ten times Germany’s domestic natural gas production.

By using unconventional natural gas, the USA could prevent a threatening dependence on energy imports. Today, more than half the natural gas produced in the United States is obtained from unconventional sources. Following this example, many countries are currently looking to use domestic reserves of shale and coal seam gas. Thus, all European countries with experience in the production of natural gas are starting to explore unconventional gas. However there are as yet no reports of commercial production of shale gas in Europe (as of 03.2011).

Current state of Germany's unconventional natural gas

In Germany too, intensive exploration for reserves of shale gas and coal seam gas is underway. Mining rights have been issued for large areas of the country, especially in Lower Saxony and North Rhine-Westphalia, as well as in Saxony-Anhalt, Thuringia, Saarland and Baden-Wuerttemberg. The companies currently exploring these deposits have been especially preoccupied with the geoscientific characterization of gas-bearing rock strata and the development of economically viable technological possibilities. Up to now these explorations have been carried out alongside initial fracking attempts to test gas production behavior from the reservoir.

Reliable estimates for recoverable quantities of unconventional gas are not currently available either globally or for Germany. This is partly because the methods for assessing conventional natural gas resources cannot be directly applied to shale gas and coal seam gas. Additionally, exploration in many parts of the world, including Germany, is not sufficiently advanced to provide nearly enough reliable data to determine the quantities of gas available. Therefore, the Federal Government has commissioned the German Mineral Resources Agency (DERA) to assess the potential of natural gas and crude oil in Germany's shale. Other initiatives to quantify potential unconventional gas reserves are underway both internationally and at European level. It is quite certain that the quantities of unconventional natural gas are extensive enough that the wide use of this resource will change the world's natural gas map. In addition to the major conventional natural gas producing countries, such as Russia, Iran and Qatar, new producers of unconventional gas will gain importance in the supply of natural gas. For Germany too, domestic production of unconventional natural gas could contribute to securing its supply.

Production in Germany – Pros and Cons

Initiated by reports from the USA on the technological intensity of producing unconventional natural gas and on the potential impact on ground water, the exploration phase currently underway in Europe is accompanied by a controversial public debate over the feasibility and necessity of domestic shale gas and coal seam gas production. Public fears and concerns from interest groups have mainly focused on the impact of drilling and fracking on subsoil and groundwater, as well as the density of the production infrastructure. Since the production of unconventional natural gas in Germany is only conceivable with broad public acceptance, it is enormously important to ensure that factual information is disseminated on the technologies used, their effects and on the benefits of using domestic mineral resources. Additionally, it should be noted that, compared to the USA, Germany has higher environmental and safety standards, that development and production technology may not be as easily assigned and that the cost effectiveness of unconventional gas is not necessarily assured.

A powerful argument made for domestic production is primarily based upon increasing security of supply. Germany's natural gas production has been declining for years due to exhaustion of known deposits. Currently about 86% of the natural gas used in Germany is imported. Starting to produce natural gas from unconventional deposits could secure Germany's own long-term production of natural gas. Another major economic advantage of domestic production is the ability to use the existing natural gas infrastructure and its proximity to consumers.

2.4 Importance of energy for the German economy

A recent study by the Munich Ifo Institute highlights the critical importance of the energy industry for the German economy. The term energy industry includes grid-based energy supply (electricity/gas and district heating), coal mining, extraction of oil and natural gas as well as coking plants and mineral oil processing:

- The energy industry is one of the leading economic sectors in Germany. With a value added of € 191,000 per employee, this industry is outstanding in terms of labor productivity. In 2008, the energy industry invested € 14.5 billion, making it one of the largest investors in Germany alongside the automotive industry. In terms of other economic indicators too, such as value of production, gross value added and number of employees, the energy industry is a top performer.

- An essential basis for economic growth and employment is a consistently reliable supply of energy, particularly electricity. Germany has the lowest number of power outages in the world.

- On the other hand Germany's high prices for electricity on an international scale, due mainly to government charges, have a negative impact on the country's industrial development.

- The energy industry works in close cooperation with industry to further advance innovations in the production, conversion, distribution and utilization of energy.

Results of the study: The energy industry is one of the most important branches of industry in Germany. This is confirmed using central national economic indicators which the Ifo Institute have established for the energy, automotive and chemical industries:

- The production value or output of the energy industry is € 206 billion, second only to the automotive industry.

- The same applies to gross value added – an indicator obtained by measuring the difference between output and intermediate consumption. This figure amounts to € 59 billion. Only the automotive industry exceeds this with a figure of € 66 billion. The chemical industry's gross value added amounts to € 53 billion.

- The energy industry is one of the major investors in manufacturing. In 2008, investment volume amounted to € 14.5 billion, of which € 12.1 billion went to grid-based energy supplies, i.e. electricity, gas and district heating. For comparison: investments in the automotive industry were € 14.8 billion and € 8.0 billion in the chemistry industry (both related to the year 2008). Thus, the energy industry provided 16.5% of the total investment expenditure in the manufacturing industry (excluding construction).

- Measured by the number of employees, the energy industry is behind the automotive industry and the chemistry industry with 311,000 employees.

Table 2.2: Ranking of selected German sectors in 2008

Absolute values

Ranking	Employee		Production value		Gross value creation		Investments	
	Sector	1,000	Sector	Billion €	Sector	Billion €	Sector	Billion €
1.	Automotiv industry	829	Automotiv industry	302	Automotiv industry	66	Automotiv industry	14.8
2.	Chemistry	463	Energy	206	Energy	59	Energy	14.5
3.	Energy	311	Chemistry	160	Chemistry	53	Chemistry	8.0

Key figures

Ranking	Labor productivity		Degree of modernity		Value added ratio		Rate of investment	
	Sector	1,000 € Security/ Acquisition	Sector	Equipment Net to Gross %	Sector	Security/ Produc-tion %	Sector	Investm./ Produc-tion %
1.	Energy	191	Energy	55.2	Chemistry	33.2	Energy	7.0
2.	Chemistry	115	Automotiv industry	52.2	Energy	28.9	Chemistry	5.0
3.	Automotiv industry	80	Chemistry	48.8	Automotiv industry	21.9	Automotiv industry	4.9

Source: Ifo-Institute for Economic Research at the University of Munich, The Importance of Energy for the Economy, Munich 2011 (ifo-Institut für Wirtschaftsforschung an der Universität München, Bedeutung der Energiewirtschaft für die Volkswirtschaft,)

- A special feature of the energy industry is the high level of capital investment. Production and value creation are achieved in the energy industry with fewer workers but greater capital investment than in the automotive and chemical industries. The result is that the energy industry has a labor productivity value that is far above average.

According to calculations by the Ifo Institute, every billion Euro invested by the energy industry generates an overall economic effect of € 2.86 billion. The reason for this multiplier effect: in a national economy, investments also impact on production in upstream and downstream sectors. These direct and indirect inputs are also supplemented by income-inducing effects resulting from increased consumer demand from employees within the affected sectors.

Within the energy industry, the largest sector is that of electricity which accounts for 50-80% of the overall totals for the energy industry reported in key data on the national economy. A safe and cost-effective power supply is an indispensable foundation of every modern industrialized society. Security of supply also substantially affects the competitiveness of national economies. The study confirms that in an international comparison, Germany occupies a top position in terms of security of supply. On average, in 2008 each German customer suffered only 18 minutes of power outages.

One reason for this is that Germany has a particularly closely-meshed power grid which is much less susceptible to defects than the wider-meshed grids of neighboring European countries. In order to maintain the high quality of this supply security – especially against the backdrop of the enormous expansion of renewable energy sources – investments must be made in the maintenance and expansion of transfer and distribution networks (see chapter 1). According to estimates by the BDEW over € 40 billion will be required in Germany up to 2020.

Compared to other states, Germany places a particularly high value on a secure and competitive energy supply, since, at 26%, this industry's contribution to overall economic output exceeds the average of all the EU states by six percentage points. For comparison: in France the share is 14%, in Spain 17% and in Great Britain 18%. Despite the structural changes in recent decades, the economic importance of this industry is still central for Germany.

On the other hand, the competitiveness of industrial enterprises is significantly impaired by cost increases for energy and electricity consumption in view of the predominantly industrial basis of the German economy. International comparisons are already showing that electricity prices for Germany's industry and private households are well above the average rates in other European industrialized countries. The loading of electricity prices as a result of German energy policy, particularly due to the increased use of renewable energies for power generation, has led to significant price increases in recent years and thus to higher costs. According to the Ifo Institute, this could impair Germany's economic development.

Besides electricity supply, the study also addressed the importance of gas supply. "Germany's gas industry is a major European player due to the size of the market and its central location," according to the Ifo Institute. This is true even though – measured by number of employees, production value, gross value added and investments – the gas industry is considerably smaller than the chemical and automotive industries. However, in terms of labor productivity it far exceeds these sectors and the average for all economic sectors.

2.5 EEX – the consolidation of energy markets

Trading volume

Trading volume on the European Power Exchange Spot SE (EPEX[7]) and the European Energy Exchange (EEX) continued to increase in 2010. There were significant increases on the previous year's trading, especially in gas and emission allowances: over 150 million emission allowances were traded (2009: nearly 32 million) and a total of over 46 million MWh of gas (2009: 16.1 million MWh). There was also greater electricity trading activity with an increase in trading volumes from 1,231 TWh (2009) to 1,487 TWH (2010). That is almost three times the overall German consumption (538 TWh, 2010 preliminary figures[8]).

In its booklet "Market and Competition – key energy figures for 2010", the Bundesnetzagentur or German Federal Network Agency (FNA) also includes figures for bilateral (OTC[9]) trades from the previous year: 4,707 TWh was traded on the electricity market in 2009 via brokerage platforms. Typically, the front year has the highest volume for trading products: over half of the trading volume was centered on the front year in the year 2009.

7 EPEX Spot SE operates the electricity spot markets in France, Germany, Austria and Switzerland. Its headquarters are in Paris, with a branch office in Leipzig.

8 BDEW: "Entwicklung der Energieversorgung 2010" [Development of energy supplies in 2010] (February 23, 2011)

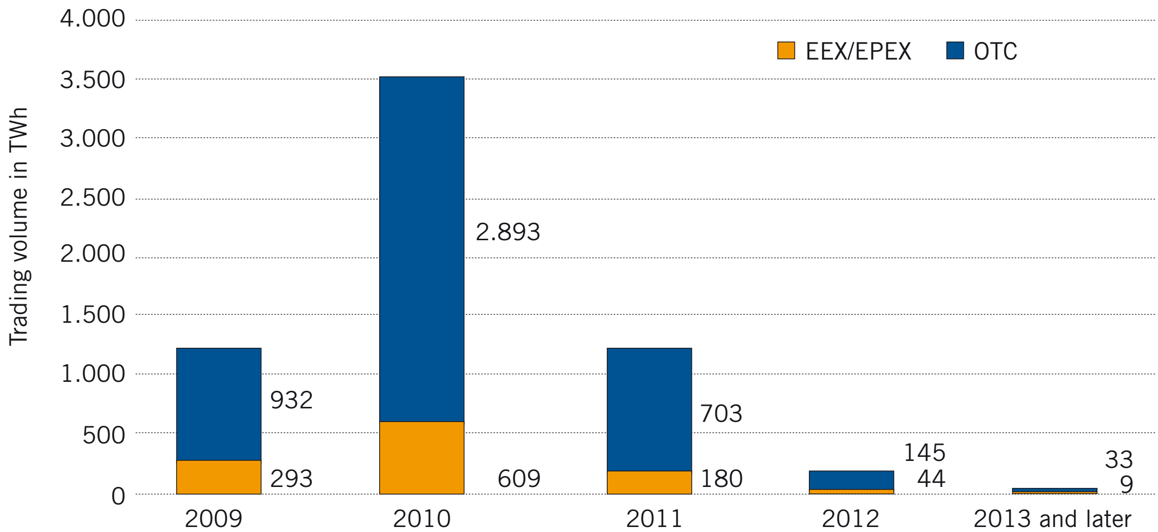
9 OTC = over the counter – bilateral transactions which take place off-exchange and which can, if necessary, be "cleared" (i.e. settled) through the stock exchange.

Electricity

The financial crisis had only a minor impact on trading volumes – and on wholesale electricity prices. Spot market electricity prices in 2010 surpassed values for the previous year, although here the very cold temperatures at the beginning and end of the year played an important role. In a comparison of the three price zones Germany/Austria, France and Switzerland, it was Germany/Austria which generally had the lowest market prices.

