Energy for Germany 2013

Facts, outlook and opinions in a global context

In focus:

Unconventional natural gas deposits in the USA and their impact on Europe

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Foreword

2013 is a year of major events within and outside of the World Energy Council, above all the 22nd World Energy Congress being held in October in Daegu, South Korea under the motto "Securing Tomorrow's Energy Today". For the World Energy Council, "sustainability" is not the new century's buzzword. Since its foundation in 1923, we have campaigned for the sustainable production and supply of energy to the benefit of all.

The world still finds itself in a state of gross imbalance between the highly developed countries, the emerging newly industrialised countries, which need to secure and cheaply satisfy their demand for energy, and the developing countries, in which a total of 1.2 billion people still have no access to electricity.

The energy and climate policy goals for 2030 are already being defined in Europe. They establish security in planning for companies, and guidelines for national energy policy. Shared rules and goals are central in a European internal market for electricity and gas in establishing competition and synergies. As presented in our October 2012 study on hydropower storage in Europe, more of Europe in the electricity network would lead to improved integration of renewable energies, and also increase the security of supply. At the same time it is clear: any political decisions made on one side of a cross-border cable will have a direct impact on countries, systems and investors on the other side. This makes close political coordination at the European level important. Only so can sustainable, secure and, above all, also affordable energy supply be ensured.

Besides the inconclusive discussion of an "electricity price brake" (Strompreisbremse) brought about by the upcoming elections, not much more has happened in Germany. This is despite the fact that it is more necessary than ever to also focus on costs. The Federation of German Industries has calculated that over €350 billion will be invested in the energy system by 2030. In 2013, consumers have to pay €20 billion for the reallocation charge of the German Renewable Energy Act (EEG). The electricity price for end customers is constantly rising, despite falling wholesale prices. Efficient gas-fired power plants sit idle in part, as they are less and less profitable. The design of the market has found its limits and needs to be promptly reformed. There is also continuing scepticism from abroad that Germany can meet its targets and at the same time maintain its economic power, as demonstrated by our international survey conducted in March 2013 (see survey on page 110).

The "shale gas revolution" in the USA brings Germany's and Europe's competitiveness into further question, where both energy self-sufficiency and reindustrialisation are in sight. US gas prices are many times lower than in Germany, and this gives rise to enormous advantages compared with the rest of the world, both in terms of climate policy and of being an internationally competitive location for industry. Both Europe and Germany have the technical and economic option of preparing the groundwork for the production of unconventional natural gas. The potential in Germany alone is significant: According to the BGR, up to 2.3 trillion m^3 of technically recoverable natural gas exists, representing ten times the amount of conventional reserves and resources (see chapter 4.4).

The countries of Europe should evaluate the opportunities and risks of producing unconventional gas themselves, using advanced, environmentally friendly methods and not rule it out in advance. Only so can Europe remain a location for the development of new technologies while also guaranteeing a competitive environment for industry. Workable solutions, in terms of sustainability, have to be found by government and business together that also receive broad acceptance.

Jürgen Stotz

Chair
Weltenergierat – Deutschland e.V.

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In focus:
Unconventional natural gas deposits in the USA and their impact on Europe*

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* The following article is a translation of the German original “Nicht-konventionelle Erdgasvorkommen in den USA und ihre Auswirkungen auf Europa”. The Weltenergierat – Deutschland wishes to expressly thank the authors of this chapter, Prof. Felix Müsgens, BTU Cottbus and Prof. Andreas Seeliger, DHBW Mosbach, for the following analysis and assessment.

Executive Summary

Shale gas is now of great importance to the energy industry in the USA. By the end of 2011, shale gas had come to represent 30 percent of all of US production, with the upward trend continuing. This has led to decreasing American gas imports and a fall in gas prices. The lower gas prices have in turn led to natural gas being increasingly used in the production of electricity. Thus, the lower gas prices have influenced electricity prices, which are also falling. The drop in prices of these two important final energy sources has resulted in a clear decline in energy costs for the manufacturing industry. Production conditions in the USA have particularly improved for energy-intensive sectors such as paper manufacturing and basic chemicals production, where energy costs can represent over 10 percent of total production costs.

A comparison between Germany and the USA shows that electricity and gas prices for the manufacturing industry in Germany are currently at significantly higher levels than in America. In this regard Germany (together with many other countries in Europe) currently has worse conditions with respect to location than the USA. Investment decisions are however not just based on existing conditions, but also expectations regarding future developments. The central questions are thus: will the current price differences also exist in the future, and, will shifts in the location of future investments take place as a result of these?

At present, this is difficult to predict, as numerous competing factors have to be taken into consideration. With respect to the gas industry in both countries, it does however seem plausible that the price differences may be permanent. In addition to gas production factors and different pricing mechanisms, the long distance transport of gas plays a significant role here.

Concerning production, it can be assumed that the extraction of shale gas in Germany and Europe will develop less dynamically than in the USA due to the smaller and probably more cost-intensive deposits, but above all due to the sceptical political attitude present in important countries (especially Germany).

The high price differences between Germany and USA can also currently be attributed to different pricing mechanisms. In the USA the gas prices are determined exclusively by supply and demand in the market, whereas in Germany and large parts of Europe there are still long-term supply contracts linked to oil prices. In future however, the significance of the link to oil prices will also decrease in importance in Europe. This will lead to a structural decline in prices in Europe (in Germany the prices in contracts without a link to oil prices are currently lower than for those with such a link). Be that as it may, this effect will not be sufficient to drive prices down to the current price level in the US, even in the case of increasing intercontinental trade flows.

Permanent price differences are also cemented by the high transport costs between USA and Europe. Despite increased capacities in international gas transport per tanker (LNG) and cost reductions that have already been realised, and even given the present low US prices (which currently stand at around a third of German price levels), transport costs remain so high that although US shale gas can be supplied at competitive prices this will not result in significant price reductions in Germany.

Analysis of conditions in the energy industry leads us to conclude that the existing situation will result in a lasting competitive disadvantage for European industry. Given this environment, to safeguard value creation and workplaces in Germany and Europe, the disadvantages have to be minimised as far as possible – or compensated for by advantages in other areas. For example, the sceptical attitude towards domestic shale gas production could be re-evaluated.

1.1 Introduction

The extraction of unconventional energy resources, in particular shale gas, is currently being heatedly debated worldwide. The decline of conventional gas and oil deposits has been more than compensated for by technical advances in the extraction of unconventional deposits. The extraction of unconventional natural gas deposits has consequently resulted in an increase in the aggregate production of natural gas in the USA.

The discussion is also very topical in Germany as well, where two connected issues are the focus: firstly, if, and under which conditions, should shale gas production be permitted in Germany as well. Although the Federal Minister for the Environment and the Federal Minister for the Economy reached agreement on joint proposals at the end of February 2013 (BMU/BWMi 2013), these do not allow any firm predictions regarding future dealings involving shale gas production in Germany. The risks rather than the opportunities regarding unconventional energy sources tend to be the focus of debate in Germany, while in the USA discussion seems to focus more on the opportunities. This second issue of the active promotion of the technology in the USA is also being discussed in Germany. Among other factors, as the USA has committed to the extraction of shale gas for many years and now produces large volumes of it, gas prices in the USA are currently very low in comparison to Germany and other industrialised nations. Given this situation, much discussion has focussed on what impact this has on industry in the USA ("reindustrialisation") and consequently on the competitiveness of Germany as a place of business.

It is notable that both issues are of interest not just to experts from the energy industry and geology, but are also being intensively discussed in the (mass) media,[1] if not always objectively. The goal of the following analysis is to bring some objectivity to the debate. The introduction in chapter 1.2 initially presents the subject of the global availability of natural gas. In the course of this, brief questions will be addressed: How much natural gas is there? Where is it? How long will it last? Chapter 1.3 describes development in the USA. This is intentionally limited to past development, to avoid uncertain forecasts. Chapter 1.4 discusses the development of the American natural gas industry in a global context. Chapter 1.5 analyses the advantages accruing to the USA by means of its production of shale gas in comparison to other countries, in particular Germany. In doing so, the competitiveness of business locations will be addressed, especially with regard to the establishment of energy-intensive industries. Chapter 1.6 analyses the uncertainty regarding the future development of the natural gas market in the USA and in Europe in particular, and presents a plausible scenario in which the price for natural gas in the USA remains lower than European levels also in the long-term. Chapter 1.7 concludes the analysis.