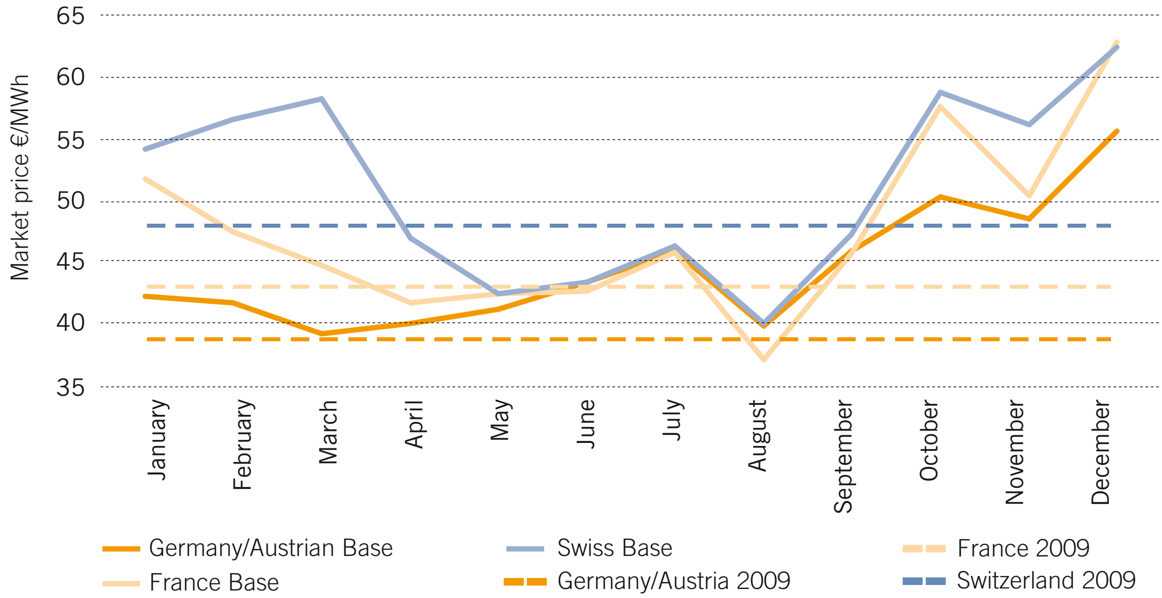
Since October 2010, the EPEX spot exchange has emphasized its pan-European aspirations with the European Electricity Index ELIX. This is calculated on the basis of the aggregated supply and demand curves of the EPEX market regions and thus corresponds to the uncongested market price, i.e. without bottlenecks in transmissions between countries. EPEX Spot and EEX publish the ELIX on the Internet daily, based on the results of the national stock markets. The market zones German/Austria, France

Figure 2.21: Stocks and OTC trading volumes ordered in 2009 in acc. with the delivery year



Source: FNA, indicators for market and energy competition in 2010 The EEX is subject to supervision by the Saxon Ministry for Economy and the Federal Financial Supervisory Authority (sächsische Wirtschaftsministerium und der Bundesanstalt für Finanzdienstleistungsaufsicht BaFin). EPEX Spot SE is supervised by the French energy regulatory. Commission de régulation de l'énergie (CRE)

Figure 2.22: Monthly base load for electricity averages on the spot market in 2010 compared to annual averages from 2009 for the EEX trading zones



Source: EEX, own calculation

and Switzerland represent over a third of Europe's electricity consumption. Deviations in the national market prices compared to ELIX are due to network congestion.

The EPEX goal of an integrated regional market is supported by the increased use of implicit auctioning in the case of congestion ("market coupling"). On November 9, 2010, market coupling was successfully established for the wholesale markets in Belgium, the Netherlands, Luxembourg, France and Germany/Austria. This means that, alongside Nord Pool there is now a second cross-border intra-day trading region. In December 2010, the Florence Forum[10] proposed uniting the two market areas into a single intra-day trading platform.

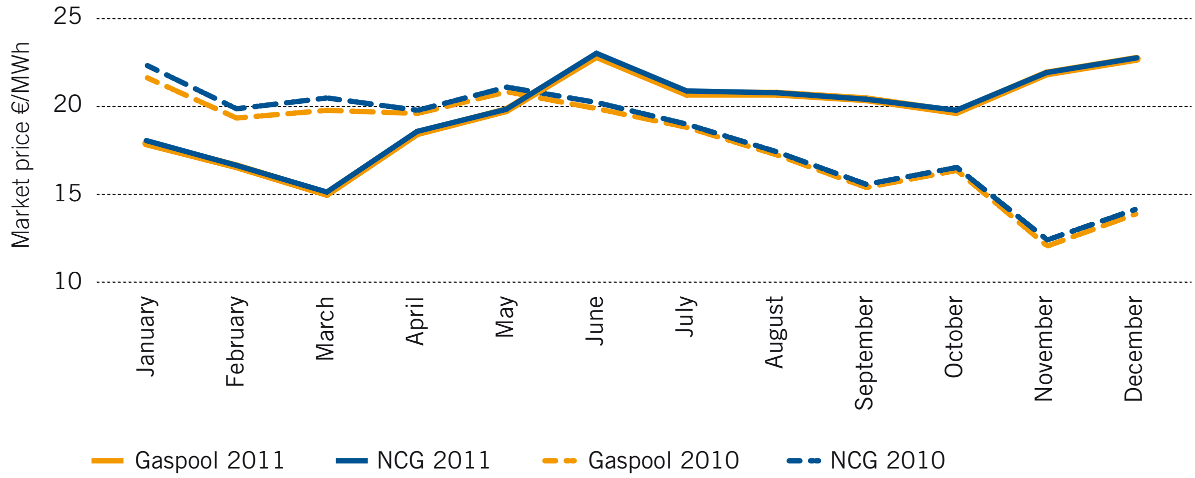
10 The European Energy Forums, like the Florence Forum for electricity and the Madrid Forum for gas, were launched by the European Commission to contribute to the harmonization of energy markets and bring all interested parties and market participants to a common table.

Table 2.3: Market shares for German production and end user markets

Company	Capacity (GW 2010)	Share of capacity	Sales to end users (TWh 2008)	Share
RWE	34.0	23%	86	16%
E.ON	17.6	12%	78	14%
Vattenfall	16.3	11%	24	4%
EnBW	11.2	8%	82	15%
Statkraft	2.2	1%	not applicable	not applicable
GDF Suez	2.1	1%	not applicable	not applicable
SWM	1.8	1%	8	1%
others	63.8	43%	not applicable	not applicable
total	149.0	100%	549	100%

Production shares (data set 2 years earlier than the record sales figures) clearly show diminishing concentration: Only slightly more than 50% of generating capacity are in the hands of the four largest market participants.
Source: CERA, 2010

Figure 2.23: Monthly closing prices for forward buying of gas supply in 2011 (Market data from 2010) in comparison to prices for on-time delivery in 2010 (Market data from 2009) for delivery areas Gaspool[1] and NCG[2]



1 The market area Gaspool (H-gas) is a former BEB-area as well as VNG-ONTRAS and WINGAS.
2 NCG (H-gas) is the market area of United NetConnect GmbH and Co. KG.

Source: EEX, own calculation

The consolidation of the markets also significantly intensifies competition on the electricity markets. While the antitrust authorities of the Scandinavian countries adjusted years ago to the common power exchange Nord Pool and thus use regional concentration indicators, the German antitrust authority still pursues a purely national approach.

The EEX Transparency Platform (www.transparancy.eex.com) has been publishing generation and consumption data for over a year now. Currently, 22 companies report their data, thus fulfilling statutory disclosure requirements as well as voluntary commitments by market participants. Data on planned and actual production of electricity from conventional power plants, as well as wind farms and solar power plants, is presented accurate to the hour on the homepage itself. Reports on availability and power plant outages are also available. In early January the Austrian transmission system operator (APG) joined the EEX transparency initiative – thus kicking off European expansion of the platform.

Natural gas

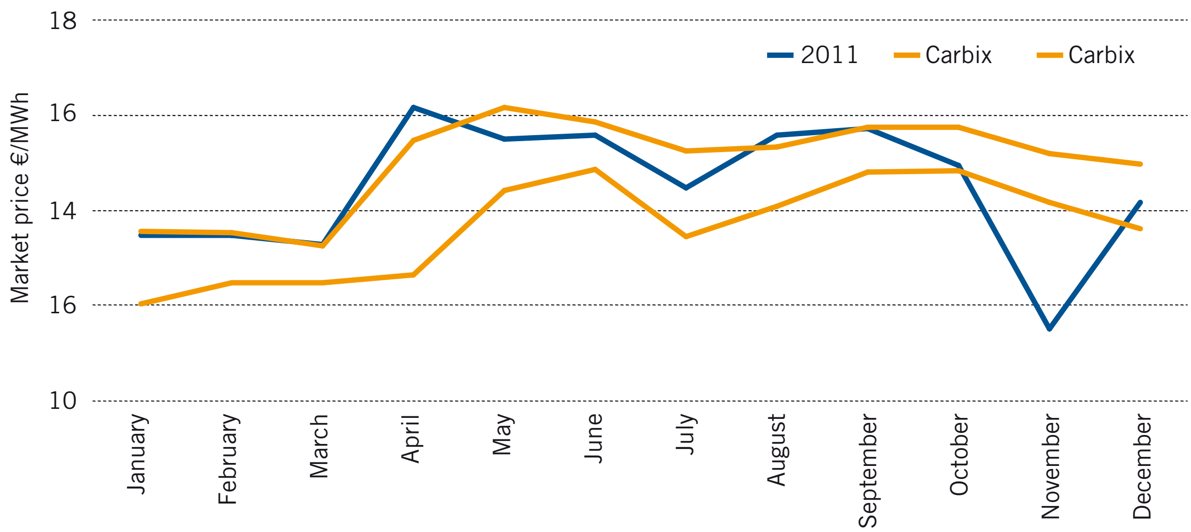
In 2010, trading prices for natural gas recovered somewhat from the low levels at the end of 2009 and increased over the course of the year to around the level seen in early 2009. It was not only the low temperatures in late 2010 that drove up prices, but also confidence in increased gas consumption resulting from an improvement in the economic situation.

Exchange prices for natural gas are assuming an increasingly important role in procurement. Gas prices came under pressure due to the continuing gas surplus as a result of large quantities of unconventional natural gas in the USA[11]. This significantly reduced US imports of liquefied natural gas (LNG) thus increasing global LNG supplies. This meant that large quantities of LNG were available to other markets, which pushed down market prices there.

Trading volumes on the EEX rose significantly: at over 15 TWh, trading on the sport market was over four times as high as in 2009, whilst on the derivatives market trade was almost two-and-a-half times increased on 2009 at over 30 TWh. An important reason for the active trading on the spot market was the introduction of “within-day natural gas”. This permits trading on the remaining hours of the current gas delivery day with a three-hour lead time.

11 See also “Survey of Energy Resources: Focus on Shale Gas “(WEC September 2010, London)

Figure 2.24: Monthly close for EU emission rights delivery in December 2011 as well as the lowest and highest value of the Carbix Spot index for the EEX per month



Source: EEX, self calculation

CO_2

Market prices for EU emission allowances increased rapidly in the course of the second quarter – but fell towards year end to below the market price at the start of the year, although they did recover again due to weather conditions.

Regulatory framework

Exchanges will also have to adjust increasingly to a new regulatory framework. An exchange like EPEX with its headquarters in Paris and business transactions in Switzerland, Germany and Austria can no longer be regulated entirely at national level, but must instead be included within a European framework[12]. Otherwise national idiosyncrasies will continue to undermine consolidation into a regional market.

12 See also "Road map towards a Competitive European Energy Market" (WEC Oct. 2010, London)

2.6 Sector inquiry into wholesale electricity trading by the Bundeskartellamt

In mid-January 2011 Germany's cartel authority, the Bundeskartellamt, published its final report on a sector inquiry into wholesale electricity trading commenced in March 2009. The study examined the competitive environment and pricing on Germany's electricity market. The Bundeskartellamt did not identify a systematic withholding of generation capacity in order to drive up wholesale prices. However, the authority did criticize an existing opportunity to influence prices and proposed that the energy exchange and power plant operational control systems should be subject to supervision by the Bundeskartellamt. This would necessitate better access to power plant generation data – for this, the authority suggests introduction of a market transparency scheme.