1 The search for the term "Schiefergas" (shale gas) alone on 11 March 2013 returned 39 relevant articles in the Frankfurter Allgemeine Zeitung, 75 relevant articles in the Handelsblatt and 62 relevant articles in Die Welt.

1.2 Global availability of natural gas

Overview of global natural gas deposits

Global natural gas reserves currently total around 196 trillion m³.[2] This quantity already comprises some unconventional deposits. In addition to tight gas quantities, which have not been separately disclosed for quite some time, around 3 trillion m³ of shale gas and around 2 trillion m³ of coalbed methane are included.[3] Given the current worldwide annual rate of production of 3.3 trillion m³, these reserves have a static lifetime of just under 60 years.[4] These reserves could be prospectively increased by accessing conventional resources, which currently total a further 307 trillion m³, extending the static lifetime of reserves to over 150 years. Furthermore, the BGR estimates unconventional resources totalling 478 trillion m³. The majority of this consists of unconventional close-to-market deposits (157 trillion m³ shale gas, 50 trillion m³ coalbed methane, 63 trillion m³ tight gas) and the remainder of aquifer gas and methane hydrate, which are currently not technologically and commercially viable. Taking into account previous production of natural gas totalling around 99 trillion m³, a total potential of 1,080 trillion m³ can be arrived at, illustrated in figure 1.1.

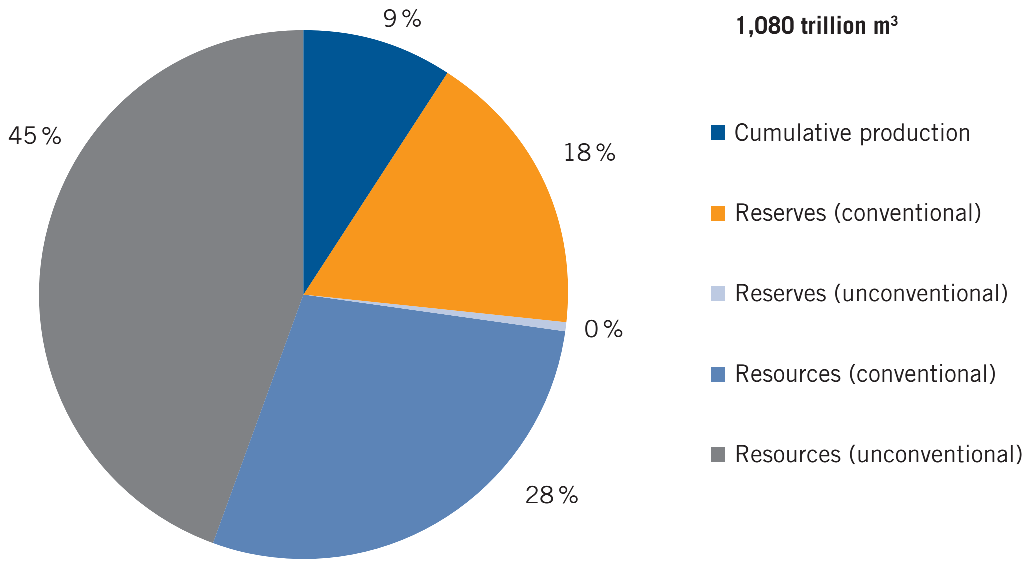
In this context, a comparison with oil is of interest. Unconventional oil deposits have been established in the market for quite some time, represented above all by Canadian oil sands and Venezuelan extra-heavy oil. Conventional reserves of natural gas and oil are around the same level with respect to their energy content. If shale gas and coalbed methane reserves are included in natural gas reserves, they increase total reserves by only 3 %. This contrasts with an almost 30 % increase in oil reserves achieved when unconventional reserves are taken into account. As, however, unconventional resources comprise a greater proportion of total resources with natural gas than with oil, promoting unconventional gas

2 These and the following figures have been obtained from the BGR (2012a). Other sources may provide differing figures due to different measurement methods applied. These differences are however much smaller than those involving oil. BP (2012), for example, estimates reserves at 208 trillion m³, while OPEC (2012) puts the figure at 196 trillion m³.

3 Tight gas and shale gas are natural gases stored in rock with low permeability. Tight gas is extracted from sandstones, while shale gas is trapped in mudstones. The latter in particular requires significant additional effort to extract the natural gas. Coalbed methane can be extracted from coal beds, with distinctions being made between undisturbed coal beds, disused coal mines and coal mines still in operation. See BGR (2009) and IEA (2012a) for more detailed descriptions.

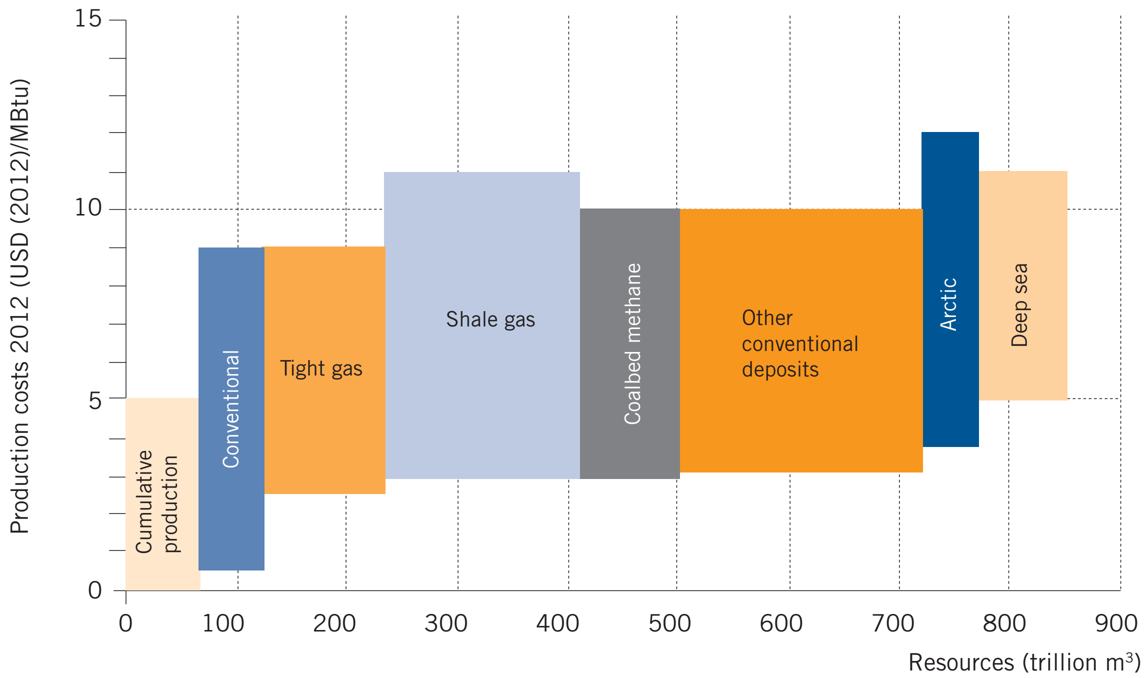
4 The static lifetime (also known as the reserves-to-production ratio, or RPR) is a popular, yet also commonly misunderstood indicator of natural resource availability. Both factors, i.e. reserves and production, are variable over time, so the calculated lifetime in years can be considered only a very rough indicator.

Figure 1.1: Overview of global natural gas potential



Source: Weltenergierat – Deutschland, based on data from the BGR (2012a)

Figure 1.2: Production costs of different natural gas deposits*



* MBtu (Million British Thermal Units) is a traditional unit of energy measurement for natural gas. At current exchange rates (1 EUR = 1.30 USD) one USD/MBtu corresponds to approximately €2.60/MWh. MBtu is also commonly written as MMBTU, and both correspond to one million, as in the latter description the M is the Latin number for one thousand, and MM signifies in this context "1000 times 1000". Strictly speaking, it is not possible to convert these figures to m^3 without knowledge of individual heating values (unit volume vs. energy content). 1 m^3 however corresponds to approximately 10 kWh or 0.03 MBtu.

Source: Weltenergierat – Deutschland, calculated based on data from the IEA (2010), IEA ETSAP (2010), IEA (2012a) and Deutsche Bank (2013).

production technology can significantly increase recoverable reserves.[5]

Physical vs. commercial availability

The figures presented thus far demonstrate that no physical shortage of natural gas is to be expected in the foreseeable future. This is also true if (as expected) there are technical, economic and environmental reasons to exclude the use of methane hydrates (and potentially aquifer gas) for the foreseeable future.

From an economic perspective, physical availability alone is only one of many central parameters. An even more important factor for extraction is the commercial availability, i.e. the reserve development and production costs in relation to the current and predicted prices of gas and possible substitutes.[6] As figure 1.2 makes apparent, the extraction costs of unconventional natural gas deposits lie for the most part above those of conventional sources, but there is an extensive overlap.

This indicates that, with respect to their extraction costs, many shale gas, tight gas and coalbed methane deposits can compete strongly with most conventional deposits.

Regional distribution of deposits and output

Unconventional resources are widely distributed around the world. The largest deposits are presumed to be in North America (the USA, Canada and Mexico), as well as South America (for example, Argentina), East Asia (above

5 The resource data however includes aquifer gas, methane hydrate and oil shale. If these resources, which are accompanied by a high degree of uncertainty, are excluded, natural gas resources are still in the lead, but not by such a great extent. A detailed treatment of this can be found in BGR (2012a).

6 For more detail see also Adelmann (1990).

all China) and Australia. These assessments however contain a high degree of uncertainty, and vary depending on their source and year of publication. Although this is in principle true for data from the USA, the data from the USA are of the highest quality, as commercial production of unconventional resources is at its most advanced there. Accordingly, US deposits predominate global unconventional natural gas reserves (3.3 trillion of 4.6 trillion m^3).[7]

With information regarding production volumes, it has to be taken into consideration that consistent data can no longer be found for tight gas deposits (sandstone and carbonate) as these have long been included in conventional production volumes. Smaller quantities are also produced in Germany (among other countries); however the largest quantities produced globally come from the USA (around 170 billion m^3 per year). Only the USA produces shale gas in quantities worth mentioning (around 190 billion m^3 per year), and the majority of the 65 billion m^3 of coalbed methane produced per year also comes mainly from the USA (around 45 billion m^3 per year) as well as Canada (around 7 billion m^3 per year).[8]

Irrespective of the wide distribution of resources around the world, a discussion of the contribution of unconventional deposits (and shale gas in particular) with regard to reserves and production figures, has to pay particular attention to the USA. Chapter 1.3 thus not only analyses the current state of affairs in greater detail, but also discusses the enormous dynamism of this market segment in the USA.

7 In other countries the classification as a reserve is precluded as, by definition, it is a prerequisite that the deposit is known (or is considered present with a high degree of probability).

8 See BGR (2012a) and www.eia.gov. More detailed, but less up-to-date information can be found in BGR (2009) as well as Geny (2010).

1.3 Development in the USA to date

The "Shale Gas Revolution" in the USA

Unconventional deposits have long been a component of natural gas supply in the USA, although their previous contribution only increased gradually. The decline in conventional deposits has been counterbalanced above all by the production of tight gas (from before 1990) and, to a lesser extent, coalbed methane (from 1990 onwards). Through continuous expansion, tight gas producers have acquired a share of around 25 % of all US production. The slow (but steady) increase in production, and that tight gas is no longer separately reported in official statistics has led to this success being nearly unnoticed by much of the (gas) world.[9] It was rather the "shale gas revolution" that has brought unconventional natural gases to the forefront of public discussion in recent years. In comparison to tight gas, shale gas production has increased sharply over the last few years. The increase has been so pronounced that it has not only been able to compensate for declining conventional quantities, but has actually managed to significantly increase total production for the first time in decades.

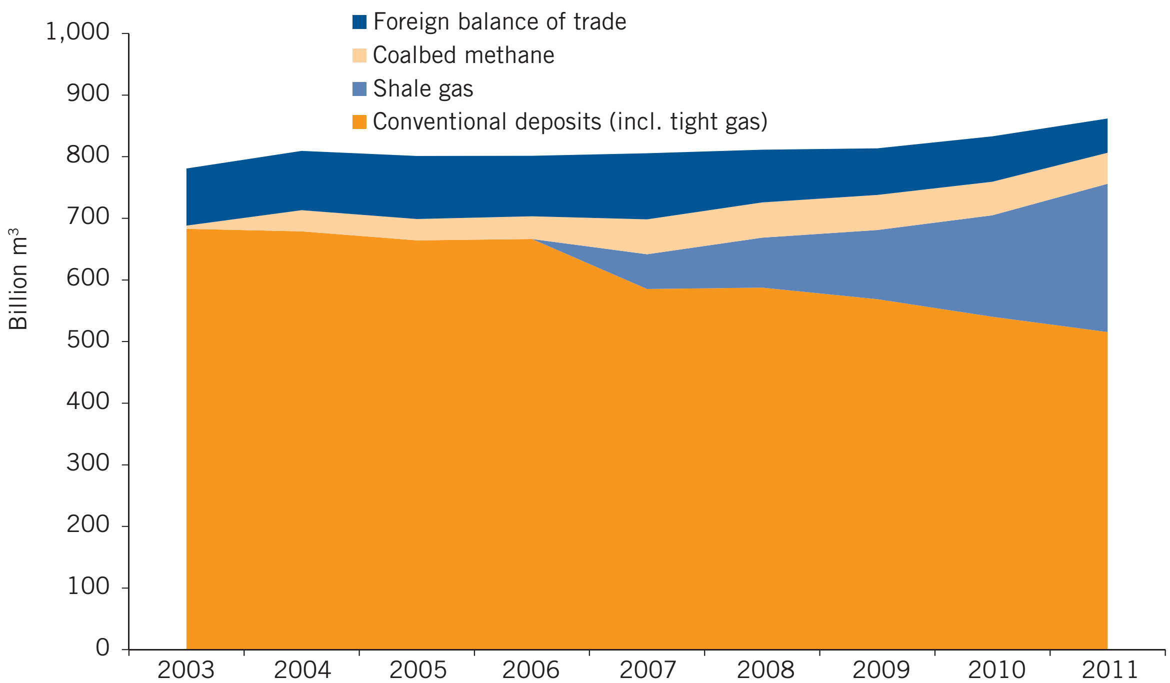
9 See Geny (2010).

Figure 1.3 illustrates the development of natural gas production (gross withdrawals[10]) in the USA between 2000 and 2011. The chart shows a decline in "traditional extraction" (including tight gas), while at the same time illustrating an increase in the production of coalbed methane and shale gas in particular, which has achieved a continually increasing share of US domestic natural gas extraction. Whereas the shale gas share was not reported up to 2006, and was below 10 % in 2007, by 2011 it had reached a share of around 30 % of domestic production.

The increase in shale gas production can consequently not only compensate for the decline in conventional domestic production, but also reduce net imports (imports less exports). This development has taken place against a background of overall rising demand for gas in the USA. At present, however, the USA is still a net importer of natural gas. The intensive discussions currently being conducted regarding the extent to which shale gas should or may be exported are thus of particular relevance for

10 The figure for gross withdrawals exceeds marketed production as it includes gas used in extraction and other components that are not marketed. See http://www.eia.gov/dnav/ng/TblDefs/ng_prod_sum_tbldef2.asp for an exact breakdown.

Figure 1.3: Development of natural gas supply in the USA



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_nus_a.htm) the future. This topic will be discussed in greater detail in chapters 1.4 through 1.6.