In order to evaluate the authority's results, it is important to examine the underlying assumptions. The Bundeskartellamt is assuming a significantly reduced market area in two respects. Firstly, the exchange of power with foreign countries is completely ignored and the existence of a European market denied – the influence of electricity traders and producers such as EdF (France), GdF Suez (Belgium/France) or Statkraft (Norway) on the electricity exchange in Leipzig is assumed to be absent. Secondly, quantities of power generated from renewable sources and subsidized under the Renewable Energy Sources Act or EEG (commonly called 'EEG power') are not considered to be influential on markets and prices since, according to the Bundeskartellamt, the EEG was set up on the basis of a planned economy, and is therefore independent of demand and price signals.

This is in clear contradiction of the results of CERA (Cambridge Energy Research Associates, European Power Country Profile Germany, December 2010), which came to the conclusion that the four largest companies make up 53% of the total market, which is significantly less than the Bundeskartellamt figure. CERA also neglected the regional markets in its first step and used only German figures. EEG power, with over 40 GW of generating capacity (monitoring report by the Federal Network Agency, 2009) is now the largest market participant.

The fact that wholesale electricity trading in Germany is highly successful is shown by the monitoring report of the Federal Network Agency: in 2009, 5,843 TWh were traded, about 10 times the German electricity consumption. The German electricity market is integrated into the European market. German wholesale electricity trading prices are generally lower than in neighboring countries. In 2009, Germany's trade balance was an export credit of 12 TWh. This would not have occurred if prices had been lower abroad than in Germany. Cross-border electricity trading and European competition ensures that outdated and expensive plants are driven out of the market, which benefits both consumers and the environment.

Table 2.4

Market participants	**generating capacity in GW (2010)**	**share of total generation capacity**
RWE	34.0	23%
E.ON	17.6	12%
Vattenfall	16.3	11%
EnBW	11.2	8%
Statkraft	2.2	1%
GDF Suez	2.1	1%
Munich Public Utility	1.8	1%
others (including. EEG-equipment)	63.8	43%
Total	**149**	**100%**

Source: CERA, supplemented by corporate data

A market transparency system as proposed by the Bundeskartellamt could foster lasting trust in the wholesale market. Preconditions for this are uniform, standardized and mandatory transparency rules for all European trading platforms and corresponding EU supervision. This will guarantee legal equality in all EU Member States and thus promote liquidity. A European supervision system is also the only meaningful option to monitor the high proportion of cross-border trading.

2.7 Energy efficiency indicators

Energy consumption per unit of real gross domestic product

Total energy consumption in Germany (primary energy consumption) in 2010 was 480 million TCE, a decline of 6% on consumption of 509 million TCE in 1990. During the same period gross domestic product increased in real terms by 31%. Energy efficiency – expressed as the ratio between primary energy consumption and gross domestic product – improved correspondingly by a total of 28%. This represents an average annual increase in energy efficiency by 1.6% over the whole period from 1990 to 2010. Important: in the two decades since 1990, different annual growth rates were realized.

- 1990 to 2000: 2.2% per annum
- 2000 to 2010: 1.1% per annum

Thus, the pace of the efficiency increase has slowed. The effects of reunification were a major factor in enabling the particularly strong improvement in the statistical energy efficiency figures in the first decade after reunification. The pool of power plants in the new states was almost completely replaced or modernized. Inefficient energy-intensive industrial productions were also shut down. There was extensive renovation of existing buildings together with a conversion from heating systems operated with brown coal briquette to natural gas and fuel oil. This is a one-off effect that is not repeatable.

For energy efficiency too, the following applies: low-hanging fruit is harvested first. With the realization of potential for energy efficiency it becomes more and more difficult – and usually more costly – to maintain the pace achieved in the past. Furthermore, it should be noted that indicators by which energy efficiency is measured have their own pitfalls and uncertainties.

- Thus, substituting electricity generation from nuclear energy with generation from renewable energy sources leads to an improvement of energy efficiency statistics. The reason: based on the amount of electrical energy generated, nuclear energy is reported as consuming three times as much primary energy (efficiency: 33%). Electricity generation from renewable energy sources on the other hand – also unlike the situation with natural gas and coal – is entered in the primary energy balance at its actual generation value (efficiency: 100%). Hence, transforming our energy supply to renewable energy sources is shown in the statistics as an improvement in primary energy efficiency.
- Another example: the ratio of primary energy consumption to gross domestic product can also improve in response to a change in the range of products within individual industry sectors or structural changes between different branches of industry. The relocation of energy-intensive primary production industries out of Germany will also presumably lead to an increase in value added per unit of energy in Germany. The fact that, on a global scale, more energy is being used in the value added chain and that efficiency is in fact reduced, is thereby masked.

The statistical indicator of energy efficiency is thus of limited value.

The German government's Energy Concept formulated the goal of reducing primary energy consumption by 20% by 2020 and by 50% by 2050 compared to the figures for 2008 and achieving an annual increase in energy productivity of an average of 2.1%, based upon final energy consumption. Changes in the mix of energy sources for electricity generation do not impact this indicator (which relates to energy consumption). If the efficiency of final energy consumption is now to be increased by 2.1% per annum, this means: over the next 40 years energy efficiency must be increased consistently each year by a figure double that achieved in the last ten years.

- In the industrial sector, for cost reasons alone energy is already used extremely sparingly. Actual improvements in the efficiency of industrial process cannot be accelerated at will.

- In the building sector there is great potential for improving energy efficiency both in the use of building materials and in heating systems. However, such potential can only ultimately be realized with major investment. The willingness and ability of homeowners and tenants to bear the associated costs is surely limited.

- In the transport sector there is also considerable potential for reducing energy consumption. This applies to both freight and passenger transport. Important factors are more fuel-efficient combustion engines, use of natural gas/biogas, as well as moving towards electromobility. With the provision of electricity from renewable energy sources, electromobility can make a significant contribution to increasing energy efficiency.

Implementation of the German government's ambitious energy efficiency goals will depend on strong political support directed primarily at the building and transportation sectors.

Power consumption per unit of real gross domestic product

Gross electricity consumption in Germany has increased by 10% from 551 TWh in 1990 to 604 TWh in 2010. In the last ten years too, energy consumption rose slightly initially (until 2007) and reduced only in 2008 and 2009 – as a result of the economic crisis. However, in 2010 there was another rise in electricity consumption by 4.3% on the previous year. Thus, in 2010 power consumption was 4.2% above the level in 2000.

Efficiency in utilization of electricity – expressed as power consumption per unit of GDP – has improved from 1990 to 2010 by an average of 0.9% per annum. Here too there are different values for the two decades since 1990:

- 1990 to 2000: 1.3 % per annum
- 2000 to 2010: 0.5 % per annum

The German government's Energy Concept provides for a reduction of 10% in electricity consumption by 2020 and of 25% by 2050 (as compared to figures for 2008). However, electricity is a modernizing energy which does not release CO_2 when used. With the increased use of renewable energy sources it is possible to generate electricity with extremely low levels of CO_2. As long as fossil fuels continue to be used for power generation over the long term, the basic technological solution is the capture, storage and utilization of CO_2. However, unlike in electricity generation and in industry, the capture and storage of CO_2 is not economically feasible for fossil fuel energy sources for remote or mobile use.

Electricity also has an important function in control and regulation technology. In many cases, an increased use of electricity is needed to achieve additional efficiency potential.

Possible measures/Technologies to increase energy efficiency

The proportion of final energy consumption used by private households is just under 30%, of which in turn 85% is used for space heating and hot water. Against this background there is major potential for savings in the renovation of existing buildings. This would require simultaneous updating of heating systems and energy efficient renovation of building shells. It would depend on the intelligent linking of the two approaches, although the various renovation phases and the very different capital requirements with regard to the level and duration of amortization would also have to be considered. Measures for climate protection and energy saving must be designed to enable cost-effective implementation, i.e. they must be affordable for consumers.

In addition, without substantial adjustment of subsidy rates and efficient organization of subsidy mechanisms, it will not be possible to increase the renovation rate in Germany – as provided for in the government's Energy Concept – to 2% per annum to achieve the corresponding savings in heating needs (20% by 2020 and 80% by 2050). There must also be a simplification of the existing regulatory framework by a clear focus on energy source neutrality and an openness to technology. Consumers should be able to decide for themselves on the basis of fair competition of costs and services on the best option for them. Other important factors are the establishment and development of easily accessible, decentralized and neutral information and consulting services.

For the reconfiguration of heat provision there are already a number of efficient technologies on the market, others are on the verge of market introduction or in development. Examples worth mentioning are gas-fired condensing boilers which can also be combined with solarthermic energy, gas heat pumps or micro-CHP systems as well as electric heat pumps. Increasing energy efficiency will also depend significantly on intelligent networking and control of the various applications of energy in the household (heating, lighting, operation of household appliances). There are already appropriate solutions on the market (Smart Homes).

2.8 dena Grid Study II – Summary

Due to an increased proportion of renewable energies (especially wind energy) in the German energy mix and the associated geographical shift of the main power producers to the north of Germany, and due to the increasing fluctuations in power feedins, Germany faces enormous challenges in terms of adjusting its network infrastructure.

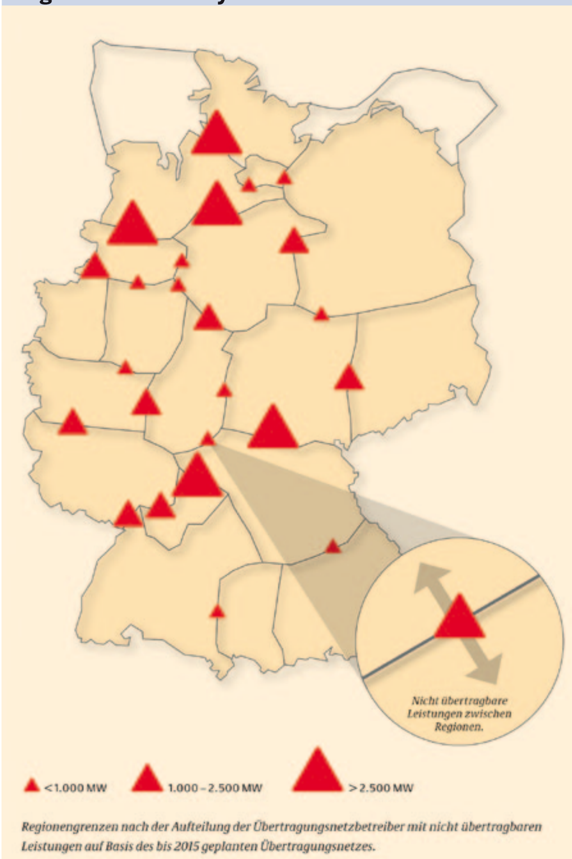
This summary gives an overview of the results and recommendations generated by the dena Grid Study II for the integration of renewable energy sources into Germany's electrical supply system, which are also discussed in the main topic of this year's publication (see Chapter 1).

As part of the dena Grid Study II, suitable system solutions and technological options for the further development of Germany's power supply system were examined with a view to full integration into the transmission grid of the projected 39% proportion of which it is predicted will be generated by renewable energy sources by 2020-2025. The study also considered supply security and the effects of the liberalization of the European energy market, as well as the suitability of demand-side measures to shift loads and optimize the entire system through new technologies for storage. The actual measures for grid enhancement and the need to expand cabling by 850 km by 2015 identified in the dena Grid Study I have already been taken account of as projects for priority implementation in the Power Grid Expansion Act (EnLAG 2009). Therefore, these projects were presumed to have been realized in the dena Grid Study II. To date (as of 03/2011) however, less than 100 km of these new cables have been added.

Network expansion

The basis of the study is the simulated infeed of wind energy for the year 2020. For this purpose, wind time series were initially generated on the basis of historical weather data in order to then transfer them in performance flows to current wind turbines by way of representative performance curves. Thus, the non-transferable benefits of Germany's transmission grid could be identified (see figure 2.25). Network expansion costs for this reference scenario (without the use of additional storage facilities) amount to 946 million €/a for new cabling with a total length of 3,600 km (i.e. in addition to the 850 km length required for grid expansion as stated in the dena Grid Study I).

Figure 2.25: Non-transferable services between regions in Germany

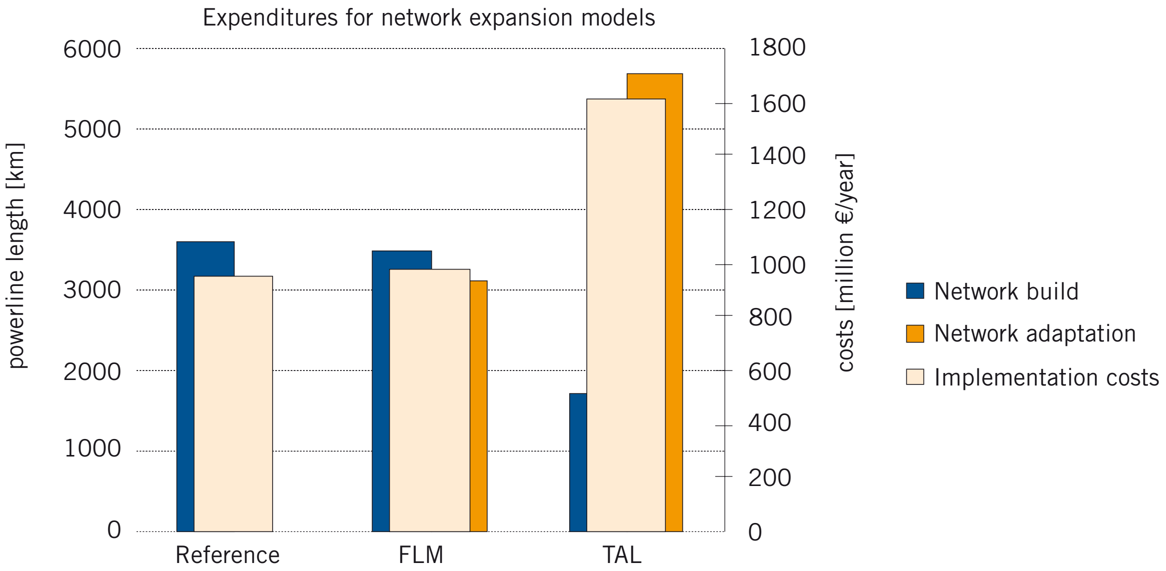


Source: dena grid study II, 2010

In addition to this reference scenario, options were examined for reducing the grid expansion deemed required. For example, overhead line monitoring[13] (OLM) and the use of high temperature cables (TAL) lend grids greater load-bearing capacity and thus reduce the need for expansion. However, adaptation of the existing networks to the new technology would then be required, which would raise costs for both options (see Figure 2.26). Using overhead line monitoring would result in only a minor reduction of the required grid expansion to 100 km (with additional adaptation of the existing 3,100 km of cabling).

13 Overhead line monitoring refers to the continuous monitoring of temperatures on the overhead power lines when the conductor temperature increases with electrical load. Since standards require tolerance to ambient environmental conditions of 35°C and 0.6 m/s wind speed, there are reserves, i.e. heat dissipation, available for periods when wind speed is greater, so that the temperature monitoring using overhead line monitoring enables increases in power-bearing capacity of up to 50%. Power-bearing capacity can be increased by the same extent through use of high temperature cables (TAL).

Figure 2.26: Minimizing the need for network expansion



Source: Own representation of the data after dena Grid Study II, 2010

Compared to the reference scenario, costs would increase from 946 million €/a to 985 million €/a. Use of high temperatures cables would reduce the need for network expansion to 1,700 km with simultaneous adaptation of the existing 5,700 km of cables. However, these costs of 1,617 million €/a would considerably exceed those of the reference scenario.

Besides the two mentioned possibilities for minimizing the need for network expansion, the use of storage facilities was also investigated. However, in this study the storage facilities assumed to be situated north of the primary course of network congestion could not be operated economically based upon current market regulations and the current state of technology.

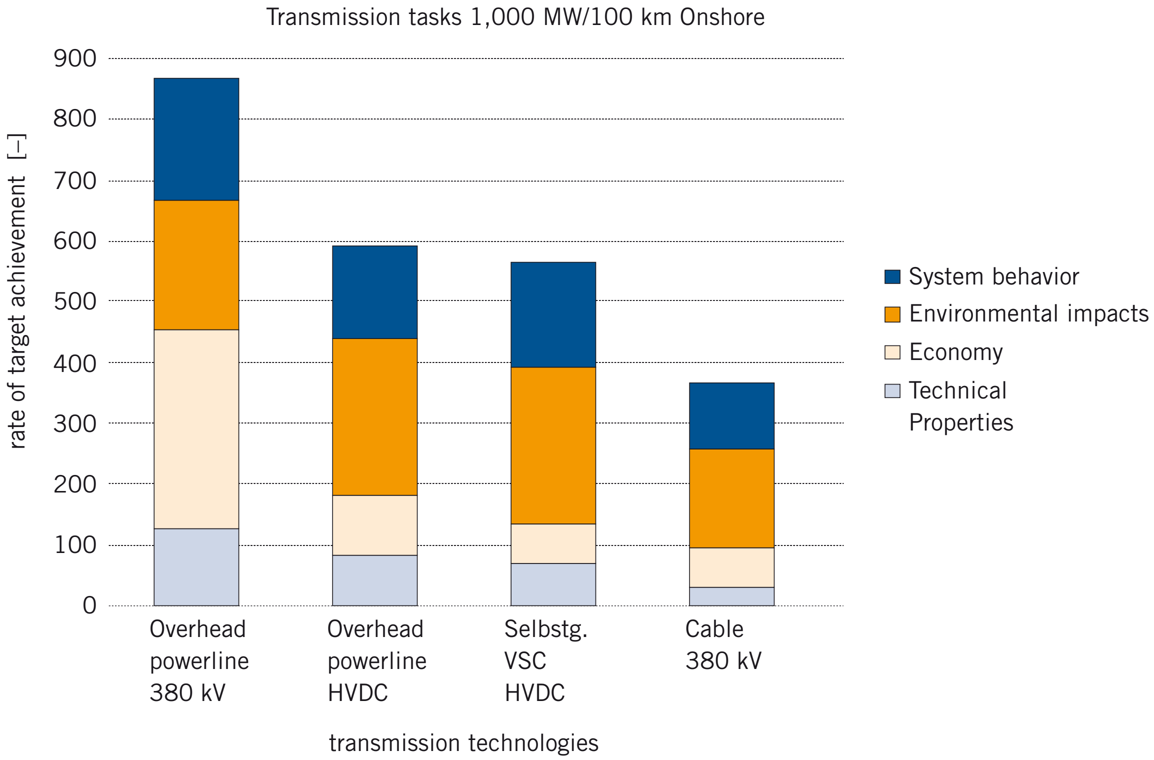
For the new cabling to be established in this reference scenario, various electricity transmission technologies were also assessed. In addition to cost-effectiveness and technical characteristics, the system compatibility and environmental impact of the technologies were also considered in the assessment and then weighted for various transmission tasks on land and sea. The increasingly important acceptance of power line expansion was taken account of by the study's criterion of environmental impact (see Figure 2.27). For example, underground cables stand out in comparison to overhead line as having a higher acceptance rate in the population, since underground lines are not visible. However, the economic advantages of overhead lines compared to underground cables are nonetheless according to this assessment that use of overhead lines proved more suitable (in sample projects from the dena Grid Study II). For the connection of offshore wind farms on the other hand, the criteria were weighted differently to take account of the specific issues of the situation (different from Figure 2.27), so that for offshore transmission self-guided VSC-HVDC technology[14] was identified as a suitable technical solution.

Flexibility of the electricity supply system

As part of the network study, in addition to expanding the network, flexibilization options for the power supply system to compensate for fluctuating infeeds from renewable energy sources were also examined and evaluated. Here, the provision of operating reserve by renewable energy plays an increasingly important role.

14 Self-commutated VSC-HVDC technologies enable simple control of reactive and real power in the network and the establishment of a standalone power supply (black start capability) and are therefore particularly suitable for connecting offshore wind farms (VSC-HVDC: Voltage Source Converter – High-voltage direct current transmission).

Figure 2.27: Transmission technologies



Source: Own representation of the data after dena Grid Study II, 2010

Use of demand side management[15] in the power plant model of the dena Grid Study II enabled the coverage of around 60% of demand for positive operating reserve[16], whereby the required capacity of peak load power plants was reduced by 800 MW (see Chapter 1).

As an option for system flexibility, provision of reserve power by way of wind power and biomass was also investigated. Generally, although positive operating reserve could be made available by throttling wind turbines, and thereby quickly injecting more performance during peak load periods, this is only economically viable in rare cases. On the other hand, negative operating reserve could be made available extensively if wind turbines are operated in a reduced-capacity mode depending on demand.

Potentially, this also offers a 45% improvement in forecasts of wind power infeeds. This results in a maximum demand for point-to-point positive secondary and minute reserves of 4,200 MW and negative secondary and minute reserves of 3,300 MW. These requirements are within the scope of requirements today, but significantly below the forecasts of the dena Grid Study I.

Another measure to improve flexibility is represented by market-driven deployment of large-scale storage facilities (e.g. pumped storage plants in southern Germany).

Outlook

Enhanced European cooperation will be increasingly important in view of the necessary grid expansion and modernization of the network infrastructure. Within this context, it is important to mention development of common economic cooperation in Europe and creation of uniform

15 Demand side management refers to the control of demand for power by way of load shedding and load shifting among industrial, commercial and household consumers.

16 Operating reserve describes the amount of energy needed to compensate for performance differences between producers and consumers. Negative operating reserve is provided when excess power is available in the network. Positive operating reserve is required on the other hand when additional capacity must be provided. Primary, secondary and tertiary control are mainly distinguished by speed of provision and change.

framework conditions for the internal European electricity market.

Against the background of the German government's plans to generate 50% of electricity from renewable energy sources by 2030, further expansion of the network infrastructure is essential.[17] This need is further underlined by the increased use of energy storage capacities in southern Germany, the Alpine countries and the Scandinavian countries. Implementation periods for infrastructure projects are currently up to 10 years, which makes it clear that there is a discrepancy between the development of renewable energy technologies and existence of the necessary network infrastructure. In order for the government to achieve its stated goal for a regenerative era, the dena Grid Study II recommended the following measures:

- Acceleration of the approval process for network expansion projects, taking into account development of the legal framework and improvement of staffing levels for parties involved with, such as network operators and approval authorities.

- Increased public acceptance for required network expansion involving all stakeholders, which include policy makers and network operators, as well as power producers, approval authorities, and not least the public.

- Within the course of future network planning, consideration must be given to optimizations with regard to technical network integration, optimization measures in corporate management and use of alternative transmission technologies.

- Detailed investigations must be made to identify suitable framework conditions for increasing use of energy storage facilities and to optimize their technological conception.

- Demonstration projects should be conducted for the use of selected technologies such as overhead power lines with AC/DC hybrid operation.

- Pilot projects should be established with high temperature conductor cables, since they have a high development potential.

- Further development of technical concepts for multi-terminal solutions and the standardization of DC current technology at European level is recommended.

17 Energy Concept of the Federal Government, Federal Ministry of Economy and Energy, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin, September 2010

2.9 Power plant projects in Germany

(As of: 01. April 2011)

Abbreviations for the intended primary energy sources:

Bi = biomass	Dg = landfill gas	Eg = natural gas	Gr = methane gas	Mu = garbage	St = coal
Br = brown coal	Di = diesel	Gg = furnace gas/coke gas	Ke = nuclear energy	Ps = pumped storage	Wi = wind
Bg = biogas	Dr = compressed air reservoir	Gt = Geo thermal	Lw = running water	So = solar	We = wave power

Source: Company press releases, company information

Note: Some of the projects listed, which are named as such by companies in the areas of construction, approval process or in planning. The naming or reference of any of the projects contained within this list is not associated with a determination regarding the likelihood of the projects realization. For a classification of the project's progress, the status column will be used as an indicator; project-specific events will sometimes contain remarks in the column. Due to the large number of offshore wind farms that are currently being planned or are awaiting the approval process, this list only contains those that are well within the planning phase and approval process. For more information, contact the Federal Maritime and Hydrographic tomography (www.bsh.de).

Source: BDEW, supplemented by corporate data.