There are many reasons for the increase in shale gas production in the USA. One significant reason is American legislation. In the USA, the owner of the respective piece of land owns the production rights, while in Germany most of the margin from production remains with the state and the land owner only receives compensation. A further reason is invoked by Paul Joskow (2013), one of the most renowned American economists: The early deregulation of the American natural gas market. According to Joskow, the dynamic development of the American shale gas market would have been almost impossible in a regulated system. In addition to this, tax incentives are provided for shale gas production in the USA, and environmental regulations appear moderate in comparison to Germany. Further reasons can be found in the very high forecast for import requirements at the beginning of the 2000's century. High demand for LNG imports was expected at the time, which, due to their significant costs, were only economical at relatively high prices. These high price expectations, which were also partially reflected in the futures market, lead to an intensive examination of alternatives, such as investing in shale gas exploration. As a result, many shale gas production projects became economically feasible which put downward pressure on prices, as discussed in the next subchapter. Technical, market structure and further economic factors also played a significant role.[11]

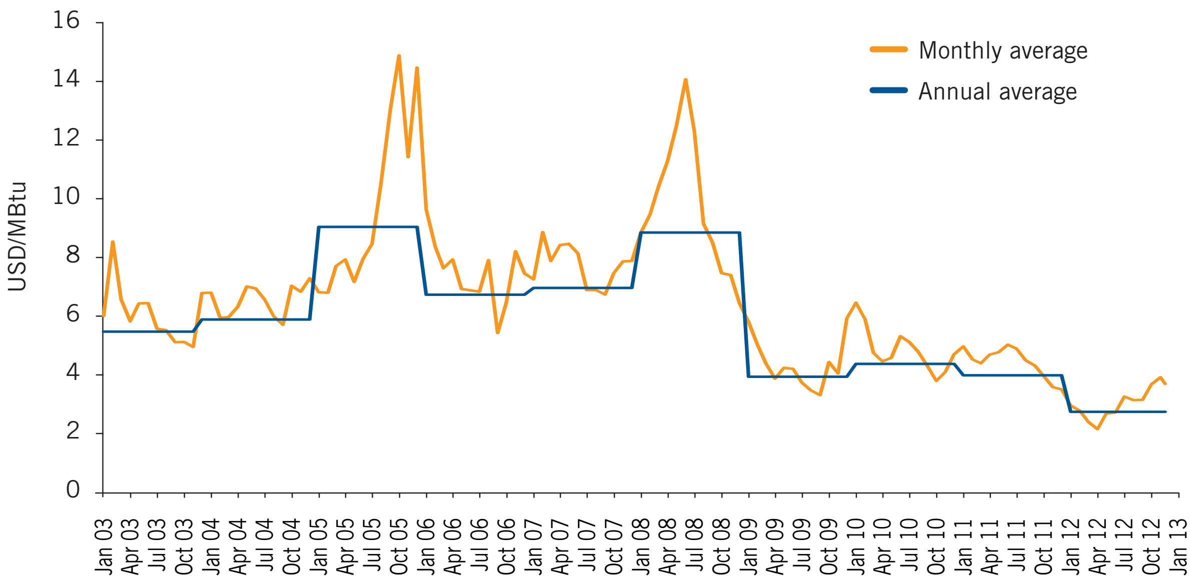
Influence of shale gas on natural gas prices

Gas prices in the USA have been falling for over five years. The high level of shale gas production is the main driver for this development. The American economy's recession in 2008 (GDP –0.4 %) and 2009 (GDP -3.5 %)[12] played an additional role in this, though domestic gas consumption only decreased marginally in 2009 and significantly increased again in 2010 and 2011. Figure 1.4 shows gas price development in the USA on the Henry

11 In comparison with conventional sources, disproportionate volumes can be extracted from shale gas deposits in the initial years, with the rate of extraction declining rapidly in the following years. Increasing the rate of extraction from this point is only possible with significant follow-up investments, rarely made by market participants. An overview of the market conditions for shale gas can be found in Foss (2011).

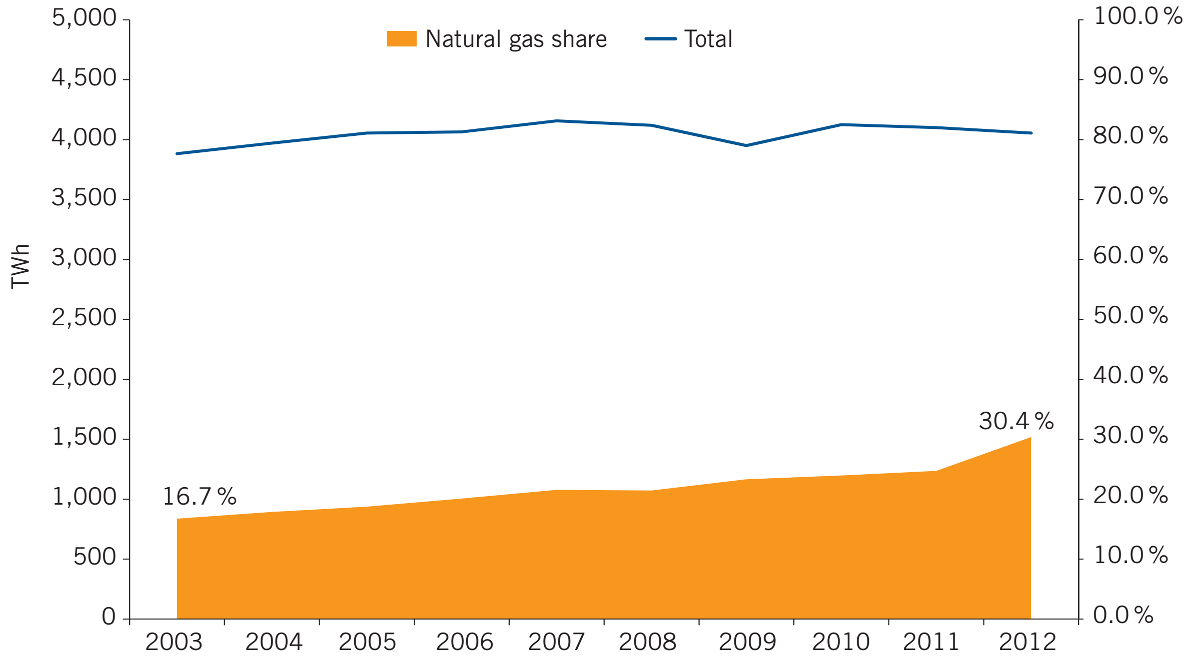
12 Annual change in Gross Domestic Product. Source: World Bank (2013), http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

Figure 1.4: Development of natural gas prices in the USA (Henry Hub Gulf Coast Natural Gas Spot Price)



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/dnav/ng/hist/rngwhhdd.htm)

Figure 1.5: Development of electricity generation in the USA



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_1)

Hub[13] from 2003 to 2012. The blue line indicates the annual average price and the orange line the monthly average price, which exhibits high volatility in comparison to the annual average price. It's clear to see that, despite increased demand directly following the recession, gas prices in the USA have remained at a relatively low level or have even fallen. Even the nominal average price (all price data in this chapter are nominal) in 2012 is the lowest natural gas price since 2003. The inflation-adjusted figures produce a price difference that is even greater, especially in comparison to earlier years.

Gas prices are however not the same in all American states. Bottlenecks in the gas network lead to regional price differences. A report published by the American Federal Energy Regulatory Commission (FERC 2012), using data from the ICE futures exchange not available to the public, however concluded that for 2011 (as an example), prices across almost the entire country were between USD 3.77/MBtu and USD 4.23/MBtu, with the Henry Hub in the middle. The AECO-Hub[14] was an outlier, deviating downwards (USD 3.66/MBtu), as was the north-eastern USA, which deviated significantly upwards (Algonquin Citygates as well as Transco Z6 NY both had prices of USD 5.02/MBtu). Even the prices in the north-east were still considerably under pre-2008 price levels, before the beginning of shale gas production.