Table 2.5: Power Plants in construction/approval procedures/in planning

Business	Power plant	power MWel net	Energy sources	Expected commissioning		Status
RWE Power	BoA2&3 Neurath	2,100	Br		2011	under construction
Evonik Steag/EVN AG	Duisburg-Walsum 10	725	St		2011	under construction
E.ON power plant	Irsching 4	530	Eg	Summer	2011	under construction
RWE Power	Lingen (Modernization)	+ 122	Eg		2011	under construction
EV Hall	HKW-Hall Trotha (Modernization)	41	Eg	End	2011	under construction
infraserv maximum	industrial park maximum	70	Mü		2011	under construction
EnBW Energy Solutions GmbH	Industrial Park City of Eisenhütten	32	Mü	Spring	2011	under construction
EnBW	Offshore-park “Baltic 17 Baltic Sea	48	Wi	April	2011	approval granted
BARD Engineering GmbH	Offshore wind farm “Veja Mate”	400	Wi		2011/12	approval granted
Vattenfall Europe	Boxberg/Block R	675	Br		2012	under construction
Vattenfall Europe	Hamburg-Moorburg	1,640	St		2012	under construction
RWE Power	Hamm	1,530	St		2012	under construction
E.ON power plant	Datteln 4	1,055	St		2012	under construction/ building freeze
GDF SUEZ Energy Germany AG/BKWFMB Energy	Wilhelmshaven	800	St		2012	under construction
GDKW Bocholt Power GmbH (Advanced Power AG (CH), Siemens Project Ventures)	Bocholt/Industrial Park Mussum	415	Eg		2014	approval granted
WS Saarbrücken	GuDSüd/Saarbrücken	39	Eg		2012	under construction
EnBW/EDF	Expansion Iffezheim	+ 38	Lw		2012	under construction
SüdWestStrom (South West Energy) EWE/Enova	Offshore wind farm “BARD Offshore 1” Offshore wind farm “Riffgat”	400 100	Wi Wi	End	2012 2012	under construction approval granted
Trianel	Borkum West II	400	Wi		2012/13	approval granted
RWE Innogy	Offshore wind farm “North Sea East”	295	Wi		2012/13	approval granted
E.ON power plant	Staudinger 6 (Großkrotzenburg)	1,100	St		2016	in the approval process, first partial permission approved, Activation by 2014

Table 2.5: Power Plants in construction/approval procedures/in planning

Business	Power plant	power MWel net	Energy sources	Expected commissioning		Status
EnBW	Karlsruhe/Rhine port RDK8	912	St		2013	under construction
GKM	Mannheim/Block 9	911	St		2013	under construction
Trianel Power	Lünen	750	St		2013	under construction
Rhein Energie AG	Cologne-Niehl	1,200	Eg		2013	in the approval process, activation by 2014
Statkraft	GuD-Knappsack II	450	Eg		2013	in the approval process, activation by 2014
swb AG (Bremen)	Community Power Station Bremen	420	Eg		2013	approval granted
Atel Holding AG (CH)	Premnitz	400	Eg		2013	in the approval process A/preliminary notice granted
Heag Südhessische Energie AG (HSE)/Stw. Munich/EGL AG/Es portes offshore involvement GmbH/Nordland project GmbH/AG Windreich	Offshore wind farm "Global TechII"	400	Wi		2013	approval granted
EnBW	Offshore wind farm "Baltic 27 Baltic Sea	288	Wi		2013	approval granted
Vattenfall/Stw. Munich (SWM)	Offshore wind farm "DanTysk"	288	Wi		2013/14	approval granted
Enovos	Eisenhüttenstadt	900	Eg		2013/14	in planning, activation by 2014
GETEC Energy AG	Community power station/ Bayer Industrial Park	800	St		2014	in the approval process, activation by 2014
Dow Chemicals	Stade (2 plant)	1,000	Eg/St		2014	in the approval process, activation by 2014
berdrola	Mecklar-Marbach/Ludwigsau (North Hessen)	1,100	Eg		2014	in approval process, partial approval granted, In operation until2014
OMV Power International	Burghausen (industrial area Haiming)	850	Eg	Beginning	2014	in the approval process, activation by 2014
Repower AG	CCGT/Chemical Park Leverkusen/ Cologne	430	Eg		2014	in the approval process, activation by 2014
Vattenfall Europe	GuD Berlin-Lichterfeld	230	Eg		2014	in the approval procedure, partial approval granted, operation commissioning until 2014
Dong Energy	Offshore wind farm "Riffgrund 1"	320	Wi		2014	approval granted
E.ON Climate & Renewables	Offshore wind farm "Amrumbank West"	350	Wi		2014	approval granted
Trianel Power	Krefeld /Chemical Park Krefeld-Uerdingen	750	St/Eg (still unclear)		2014/15	in the approval process, activation by 2014

Table 2.5: Power Plants in construction/approval procedures/in planning

Business	Power plant	power MWel net	Energy sources	Expected commissioning	Status
Vattenfall Europe	Jänschwalde	250	Br	2015	in planning, activation by 2014
Advanced Power (CH)/ Siemens Project Ventures GmbH	Wustermark	1,200	Eg	2015	in planning, activation by 2014
RWE Innogy	Innogy North Sea 1	996	Wi	2015	in the approval process, activation by 2014
Vattenfall Europe	Berlin-Karlshorst	300	Eg	2016	in planning, activation by 2014
E.ON hydropower	Waldeck II (expansion)	300	Ps	2016	in the approval process, activation by 2014
Advanced Power AG	Staßfurt/project "Adele"	90	Dr	2016	in planning, activation by 2014
Donaukraftwerk Jo chenstein AG	Jochenstein/energy storage Riedl	300	Ps	2018	in planning, activation by 2014
Vattenfall Europe	Berlin-Karlshorst	40	Bi	2019	in planning, activation by 2014
Schluchseewerke AG	Atdorf	1,400	Ps	2019	in planning, activation by 2014
EnBW	Karlsruhe/Rheinhafen RDK6S	465	Eg	open	approval granted
SüdWestStrom (South West Energy)	Brunsbüttel	1,820	St	open	in the approval process
UPM (paper manufacturer)	Dörpen	150	Eg	open	in the approval process
RWE Power	BoA4 & 5Niederaußem	2,100	Br	open	in planning
MIBRAG	Profen	660	Br	open	in planning
E.ON power plant	Stade	1,100	St	open	in planning
GDF SUEZ Energy Germany AG	Saxony-Anhalt (Calbe or Staßfurt)	800	Eg	open	in planning
n.v. Nuon	Meppen	450	Eg	open	in planning
GuD Zeitz GmbH	Zeitz/Industrial Park Alttröglitz	130	Eg	open	in planning
Stw. Dusseldorf	Dusseldorf		Eg	open	in planning
Stw. Ulm (SWU)	CCPP Ulm/Leipheim Airport		Eg	open	in planning
Power Plant Mainz-Wiesbaden AG (KMW)	Mainz		Eg	open	in planning
Statkraft	Emden		Eg	open	in planning
Stw. Ulm (SWU)	Blautal	45	Ps	open	in planning
EnBW AG	Forbach (extension)	+ 200	Ps	open	under examination
RWE Power	Saxony-Anhalt (Mglw. Arneburg near Stendal)		St	open	Site Search
Summe		**38.100**			

WEC Inside

3

WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

World Energy Council (WEC)

The World Energy Council (WEC) was founded in 1924 with headquarters in London. Today, the organization comprises around 90 national committees, representing over 90 % of global energy production. The WEC is the platform for discussion of global and long-term issues relating to the energy industry, energy policy and energy technology. As a non-governmental, non-profit organization, the WEC forms a global network of competence which is represented in the industrialized nations, emerging nations and developing countries of all regions.

The activities of the WEC cover the whole range of energy sources – coal, oil, natural gas, nuclear power and renewable energies – and the associated environmental and climate issues, making it the only global network of its kind spanning energy sources. Its goal since foundation is to promote the sustainable utilization of all forms of energy – for the benefit of all people.

With this goal in mind, the WEC conducts studies and technical and regional programs. Every three years the organization hosts the most prestigious international energy conference, the World Energy Congress. The aim of this event, which lasts several days, is to promote a better understanding of energy industry issues and solution approaches from a global perspective.

www.worldenergy.org

WORLD ENERGY COUNCIL
Weltenergierat - Deutschland

Weltenergierat – Deutschland

The Weltenergierat – Deutschland is the national member of the World Energy Council for Germany. It is made up of energy industry enterprises, associations, academic institutes and individuals. As a non-governmental, non-profit organization, the Weltenergierat – Deutschland forms its opinions independently. The Presidium of the organization comprises representatives from all energy sources.

The aim of the Weltenergierat – Deutschland is the implementation and dissemination of the WEC work results in Germany, in particular to create awareness of the global and longer-term aspects of energy and environmental policy in national discussion as well.

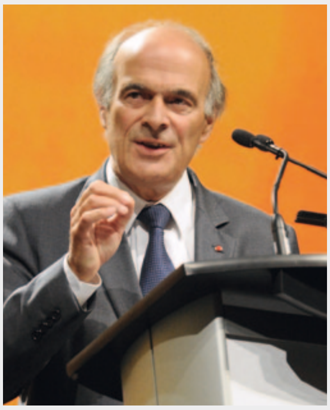
To this end the Weltenergierat – Deutschland works intensively on the opinions and studies of the WEC. In addition it also organizes its own events, conducts its own studies and, in the form of this publication "Energy for Germany", also issues an annual overview of the most important energy industry data and future prospects for the world, Europe and for Germany.

www.weltenergierat.de

Special: 21st World Energy Congress

September 12–16, 2010, Montreal, Canada

"Responding Now to Global Challenges: Energy in transition for a living planet", that was the motto of the largest international energy conference in the world with around 7,000 participants from over 130 countries. Whilst at the last World Energy Congress in Rome in 2007 the focus was on a wider understanding of international interlinking in the energy industry, at the 21st World Energy Congress on 12-16 September 2010 in Montreal the specific topics were the increasing global demand for energy and the enormous challenges this brings. High-ranking representatives of all energy sources, politicians, plant manufacturers, consultation firms and international energy agencies were widely represented in the presentations and podium discussions.



Pierre Gadonnaix, Chairman, World Energy Council

"Sustainable growth is no longer an option it is an necessity."

The main results of the congress were as follows:

- An increase of 30-40% in global energy demand is expected by 2030.
- The extent of fossil fuels is considerably greater than estimated up to now – in particular due to development in the area of shale gas.
- Fossil fuels are attributed a significant role in the global energy mix for decades to come.
- Scarcity of capital for investments in energy infrastructure is seen as a greater squeeze than energy reserves (oil, natural gas, coal).
- There is more focus on access to affordable energy and energy as a growth driver than on climate protection.
- Nuclear energy and renewable energy sources globally are considered a good supplement to achieve an environmentally sustainable and safe energy supply.

In the course of the conference it became clear that energy is a central topic in all countries. There was consensus that the widespread and affordable provision of energy is an essential precondition for growth and prosperity. However, the countries do set different priorities.

In industrialized nations, transformation of the energy systems is the central issue. For some countries this involves replacement of a sometimes outdated infrastructure, the improvement of greenhouse gas emission balances and the reduction of reliance on imports. In some isolated cases, environmental issues play a major role. In all industrialized nations energy efficiency is a particular focus. Reliable energy provision as well as affordable energy are considered important to be able to remain competitive. The greatest challenge is seen in financing the transformation. In this connection, stable political framework conditions for industrialized countries represent an important prerequisite for investment.

Dan Yergin, Chairman, IHS CERA

"… there remains one law that we all must adhere to where energy is concerned, that is the law of long lead times."

In growth regions the focus of interest is on the largescale development of an energy system which provides energy in large and reliable amounts. Strong growth in industry and increasing prosperity lead to high growth rates in energy demand. The competitiveness of industry is seen as decisive, but in growth regions energy efficiency also plays an important role. Another reason for the increasing energy consumption is transport: whilst at present around a billion cars are in use around the world, it is expected that this number will double by 2035. This is attributable in particular to the transition within growth regions.

Fatih Birol, Chief Economist, IEA

"China's energy policy will determine the future of oil prices."

For poverty regions, combating energy poverty and access to modern energy are central issues. Up to 2 billion people today have no access to modern energy – in poverty regions energy demand is mostly covered by wood burning. But without a reliable energy supply such countries have no chance of economic development. One major difficulty is the instability of the legal and political framework, so that there is no basis for an ordered process to solve the energy problem. Technological solutions must also take account of the existing education level of technical employees.

Donald Kaberuka, President, African Development Bank
"The whole African continent has less energy capacity than the country of Spain."

The role of the individual energy sources in future supply was the focus of many presentations and discussions in Montreal. In general, every country wants to use its domestic reserves first in order to reduce its dependence on energy imports and reduce the vulnerability of its national economy. Countries with few natural resources tend to focus mainly on nuclear power production.

It is expected that global oil consumption will further increase by 2030. Although in industrial regions a "peak demand" is foreseeable, increasing demand is to be expected in developing and emerging nations. At the same time it appears that the increasing demand can be covered by current capacity reserves of an estimated 4 mb/d and the increased exploitation of oil using EOR (enhanced oil recovery, compression of CO_2).

On the gas market the extraction of unconventional gas, particularly in North America, has caused significant changes. Prices on the natural gas market dropped globally as a result of this development. Worldwide, conventional gas can be seen at 187 tcm whilst shale gas lies at 456 tcm. The extensive use of unconventional gas was preceded by a 15–20 year phase of research and development.

Khalid A. Al-Falih, CEO, Saudi Aramco
"From my perspective, there are significant opportunities to make petroleum more environmentally friendly, including cleaner burning fuel formulations, CCS, and a host of other advanced technologies that are still in their infancy, and I believe it is incumbent on our industry to do its utmost to realize those enhancements."

Peter Voser, CEO, Shell
"We believe there is enough recoverable natural gas to last for more than a century."

Coal as an energy resource is being further expanded in some countries with an eye to the increasing demand for energy and domestic reserves, whereas other states are planning to abandon existing coal mines in the coming years. Worldwide, the demand for coal increased by 46% from 1999–2009, whilst over the same period demand for oil only increased by 10 %. Particularly in the power sector, coal has gained importance. A further increase in global demand is expected in the coming years. Technologies by which coal is liquefied for instance are being further developed.

V. Kumar Singh, Chairman, Northern Coalfieds Ltd.
"Coal is the only solution for the energy to elevate the standard of living."

Nuclear energy is seen alongside renewable energies as a CO_2-free power source. In industrialized and emerging nations nuclear energy makes a considerable contribution to reliable and affordable supply. Currently there are around 60 reactors under construction worldwide. On the issue of disposal, some states, such as USA, Finland and Sweden, want to arrange permanent disposal individually within their own territories. Russian and Kazakhstan are considering offering an international disposal site.

Anne Lauvergeon, CEO, AREVA
"Nuclear offers a base energy that renewables can build on."

The proportion of renewable energies in global consumption will continue to increase over the next decades. At present their proportion is around 18 %. The main challenge for the expansion goal is the fluctuating generation of some renewable technologies. An increase in the proportion of renewable energies in global consumption could be achieved by targeted use of high-yield locations.

Hélène Pelosse, interim Director General, IRENA
"Solar will see the most growth in the period to 2050."

In discussions on the future of individual energy sources at international level, the topic of environmental protection is a central issue. The significance of CO_2-free power generation was emphasized. Nonetheless, it did become clear that the subject was afforded varying importance across regions. For industrialized countries, environmental protection is a greater priority – although individual states did stress competitiveness and security of supply as equally important goals. Internationally, carbon capture and storage is an important option on the way to achieving environmental goals.

Yvo de Boer, Global Advisor, KPMG, former (COP-15) UNFCCC Executive Secretary
"Finance is the big question."

The term "smart grid" was used a great deal during the 21st World Energy Congress in Montreal. However it became clear that motivations for a smart grid may differ. Whilst the USA wants to better exploit its existing grids, China sees above all the opportunity to distribute power over a large area. In Europe the idea behind these intelligent power networks is to give consumers details about the operation of their electronic devices. Network infrastructure plays a central role in the integration of renewable energy sources, particularly with regard to the transmission of power from its place of generation to the consumer. In states without an adequate network infrastructure in rural areas renewable energies dominate with standalone solutions.

Looking back at the 21st World Energy Congress, the World Energy Council concludes that sustainable growth must be the overriding goal. Necessary technologies seem within reach, but further investment is required to achieve sustainable growth. One challenge is political control and regulation at national and international levels. The World Energy Council and its member committees will explore these topics further in studies and other events.

The next meeting of the world's largest energy congress will be held from 13-17 October 2013 hosted by the Korean member committee in Daegu. Here the constructive exchange can be continued at international level. Further information can be found under: www.daegu2013.kr.

Opening of 21st World Energy Congress

Christian Paradis, Canadian Minister of Natural Resources

Jean Charest, Premier of Quebec

Jerzy Buzek, President of the European Parliament

Ban Ki-Moon, Secretary-General of the United Nations

Weltenergierat German Evening at the Youville Pumping Station

Weltenergierat with Lindwe Chola Dlamini from Swaziland, whose participation was sponsored by the Future Energy Leaders Programme

Weltenergierat with (from right) Consul General Klaus Geyer; Dr. Leonhard Birnbaum, RWE AG; Pierre Gardonneix, WEC; Ambassador Dr. Georg Witschel

Dr. Georg Witschel, German Ambassador in Canada

Jürgen Stotz, President of Weltenergierat – Deutschland

Discussions and lectures

Meeting Energy Demand: A Global Challenge Requires Global Solutions (from left) Dr. Benjamin Contreras Astiazarán, Undersecretary, Ministry of Energy, Mexico; Wolfgang Dehen, CEO Sector Energy, Siemens; Jean-Jacques Gilband, Secretary-General and Member of the Executive Committee, Total; Jamal Saglur, Director, Africa Sustainable Development Department, World Bank; Dr. Johannes Teyssen, CEO, E.ON; James Sturley, CEO, Ernst&Young

Dr Michael Süß, CEO, Fossil Power Generation, Siemens AG

Wolfgang Dehen, CEO, Sector Energy, Siemens AG

Dr Johannes Teyssen, CEO, E.ON AG

Dr Leonhard Birnbaum, Board Member, RWE AG

Dr. Carsten Rolle, Executive Director, Weltenergierat – Deutschland

Dr. Hans-Wilhelm Schiffer, RWE AG

German delegation for the Future Energy Leaders Programme with Weltenergierat – Deutschland President Jürgen Stotz (5th from the right)

3.1 Highlights 2010 / 2011

Since publication of the last issue of “Energy for Germany”, the World Energy Council and the Weltenergierat – Deutschland can look back on numerous activities, which will be reported below in chronological order. These include eminently attended national and international events and recently published studies.

Events 2010 / 2011

Energy Leaders Summit 2010

June 11, 2010, Beijing, China

(from left to right) Norberto Franco de Medeiros, WEC Chair for Programmes; J.K. Mehta, WEC Regional Manager SE Asia; Pierre Gadonneix, WEC Chairman; Prof. Abubakar Sambo, WEC Vice-Chair Africa; David Kim, WEC Vice-Chair Asia; Yoshiaki Imaizumi, former WEC Director Regional Programmes; Anil Razdan, former Secretary, Ministry of Power of India; Li Longxing, former Secretary of WEC China; Dr Christoph Frei, WEC Secretary General

The Energy Leaders Summit held in June 2010 in Peking/China was the first meeting of the new dialogue platform of the World Energy Council. High-ranking representatives of the Asian and international energy sectors discussed energy security in Asia, the role of renewable energies and energy efficiency. Other important topics also included financial mechanisms to combat energy poverty.

The main discussion results were:

- Energy security is a top topic in China. One promising approach to address this topic is the combination of a strong steering/regulatory policy with high competitive intensity. This latter is particularly interesting against the background of the WEC study Policy Assessment 2010, which came to the conclusion that the market reform or liberalization in China could in many cases not fulfill expectations.
- Many Asian countries focus their energy policy on their technology mix, whereby costs are considered a significant driver. At the same time it is recognizable that the areas of green growth and scientific growth increasingly address new drivers.
- Progress in achievement of the UN Millennium Development Goals can only be reached if the energy poverty of the 1.5 billion people without access to energy is tackled. In this context particular emphasis is placed on sustainable financial mechanisms. Moreover, technology concepts must take account of local conditions (e.g. local owners and operational responsibility).
- The oil catastrophe in the Gulf of Mexico led, among other things, to an intensive debate on future safety requirements. One possible approach discussed for improving safety was the use of peer-review mechanisms.

With regard to the host nation China, discussions made clear that the differentiated and pragmatic political approaches there provide the basis for actual realization of urgently needed measures and projects. These connections are sometimes underestimated by the rest of the world. China In particular is facing major challenges, such as water shortages, dramatic urbanization rates, high economic growth and local environmental pollution. The Energy Leaders Summit provided important insights into this and initiated a dialogue that should be continued.

21st World Energy Congress & Executive Assembly 2010

12–16 September 2010, Montreal, Canada

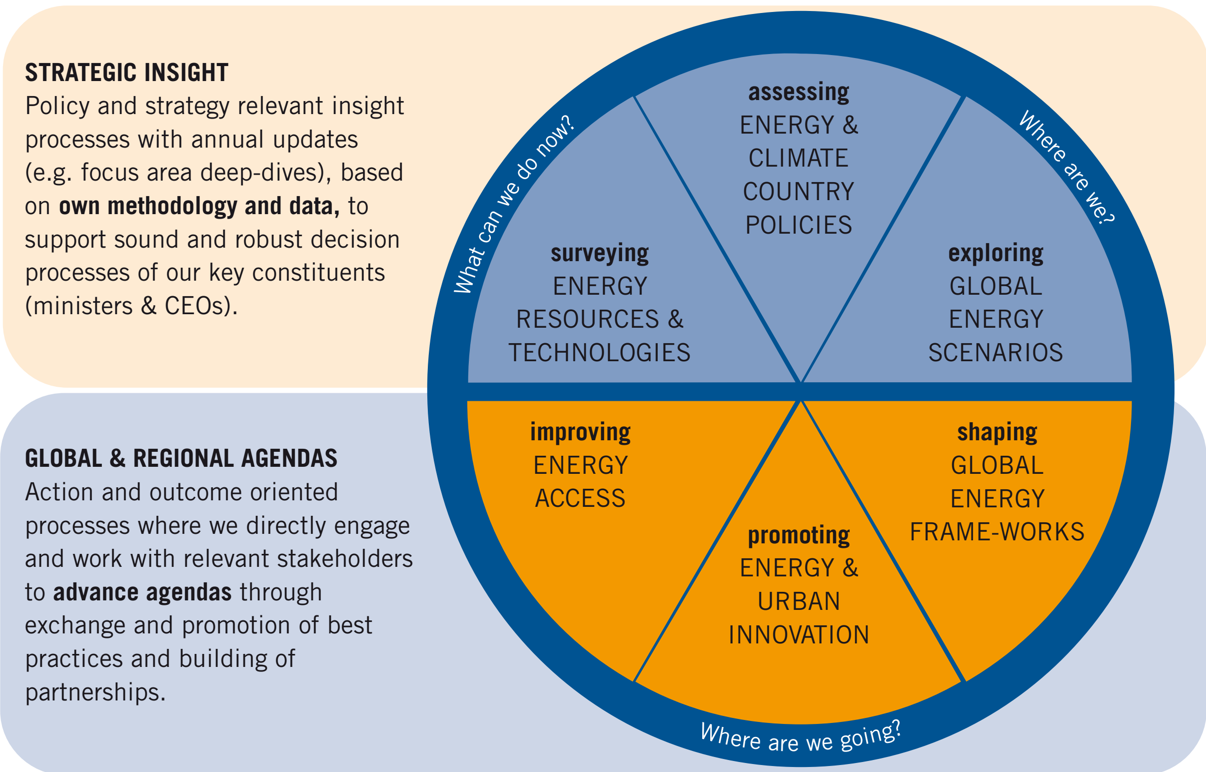
In the course of the World Energy Congress in Montreal (see Special: 21st World Energy Congress), on 12 September 2010 there was a meeting of the Executive Assembly, the highest-ranking deciding body of the World Energy Council.

Besides numerous internal reports from the working committees, the new working program was concluded. This has a long-term focus on six areas of activity, which are summarized in what is known as the Activity Wheel (see Figure 5.1).