Influence of lower gas prices on American electricity generation

The lower gas prices also influence other sections of the American (energy) economy. For example, the low gas

13 The Henry Hub in Louisiana is (by far) the most liquid market for natural gas in the world. Many pipelines from both onshore extraction sites (e.g. Texas) and offshore extraction sites (Gulf of Mexico) connect here. An LNG import terminal is also located in the nearby Lake Charles. In addition to its physical capacities, the Henry Hub is also the basis for most traded gas supply quantities in the USA and the futures market.

14 The AECO (Alberta Energy Company hub) in Alberta is very strongly influenced by Canadian production and exports. Although they are also based on the Henry Hub, they are normally slightly below US reference values due to the general direction of gas flow and the balance of supply and demand in the north.

prices have led to changes in the electricity sector. Generation of electricity from natural gas has particularly increased in recent years. Figure 1.5 shows the development of electricity generation in the USA since 2003. Due to falling gas prices, the share of electricity generation from natural gas has almost doubled from the lowest value (16.7 % in 2003) to 30.4 % in 2012. Generating electricity from natural gas replaces the generation of electricity from hard coal in particular.

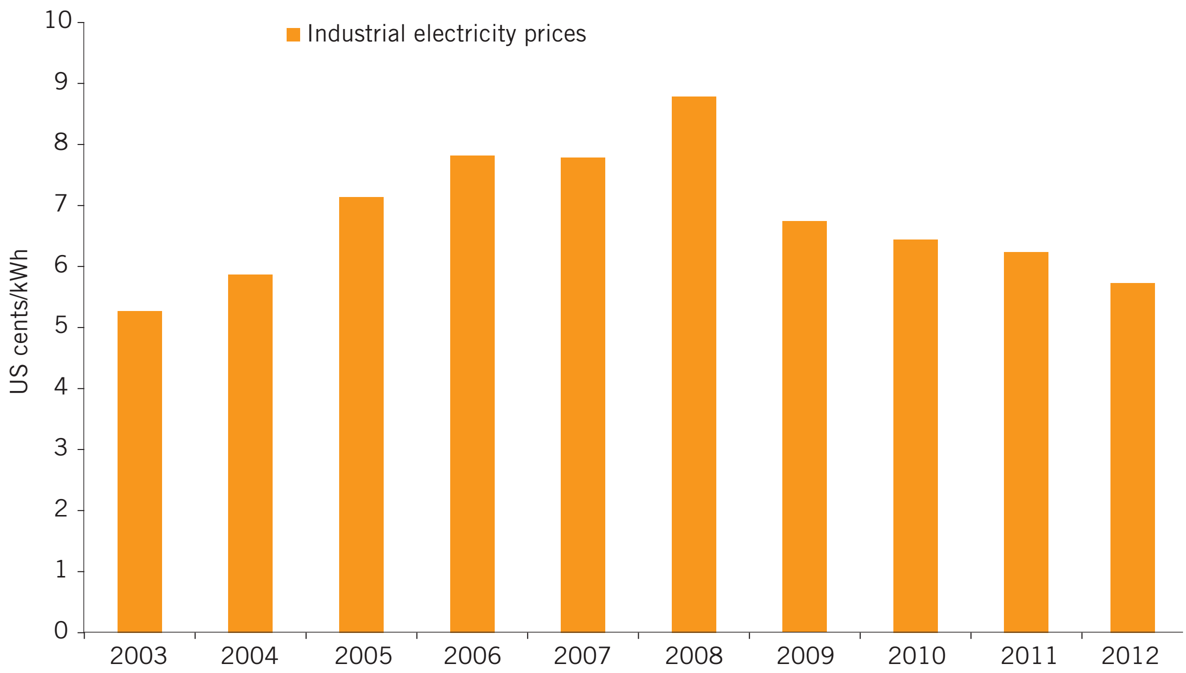
Falling gas prices impact not only the composition of electricity generation, but also electricity prices. An example of this, included here, is the average end-user price for industry in the state of Texas[15] from 2003 to 2012 (Figure 1.6). This chart also demonstrates that electricity prices show a development corresponding to that of gas prices. Although, in addition to increasing shale gas production and falling gas prices, the financial crisis could possibly explain this. The previous chart makes it clear that electricity generation (and thus electricity demand) only declined marginally in the wake of the financial crisis.[16]

The comments in this chapter focus on describing the situation in the USA. However, in addition to the absolute values of electricity and gas prices, the relative situation (i.e. the situation in comparison to alternative production locations) is particularly relevant for an in-depth analysis of the competitiveness of energy-intensive industries and manufacturing. The following chapters thus compare the advantages of the USA through its shale gas production with the situation in Europe, and Germany in particular. However, the impact of the development of shale gas production in the USA on global energy and gas markets first needs to be examined. The effects can be direct, i.e. within the gas industry, for example through changed LNG flows. They can also take place indirectly, for example through changes in coal trade flows. This development will be discussed in chapter 1.4.

15 Texas was analysed as it is both in the direct vicinity of Henry Hub and is also an important industrial location in the USA. The average industrial electricity prices in the USA however demonstrate a very similar development (see also Figure 1.10).

16 Although the decline in energy consumption in the industrial sector was more pronounced, it is aggregate demand that is relevant for the price level in a competitive electricity market.

Figure 1.6: Development of end-user electricity prices for industry in Texas



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_1)

1.4 The significance of the USA for global natural gas trade

The global natural gas market

In contrast to the primary energy sources of oil and hard coal, there is still no world market for natural gas. The natural gas market is instead subdivided into three regional submarkets that differ according to their respective histories, market structures and pricing mechanisms.[17]

In the past, the connection between these regional submarkets was weak, with only limited inter-market transactions taking place, which, in turn, resulted in significant price differences.

Transport can be regarded as one main cause for the low liquidity between the markets. In contrast to oil and coal, specifically transport costs for natural gas are higher. In particular, they also constitute a higher proportion of total costs (production costs plus transport costs). Whereas the transport costs for oil are commonly in single digit percentages, they can be up to 80 % with natural gas (for example, with supplies from Russia to Western Europe).[18]

As pipelines can be ruled out for economic, practical and technical reasons, intercontinental trade in gas is only possible with LNG[19] tankers. Since the beginning of its commercial use at the end of the 1960's, the LNG market segment has been a fringe segment. Even in 2001, only 5 % of the natural gas consumed worldwide was transported as LNG, as transport by pipeline still accounted for all of domestic trade and the majority of international trade.

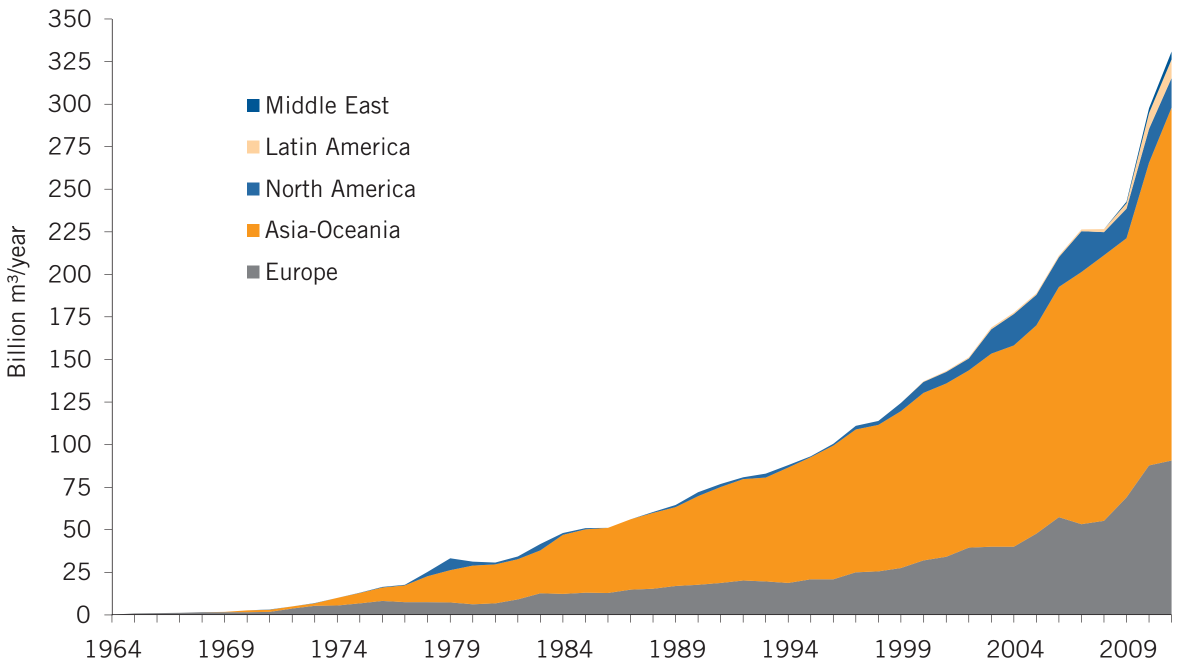
LNG trade has however experienced enormous growth in the last decade. Quantities traded have more than doubled from 143 billion m^3 per year (2001) to over 330 billion m^3 per year (2011). It has not only been traditional