The areas of Global Energy Scenarios, Energy & Climate Country Policies and Energy Resources & Technologies are visionary, strategic topics. In these working areas, the focus is on development of an individual methodology and the collection and evaluation of data. The other three areas of activity, Global Energy Frameworks, Energy & Urban Innovation and Energy Access concentrate on result-oriented processes. Collaboration is promoted with other international organizations and representatives and best practice projects are exchanged and supported. The establishment of long-term partnerships is in the forefront of these areas of activity.

For each of the six areas represented in the Activity Wheel new working groups have been formed. These working groups will be supported by what are known as Knowledge Networks which deal with related issues such as energy efficiency, and are of a short to medium term nature.

Abbildung 5.1: World Energy Council Activity Wheel



Energy Day 2010

16 November, 2010, Berlin

This year's annual Energy Day was held on 16 November 2010 in the premises of the Berlin-Brandenburg Academy of Sciences and Humanities. Over 150 participants from the fields of energy, science and politics enjoyed the presentations and discussions on the two main themes "Research and Development – The key to a regenerative age" and "Climate Change as a Global Problem – Where are the global solutions?"

In his keynote speech, Dr. Leonhard Birnbaum, Executive Board of RWE AG and Vice President of Weltenergierat – Deutschland, presented perspectives for the future of the German and European energy supply. A low-CO_2 energy supply was possible, he said, provided there was systematic implementation of three levers: high efficiency, a low-CO_2 power mix and more power input. But what was most decisive for successful and economically sustainable implementation, he said, was above all an appropriate transformation tempo.

Oliver Onidi, Deputy Head of Cabinet for European Commissioner Günther Oettinger, presented the latest European initiatives, most importantly the European energy strategy and also the EU infrastructure package. In the further course of the event experts discussed the enormous challenges facing the energy infrastructure, which represent an especially acute challenge in view of the expansion and necessary integration of renewable energies and the future development of the European internal energy market. In view of the cross-border integration, national solution approaches are now often inadequate. Energy experts were largely agreed that innovation and technical advances, particularly in the field of storage and networks, are an important key for the imminent transformation of the energy system and are gaining increasing importance.

Dr. Leonhard Birnbaum,
Executive Board Member, RWE AG

Prof. Karl Rose,
Senior Fellow Scenarios, WEC

Jürgen Stotz, President, Wentenergierat – Deutschland

(from left to right) Rainer Brüderle, Federal Minister for Economics and Technology; Nobuo Tanaka, Executive Director, International Energy Agency,; Dr Fatih Birol, Chief Economist, International Energy Agency

Introduction of the World Energy Outlook 2010

11 November, 2010, Berlin

On 11 November 2010, the Weltenergierat – Deutschland again presented of the results of the latest World Energy Outlook of the International Energy Agency (IEA) together with the Federation of German Industries (BDI) and the Federal Ministry for Economics and Technology in Berlin.

The World Energy Outlook is among the most cited energy policy publications in the world. The main topics of the 2010 report included in particular the future role of renewable energies, the trends in the Caspian region and their significance for worldwide energy supply. Alongside German Minister for Economics Rainer Brüderle, IEA Executive Director Nobuo Tanaka and BDI Director General, Dr. Werner Schnappauf, also addressed the approx. 200 representatives from the sectors of science, economics, politics and the press.

Dr Werner Schnappauf, Director General, BDI

IEA Chief Economist Dr. Fatih Birol demonstrated on the basis of the latest figures that the global hunger for energy can only be satisfied by a broad energy mix. Globally, fossil fuels still dominate, although the proportion of these is ceding to renewable energy sources and nuclear energy. The most important primary energy source remains crude oil, followed by coal. He stressed that the importance of China cannot be emphasized enough. Effective climate protection is only possible in close collaboration with the growth regions of the world. At the same time according to IEA calculations it is becoming ever more difficult to maintain the goal of keeping the average global temperature increase under 2°C compared to its level pre-industrialization. Delays in the implementation of climate protection measures have significantly increased the costs of achieving this goal.

Following the presentation representatives of companies, NGOs and politics discussed the results of the World Energy Outlook between. The main focus of the discussion was the effects of shale gas extraction on the global energy market and the question of whether this development will advance on a European level and/or in Germany.

(from left to right) Dr. Carsten Rolle, Executive Director, Weltenergierat – Deutschland; Günther Oettinger, European Commissioner for Energy; Jürgen Stotz, President, Weltenergierat – Deutschland

Meeting between Weltenergierat – Deutschland and European Commissioner Günther Oettinger

21 February, 2011, Berlin

For the first time on 21 February 2011, members of the Presidium met European Commissioner for Energy Günther Oettinger for an exchange of views in Berlin. The timing for this meeting could hardly have been better. On 4 February 2011 the energy debate had just been given an important boost by the energy summit of the heads of state and government.

On the basis of the new European Union energy strategy the participants discussed, under the chairmanship of President Jürgen Stotz, with a particular focus on the effective functioning and further development of the internal energy market. Other important topics included the urgently needed expansion of the energy infrastructure and the integration of renewable energies. Commissioner Oettinger stressed the great significance of security of supply for Europe. He also emphasized the need for long-term investment security for energy companies and called for a suitable political framework to stimulate cash flow into the energy branch.

All discussion participants drew a positive conclusion. Commissioner Oettinger stressed that he would like to utilize the expertise and network of the WEC and called for a continuation of the dialogue between him and the Weltenergierat – Deutschland. Another meeting is planned for next year.

Working lunch of the Weltenergierat – Deutschland with European Commissioner Günther Oettinger

Joint Seminar European Commission / World Energy Council

22 March, 2011, Brussels, Belgium

In Brussels on 22 March 2011 representatives of the European Commission and the European Region of the World Energy Council (WEC) met for the sixth time for a joint seminar. Over 50 participants from 26 national committees discussed, under the chairmanship of Dr. Johannes Teyssen (WEC Vice Chair Europe) with a delegation from the European Commission led by European Energy Commissioner Günther Oettinger. Under the title "European Energy Infrastructure: sharing responsibility between policy and business", the topic of infrastructural expansion was central.

Commissioner Oettinger stressed that under the EU 20-20-20 policy, the existing infrastructure is not sufficient to achieve the ambitious expansion goals set, above all in the field of renewable energies. By 2020 and beyond further development of the power supply system is required, particularly as regards the grid, the regulatory framework and technology. The Commission places particular emphasis on removing the barriers to investment. Thus presentation of the legislative implementation proposals, which the Commissioner has promised for autumn 2011, is eagerly awaited. In the long-term outlook up to 2050 the European Commission sees integration of renewable energies into the power supply system as one of the greatest challenges. In further discussion a broad range of important energy policy issues were mentioned. Such as the issues of financing the grid expansion/grid rates, promotion systems for renewable energies, smart grids, national energy mix, and even including issues relating to acceptance for the necessary infrastructure expansion.

The representatives of the European Commission and the WEC delegates pronounced the exchange of ideas very positive. The Commission signalized great interest in using the broad and considerable expertise of the WEC for development of the European energy program and also for the long-term outlooks currently in production (road maps 2050). Other fields of cooperation could become established, particularly multinational projects such as North Sea Offshore Grid or DESERTEC.

Publications 2010 / 2011

EEFA Study "The safety of our energy supply – indicators to measure vulnerability and risks"

April 2010

Private households and companies in Germany are facing significantly increasing risks in terms of energy supply. This is the conclusion of the study "The safety of our energy supply" carried out by the EEFA Institute (Energy Environment Forecast Analysis) on behalf of the Weltenergierat – Deutschland. The new methodological approach developed in the report proves that security of supply is measurable. According to the calculations, the supply risk on the primary energy level more than doubled in the period between 1995 and 2008. In an international comparison Germany thus occupies a place at the back. For the first time not only dependence on energy imports was examined, but also the energy infrastructure's vulnerability to defects and the risks for final consumers. The study explores with a broad methodological measuring concept the effects of various alternative energy policy approaches on security of supply. If the energy policy of recent years is continued there is a risk of further increases in the supply risk to almost 50% by 2030. This development can however be fundamentally avoided by various measures:

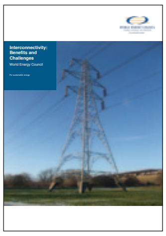
- The lifetime extension of nuclear reactors to 60 years offers by far the most powerful level to increase security of supply. Compared to the reference scenario, increased vulnerability can be more than halved.
- Investments in the constant maintenance and expansion of the energy infrastructure are of paramount importance to avoid a further increase in supply risk.
- Intelligent use of domestic coal and the forced expansion of renewable energy sources also make an important contribution to the reduction of the energy supply risk.

A sustainable energy policy must address more intensely the growing challenges of a secure energy supply and harmonize the energy policy goals which have dominated up to now – competitiveness and climate protection. The study offers very strong evidence of this. A balanced mix of energy sources, which sensibly combines the specific advantages of all available energy sources and technical options is an important key to becoming less susceptible to energy crises.

The results of the study were first presented in the context of a workshop in June 2010 in Berlin. Further presentations of the results followed

- at a press conference in Berlin in August to present the publication "Energy for Germany 2010",
- at the European Session within the course of the 21st World Energy Congress in September 2010 in Montreal, Canada and
- at the Croatian Energy Day in November 2010 in Zagreb.

Further publication of the study results is intended. The study is available for download under: www.weltenergierat.de.

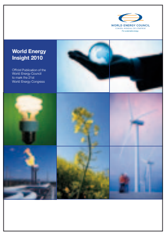


Interconnectivity: Benefits and Challenges
September 2010

This study examines the role of integration in the development of energy systems. The analysis takes account of socioeconomic, financial, regulatory and environmental aspects which are significant for successful project realization.

Survey of Energy Resources
November 2010

The 22nd edition of the Survey of Energy Resources documents the state and the development of the world's most important energy sources. As the latest publication in a long series, the report covers the situation of fossil fuels, traditional and new sources of energy.



World Energy Insight
September 2010

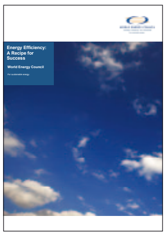
The first edition of World Energy Insight was produced in cooperation with First Magazine and published to coincide with the 21st World Energy Congress in Montreal. This annual publication produced by various corporate representatives, gives a comprehensive overview of current topics from the global energy sector.

Roadmap towards a Competitive European Energy Market
October 2010

The study explains the objectives and challenges of a common European market for energy, identifying liberalization and fair competition in the Europe-wide energy sector as important preconditions for the realization of this market.

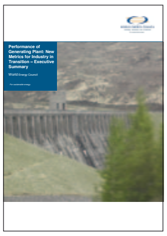
Logistics Bottlenecks
September 2010

The vulnerability of energy systems is the focus of this study. It covers the threat to energy access, energy security and sustainability. This publication explores the vulnerability in the areas of generation, consumption, exports and imports for all energy sources in seven key regions of the world for the years 2008, 2020 and 2050.



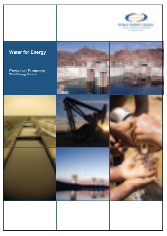
Energy Efficiency: A Recipe for Success
September 2010

Produced together with the ADEME and Enerdata, the report examines the energy efficiency, policies and trends of around 90 countries around the world. It also analyses the importance of energy efficiency measures and presents the results of their implementation.



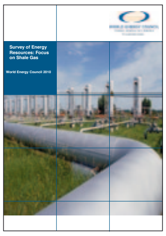
Performance of Generating Plant
September 2010

The report by the working group Performance of Generating Plant shows the challenges in identifying the key performance indicators of power stations and in the opportunities for improvement.



Water for Energy
September 2010

This study describes important connections between water and energy and their significance for climate change. Sectors are identified for which investment and new regulations are needed to secure sustainable global development.

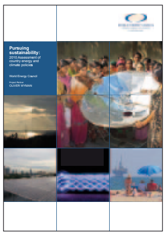


Shale Gas
September 2010

Derived from the 22nd Survey of Energy Resources, this report presents a fact-based and forward-looking contribution to the debate on shale gas as a strategic energy source.

Energy and Urban Innovation
September 2010

This report examines the energy-related challenges facing the cities of the future, particularly metropolises or "mega-cities". It analyses technical and political measures with regard to energy security and sustainability. The energy sector in particular can contribute to implementation of efficient solutions.



Pursuing sustainability: 2010 Assessment of country energy and climate policies
September 2010

The second edition of the annual publication Energy and Climate Policy Assessment presents a contribution by the World Energy Council on the design of energy policy objectives. Sustainability is central in political steering and covers three dimensions: energy safety, social justice and environmental protection.