17 An overview of the historical development of the regional submarkets of Europe (including North Africa and Russia), America and Asia-Oceania (including the Middle East) with a special focus on LNG is, for example, provided by Jensen (2004). Other common demarcations are the Atlantic market (the European market plus the American East Coast and the US Gulf region), as well as the Pacific market (Asia-Oceania and the American West Coast), with the Middle East serving as a link in the middle.

18 An overview of the technical and economic fundamentals of the gas industry can be found, for example, in Seeliger (2006)

19 LNG stands for "liquid natural gas". Cooling natural gases to a temperature of -161 °C condenses the gas into a liquid and reduces its volume to 1/600th of its gaseous state.

Figure 1.7: Global LNG imports from 1964 to 2011



Source: Weltenergierat – Deutschland, based on BP data (various years).

LNG importers such as Japan, Spain or France who have increased their purchases; this previously "exclusive club" has considerably expanded since the turn of the century. Currently 25 countries around the world obtain LNG from 18 producing countries. Despite the extension of the LNG market to new regions in South America and the Middle East, the most important sales regions remain Asia and Europe (Figure 1.7).

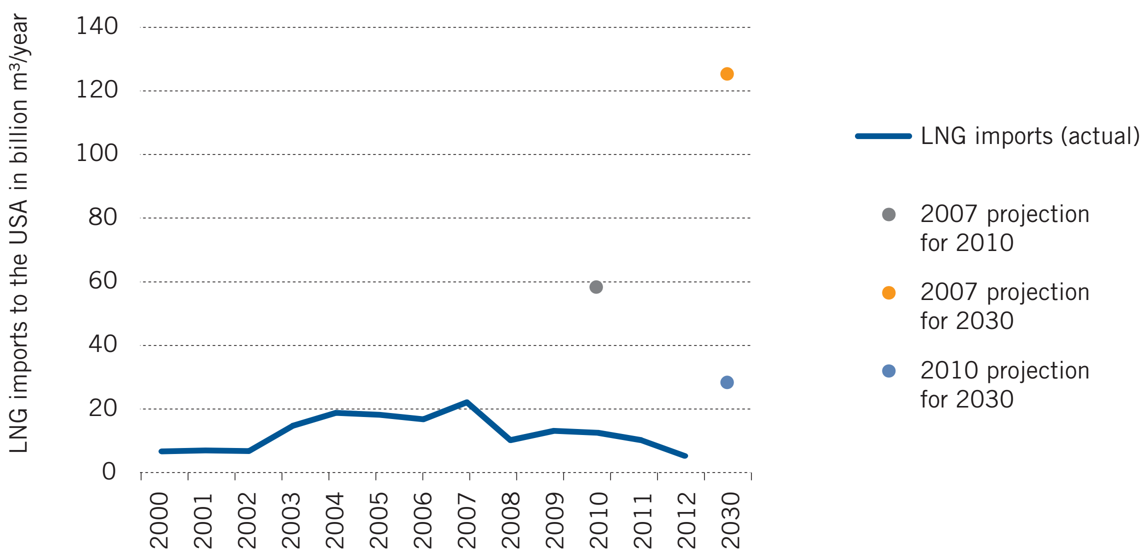
Despite the clear increase in LNG trade over the last decade, intercontinental trade has experienced only limited growth. The majority of development has thus taken place within the regional submarkets. Qatar proves an exception. By the unparalleled expansion of its liquefaction capacities, the country has managed to increase its market share of LNG exports to around a third (from only about 11 percent in 2001). The Gulf emirate is however the only notable exporter with a significant presence in all regional submarkets. High production and export capacities allow Qatar to react to fluctuating demand in individual regions and act as a global "swing supplier". Only a very few suppliers can demonstrate similar flexibility. Due to their geographical position, only Trinidad and Tobago as well as some smaller suppliers (Yemen and Peru) are able to approach the far-reaching scale of a sales market as broadly distributed as Qatar's. Most other major exporters are only active on one market. For example, Australia, Indonesia and Malaysia currently supply customers exclusively in Asia. Although other suppliers have a presence in more than one regional submarket, they tend to concentrate the majority of exports on one region only, and sell only small quantities to the other regional submarkets. For example, in 2011 Algeria supplied Europe with 16.8 billion m^3 but only 0.3 billion m^3 to Asia, and Oman supplied 0.2 billion m^3 to Europe in contrast to 10.8 billion m^3 to Asia.

The USA has been planning the expansion of its LNG imports since the 1970's. These plans have however faced repeated setbacks. The first expansion in the 1970's ended abruptly in 1980 when indexation[20] was introduced to the LNG sector and the effects of the upheavals in the oil market following the 2nd oil price crisis flowed on to the gas market. Imports collapsed in the following years, and three (of four) import terminals were shut down despite some of them being in operation for only one or two years (the US LNG bubble).[21] It was only

20 In this context, indexation refers to orienting the gas price to another reference point ("the gas price is indexed to..."). This method, developed in the 1960's, most commonly uses what can be very complex formulae to establish gas prices by linking them to price developments of oil products. This approach comes from a time in which there was no market and thus no market price for the (then) new natural gas products. The economic and historical background to indexation can be found in, for example, Austvik (2003), Lohmann (2006) or IEA (2008).

21 See Jensen (2004).

Figure 1.8: Projected LNG imports to the USA and actual development



Source: Weltenergierat – Deutschland, based on data from the EIA (2007), EIA (2010) as well as www.eia.gov at the beginning of the 2000's that the LNG sector found its feet again. Declining domestic production and a growing projected import gap led to not only a reopening of the old terminals but to the planning of numerous new projects. In 2007 LNG imports reached a new high of 22 billion m^3, but this was followed by another market slump and in 2011 imports only totalled 10 billion m^3 (a quantity that could have been taken on even without the reopened facilities). Offsetting (re)exports from the USA into other countries (especially to Asia) against this amount, 8 billion m^3 remained for domestic consumption, which covered only 1 % of American demand. In relation to the global market for LNG, US imports total only 0.6 %, making them of little importance. With regard to total global trade (pipeline and LNG) the US total of 0.2 % is negligible.[22]

Development of the natural gas trade balance in the USA

The USA has been a (net) importer of natural gas for decades. After the US LNG bubble burst, the USA bridged the difference between domestic production and consumption as far as possible with pipeline imports from Canada. As previously mentioned, LNG imports increased again from the end of the 1990's, and the development to 2007 was generally considered to be just the beginning of a US gas industry extensively dependent on LNG. Projections for the coming decade were correspondingly optimistic (from the perspective of the LNG sector). In its 2007 forecast, the EIA projected that, from the 22 billion m^3/year imported in 2007, almost 60 billion m^3/year would be imported as early as 2010, and 125 billion m^3/year in 2030.[23]

These projections soon proved way too high. Imports in 2010 were not the 60 billion m^3 as expected three years before, rather, as previously described, only 12 billion m^3. In line with this, the 2010 publication of the EIA also predicted significantly lower LNG imports for 2030 (under 30 billion m^3/year instead of 125 billion m^3/year).[24] Within only three years the USA's (projected) LNG demand dropped by almost 100 billion m^3/year – around the annual consumption for all of Germany (Figure 1.8).

Forecasts[25] released after 2010 have even proceeded from the assumption that the USA won't need to import any LNG at all in future. Current assessments instead hold that, from 2016, LNG could be exported (in addition to the small quantities shipped to Japan from Alaska since 1969). The projected amounts are however low in comparison to world market volumes (a maximum of 20 billion m^3/year from 2020) and are also subject to uncertainty. Should these projections be accurate, the (hypothetical) liquidity of the global LNG market in 2030 would be almost 150 billion m^3/year higher in comparison to market projections from a few years ago. The possible consequences for other LNG importers and, above all, for Europe are discussed in chapter 1.6.

22 All statistical data based on BP (2012).

23 See EIA (2007).

24 See EIA (2010).

25 See EIA (2011), EIA (2012) and EIA (2013).

1.5 Advantages of shale gas extraction for the US economy

The "shale gas revolution" has not only revitalised the American gas industry, it has also had positive effects on other areas of the energy industry, as well as the economy as a whole:

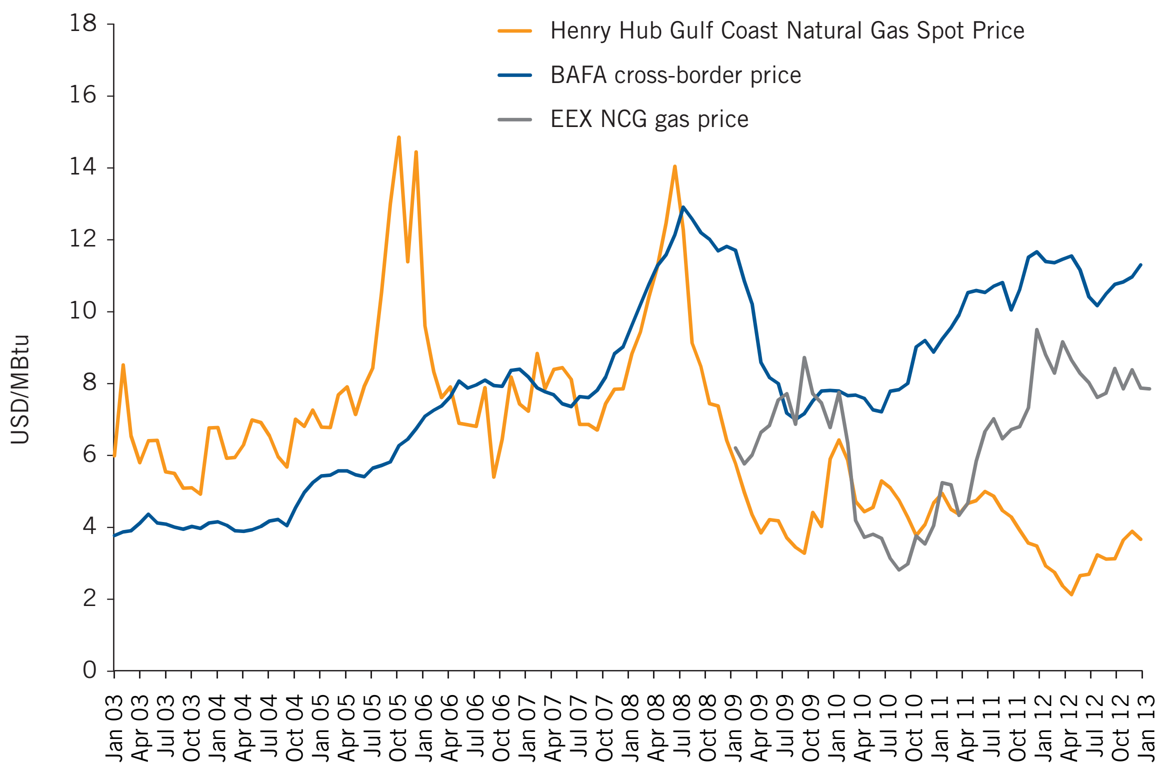
Dependency on imports has reduced considerably and redirected gas industry margins to the domestic economy.

- The gas industry has been revitalised, which has led to numerous specialised new upstream companies as well as a return of the major oil and gas giants to the USA.
- Gas prices have fallen for both the wholesale market and the end customer.
- The share of electricity generated by natural gas has doubled, and the corresponding decline in electricity generation using coal has had positive effects with regard to CO_2 emissions. This has resulted in a fall in electricity prices as well, which has unburdened consumers.

Falling gas and electricity prices have unburdened energy-intensive industrial clients in particular. Both price components have allowed the USA to improve its competitive edge, especially with regard to Europe. Wholesale prices for natural gas and end customer electricity prices for industrial customers are both not only low in historical terms, but also particularly low in comparison to Europe.

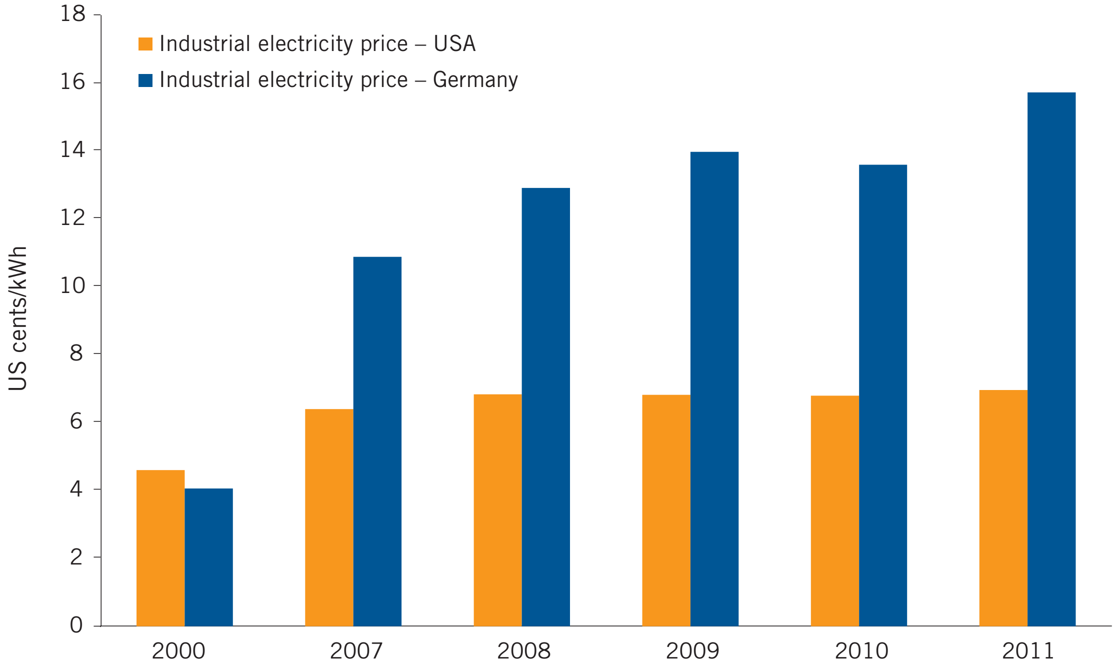
The following figures illustrate this in relation to Germany. Figure 1.9 shows wholesale prices for gas in Germany and the USA. To aid comparison, all prices have been converted to USD/MBtu (using exchange rates for the respective years). It is particularly interesting to note that the US gas price was almost the same as the German cross-border price ten years ago. Whereas the American reference price is today considerably below the price level back then, German prices are currently around three times their previous level. Gas prices in Germany are correspondingly at least twice as high as in the USA

Figure 1.9: US and German comparative gas prices



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/dnav/ng/hist/rngwhhdd. htm) as well as EEX and BAFA

Figure 1.10: Comparative industrial electricity prices in USA and Germany



Source: Weltenergierat – Deutschland, based on IEA data (Electricity Information 2012 Edition Part IV)

at present. If one uses the BAFA[26] import price instead of the EEX wholesale price (which is reflected in long-term contracts and still based on the principle of indexation) for comparative purposes, the difference is even greater.