Biofuels: Policies, Standards and Technologies
September 2010

The report by the biofuels working group tackles the debate between advocates and opponents of biofuels and examines these energy resources against the background of a rapid global increase in energy demand.

The studies are available for download under www.worldenergy.org

3.2 Outlook 2011 / 2012

Planned events

World Energy Leaders Summit
14–16 September 2011, Rio de Janeiro, Brazil

Energy Day 2011
11 October 2011, Berlin

Energy Day offers an annual forum to discuss topical issues of the energy economy from various perspectives with eminent experts. This public event is aimed not only at decision-makers within the energy industry, science and politics but also at multipliers and interested members of the public. The subject of the event will be announced on the website: www.weltenergierat.de.

World Energy Outlook 2011
planned for November 2011, Berlin

As in previous years, the results of the new World Energy Outlook will be presented in cooperation with the Federal Ministry of Finance and Technology and the International Energy Agency. This time the central issues include the instable energy prices and their economic consequences, new uncertainties with regard to nuclear energy and the discrepancy between goals and measures in climate protection.

WEC Executive Assembly, November 2011,
20–24 November 2011, Oran/Algeria

Shale Gas – Effects on the energy markets
planned for February 2012, Berlin

The extraction of unconventional gas in the USA not only led to changes on the American gas market – the consequences could be felt in gas trading around the world. Market connections, the effects on investment and security of supply as well as the potential of shale gas extraction in Europe is to be discussed with representatives from the sector.

Planned publications

On the basis of the strategic reorientation of the World Energy Council last year (see "Executive Assembly 2010"), numerous international working groups were set up. At the beginning of 2011 the study groups started their work on future publications. Some studies have already been announced for the second half of 2011:

Mobility Report
This study on the subject of energy and mobility will identify and evaluate existing and potential fuels and technologies within the traffic sector both qualitatively and quantitatively. In addition, the scenarios developed within the working group describe the potential development of fuels, technologies, traffic systems and environmental policy.

Energy and Climate Policy Assessment
This study is now looking for the third time at issues of global energy and environmental policy. The report will deal particularly with topics such as energy efficiency, energy and mobility, as well as examining financing mechanisms, describing international best practice examples and exploring the transferability of strategies and measures.

3.3 Organization of the Weltenergierat – Deutschland

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Jürgen Stotz (President)

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Klaus-Dieter Barbknecht, VNG – Verbundnetz Gas AG (Treasurer)

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Ulrich Gräber, AREVA NP GmbH

Tuomo J. Hatakka, Vattenfall Europe AG

Michael Heiland, DTK

Dr. Rainer Seele, Wintershall Holding GmbH

Dr. Michael Süß, Siemens AG

Dr. Johannes Teyssen, E.ON AG (WEC Vice Chair Europe)

Hans-Peter Villis, EnBW AG

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Dr. Hans-Peter Böhm, Siemens AG

Dr. Ruprecht Brandis, BP Europa SE

Andreas Breitsprecher, Vattenfall Europe AG

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Martin Czakainski, ETV GmbH

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Daniel Genz, Vattenfall Europe AG

Enno Harks, BP Europa SE

Dr. Joachim Hein, BDI e.V.

Dr. Jörg Jasper, EnBW AG

Karl Krüger, VNG – Verbundnetz Gas AG

Dr. René Lüddecke, EWE AG

Christian Meyer zu Schwabedissen, AREVA NP GmbH

Werner Nowak, E.ON Ruhrgas AG

Dr. Jens Perner, Frontier Economics Ltd.

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BDEW Bundesverband der Energie- and Wasserwirtschaft e.V.
BGR – Bundesanstalt für Geowissenschaften and Rohstoffe
BP Europa SE
DEBRIV – Deutscher Braunkohlen-Industrie-Verein e.V.
Deutsches ITER Industrie Forum e.V. (DIIF)
Deutscher Verband Flüssiggas e.V. (DVFG)
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VDE – Verband der Elektrotechnik, Elektronik and Informationstechnik e.V.
VDI – Verein Deutscher Ingenieure e.V.
Vestas Wind Systems AG
VGB PowerTech e.V.
VIK Verband der Industriellen Energie- and Kraftwirtschaft e.V.
VNG – Verbundnetz Gas AG
Voith Hydro Holding GmbH & Co. KG
WIBERA Wirtschaftsberatung AG
Wintershall Holding AG
50Hertz-Transmission GmbH

List of Abbreviations

Abbreviation	Explanation
ACER	Agency for the Cooperation of Energy Regulators (Europäische Energieregulierungsbehörde)
BDEW	Bundesverband der Energie- und Wasserwirtschaft e. V. (Federal Association of Energy and Water Management)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources)
BIP	Bruttoinlandsprodukt (Gross Domestic Product)
BkartA	Bundeskartelamt (Federal Cartel Office)
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry for Education and Research)
BMWi	Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development)
BnetzA	Bundesnetzagentur (Federal Network Agency)
CCS	Carbon Capture and Storage (Abscheidung und Speicherung von CO_2)
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CERA	Cambridge Energy Research Associates
CGY	Certificado de Garantía Yasuní (Garantiezertifikate für das Yasuní-Projekt)
CH_4	Methane
CO_2	Carbon Dioxide
CO_2	Carbon Dioxide
COP	Conference of the Parties der UN Climate Convention
CSP	Concentrated Solar Power (Solarthermische Anlage)
CPRS	Carbon Pollution Reduction Scheme
CPS	Current-Policy-Scenario
ct	Eurocent
DEBRIV	Deutscher Braunkohlen-Industrie-Verein (German Lignite Industry Association)
dena	Deutsche Energie-Agentur (German Energy Agency)
DERA	Deutsche Rohstoffagentur (German Commodity Agency)
DII	DESERTEC Industrial Initiative
EDM	Energiedatenmanagement (Energy Data Management)
EDV	Elektronische Datenverarbeitung (Electronic Data Processing)

Abbreviation	Explanation
EEFA	Energy Environment Forecast Analysis – Institute
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Law)
EEPR	European Energy Programme for Recovery
EEV	Endenergieverbrauch (end energy consumption)
EEX	European Energy Exchange
EGV	EG-Vertrag (Vertrag zur Gründung der Europäischen Gemeinschaft) (EC Treaty (Treaty establishing the European Community))
EIA	Energy Information Administration (Amt für Energiestatistik innerhalb des US-amerikanischen Energieministeriums DOE)
ELIX	European Electricity Index
ENTSO-E	European Network of Transmission System Operators for Electricity (Vereinigung der europäischen Strom-Übertragungsnetzbetreiber)
ENTSO-G	European Network of Transmission System Operators for Gas (Vereinigung der europäischen Gas-Fernleitungsnetzbetreiber)
EOR	Enhanced Oil Recovery (verbesserte Erdölgewinnung)
EP	Europäisches Parlament (European Parliament)
EPEX	European Power Exchange Spot SE
ERGEG	European Regulator's Group for Electricity and Gas (Vereinigung europäischer Regulatoren)
ETS	European Emission Trading System
EUA	European Union Allowances (EU-Emissionsrechte) (EU- emmission rights)
EU-15	Member States of the European Union (before the first expansion in 2004)
EU-27	Member States of the European Union (status 2007)
F&E	Forschung und Entwicklung (Reseach & Development)
FKW	Perflourierter Kohlenwasserstoff (prefluorinated hydrocarbon)
GDP	Gross Domestic Product (Bruttoinlandsprodukt)
GHD	Greenhouse Gas (Treibhausgas)
GuD	Gas- und Dampfturbinen-Kraftwerk (combined gas and steam power plant)
GVSt	Gesamtverband Steinkohle e.V. (General Association of Coal Association)
GW	Gigawatt

Abbreviation	Explanation
IGCC	Integrated Gasification Combined Cycle
GUS	Gemeinschaft Unabhängiger Staaten (Commonwealth of Independent States)
GW	Gigawatt
H-FKW	Teilhalogenierter -Flourkohlen-wasser-stoff (partially halogenated fluorinated hydro-carbon)
HGÜ	Hochspannungs-Gleichstrom-Übertragung (HVDC – High-Voltage DC Transmission System)
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle (Anlagen mit integrierter Kohlevergasung)
IPCC	Intergovernmental Panel on Climate Change
ISO	Independent System Operator (unabhängiger Verteilnetzbetreiber)
ITO	Independent Transmission Operator (unabhängiger Übertragungsnetzbetreiber)
ITRE	Committee on Industry, Research and Energy des Europäischen Parlamentes (Ausschuss für Industrie, Forschung und Energie)
JI	Joint Implementation
KMU	Kleinere und mittlere Unternehmen (SME Small and Medium Sized Enterprises)
kWh	Kilowattstunde (kilowatt hour)
KWK	Kraft-Wärme-Kopplung (Cogeneration of Heat and Power)
KWK-G	Kraft-Wärme-Kopplungsgesetz (Cogeneration Combined Heat and Power Act)
LBEG	Landesamt für Bergbau, Energie und Geologie (State Office for Mining, Energy and Geology)
LNG	Liquefied Natural Gas (verflüssigtes Erdgas)
LULUCF	Land Use, Land-Use Change and Foresty
m2/a	Square Meters / Effective Surface
Mio	Millionen
Mrd	Billion
MW	Megawatt
NAP	Nationaler Allokationsplan beim EU-Emissionsrechtehandel (National Allocation Plan for EU Emissions Trading Scheme)
N2O	Dinitrogen Monoxide
NGO	Non-Governmental Organisation
NPS	New-Policy-Scenario
NRA	National Regulatory Authority (Nationale Regulierungsbehörden der EU Mitgliedstaaten)
OE	Öläquivalent (Oil Equivalent)
OECD	Organisation for Economic Co-operation and Development

Abbreviation	Explanation
OME	Other Major Economies (Large non-OECD economies, e. g.: Brazil, China, Middle East, Russia, South Africa)
OPEC	Organization of Petroleum Exporting Countries (Organisation erdölexportierender Länder)
OTC	Over the counter (bilateral transactions can take place over the counter, it can be handled through the stock market)
PEV	Primärenergieverbrauch (Primary Energy Consumption)
PV	Photovoltaic
ppm	Parts per million
PPP	Purchasing Power Parity (Kaufkraftparität)
REDD	Reducing Emissions from Deforestation and Degration (Reduktion von Emissionen aus Entwaldung und Schädigung von Wäldern)
RÖE	Rohöleinheiten (crude oil units)
RPS	Renewable Portfolio Standards (Quotensystem für Eneuerbare Energien im Erzeugungsmix in den USA)
SEER	Strategic European Energy Review (Energieaktionsplan)
SET-Plan	Strategieplan für Energietechnologie (Strategic Plan for Energy Technology)
SF6	Sulphur Hexafluoride
SKE	CE (coal equivalent)
TEC	Transatlantic Economic Council (Transatlantischer Wirtschaftsrat)
THG	Treibhausgas (Greenhouse gas)
TWh	Terawatt hour
UCTE	Union for the Coordination and Transmission of Electricity
UN	United Nations (Vereinte Nationen)
UNEP	United Nations Environmental Program (Umweltprogramm der Vereinten Nationen)
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USD	US-Dollar
VAE	Vereinigte Arabische Emirate (UAE United Arab Emirates)
VO	Verordnung der Europäischen Union (Regulation Regulation of the European Union)
VDEW	Verband der Elektrizitätswirtschaft e.V. (Association Electricity Association)
WEC	World Energy Council
WEO	World Energy Outlook
WTO	World Trade Organization

Energy Units

Output unit \ Target Unit	Million TCE	Million toe	Billion kcal	TWh*
1 million TCE	–	0.7	7,000	8.14
1 million toe	1.429	–	10,000	11.63
1 billion kilocalories (kcal)	0.000143	0.0001	–	0.001163
1 terawatt hours (TWh)	0.123	0.0861	859.8	–

* The conversion in TWh is not equivalent to a conversion in electricity, with which the efficiency of the conversion would be considered.

(1 Barrel = 159 Liter)

Kilo	= k	= 10^3	= Thousand
Mega	= M	= 10^6	= Million
Giga	= G	= 10^9	= Billion
Tera	= T	= 10^{12}	= Trillion
Peta	= P	= 10^{15}	= Thousand Trillion

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