Figure 1.10 shows industrial end customer prices for electricity.[27] The prices in the USA are lower than in Germany here too, with the difference tending to grow over time. Note that 2000 is not representative for Germany, as prices briefly collapsed directly following the electricity market liberalisation in Germany. The prices were falling below the full costs of new power plants as well.

It is however less clear if this development has already influenced investment decisions to a considerable degree (the "reindustrialisation" of the USA).

Although industrial gas and electricity consumption in the USA appears stagnant[28] (see Figure 1.11), investment decisions in energy-intensive industries have longer lead times.[29]

It remains to be seen to what extent (if at all) a reversal of trend will occur as the financial crisis eases. Of particular relevance in this context is not only USA's ability to improve production conditions in its own industrial companies, but also its ability to attract other companies or production plants from other countries in the international competition for location.

Whether investments actually shift to other locations depends not only on the scale of price differences, but also the relevance of energy costs in individual industries. According to a BMWi publication (2010, p. 41), "despite continuous improvements in specific energy consump-

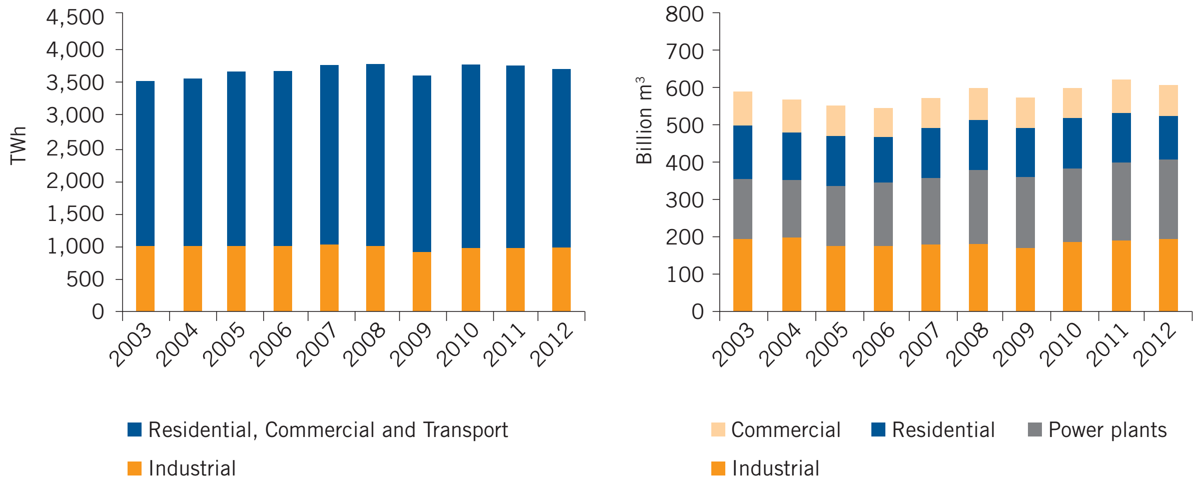
26 Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Office of Economics and Export Control).

27 Based on IEA data. The industrial prices are calculated as average amounts paid by industry and manufacturing. Taxes have been taken into account (excluding VAT and local taxes applied in the USA).

28 The previously presented increase in aggregated gas consumption in the USA results from the strong growth in gas consumption in the power plant sector.

29 Moreover, constant energy consumption during economic crises could be interpreted as a result of low energy prices, particularly as other countries impacted by economic crises have, in part, experienced steep declines in energy consumption.

Figure 1.11: Distribution of electricity consumption (left) and gas consumption (right) in the USA



Source: Weltenergierat – Deutschland, based on EIA data (http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_1 and http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_nus_a.htm)

tion in industry ... energy costs have increased considerably". Aggregated industrial energy costs totalled €21.9 billion in 2000, and by 2010 had already reached €36.2 billion.[30] These costs are however unevenly distributed across various industries. For example, in the German manufacturing industry, energy costs represented on average 2.3 % of turnover, but were far higher for individual industries. They are particularly high for paper manufacturing (13 %) and basic chemicals production (11.5 %).[31]

There are already sources from energy-intensive industries that have reported planned investments in the USA in connection with the comparatively cheap energy prices. A list associated with Dow Chemicals (one of the largest consumers of gas in the USA) is often quoted in connection with this, although it is not publically available. This names more than 100 projects with a total investment value of USD 90 billion planned for the coming years.[32] Other sources, for example publications from consulting firms, also establish that the competitiveness of the manufacturing industry in the USA has improved considerably in comparison to major competitors.

In our evaluation, low energy costs are a significant factor in determining business location. In comparison to many other locations with low energy costs, the USA also has relatively well educated employees, is near to large sales markets and has a culture (and language) familiar to Western companies. In addition, bureaucratic hurdles and environmental regulations are traditionally lower in the USA than in most European countries. At present, the USA has some of the lowest production costs among the developed economies.[33] Moreover, decisions made regarding business location always have a psychological component. Although there are no thorough empirical studies regarding this, the many positive reports published in connection with USA as a location to do business imply a favourable position.

30 BMWi (2012).

31 Commerzbank (2011).

32 Source: Financial Times, http://www.ft.com/intl/cms/s/0/4b3f6280-4609-11e2-ae8d-00144feabdc0.html#axzz2MsT5tg1l.

33 According to a press release from 21 September 2012, the Boston Consulting Group came to the same conclusion (http://www.bcg.com/media/pressreleasedetails.aspx?id=tcm:12-116389).

1.6 Future development

Shale gas forecast uncertainty

All forward-looking considerations have to deal with a degree of uncertainty. Although this means that, as a rule, the projected development does not actually take place in practise, this does not reduce the value of projections. Future-based projections are indispensable, especially in relation to the energy industry, where investment and depreciation cycles last decades. In addition, the alternative to systematic, model-based projections is often only the “gut feeling” of decision makers.

The uncertainty regarding the future development of shale gas usage is however particularly high, as the deposits in question have only been extracted on a major scale within the last few years.

The uncertainty starts with the available quantities. Estimates regarding extent of reserves (and resources) vary considerably. Even in the USA, where shale gas production is at its most advanced, data regarding the reserves vary greatly from year to year, and not just due to changes in the gas price.[34] Uncertainty is even greater in countries with projects that are less advanced. There are currently projects running in Germany that aim to establish a solid knowledge base (see BGR 2012b, as well as the remarks in this publication on unconventional energy sources in Germany). Even current estimates of available gas quantities are only rough (without stating the proportion of these that is technically or commercially recoverable). The BGR (2012b) estimates with 90 % probability that in Germany these quantities are between 6.7 trillion m^3 and 22.7 trillion m^3. Uncertainty only further increases, once the technical recoverability of the gas is taken into consideration. With regard to this, the BGR points out in its study that between 10 % and 35 % of gas quantities in the USA are technically recoverable. In the absence of better data for evaluating the technically recoverable quantities in Germany, the BGR argues for a conservative estimate using the lower limit of 10 % from the USA data.

In addition to this, there are further uncertainties with regard to important economic parameters and also with regard to political and public acceptance. For example, it is still unclear to what extent shale gas production would be accepted.[35] The situation in the USA is more transparent with respect to this too, as political and public acceptance appears to have been achieved for the moment. Measures may however be required to maintain this in the long-term, and these can also increase production costs. The IEA (2012a, p. 56) notes that production costs for an individual shale gas well increase by about 7 % once measures to increase acceptance (in accordance with the “Golden Rules”) are implemented. This corresponds to an approximate average increase in shale gas well development costs of USD 580,000 (from a total of USD 8 million to over USD 8.5 million). As these measures also include better isolation of shale gas wells, they would also further improve the CO_2 footprint of shale gas production. Further uncertainties in the USA surround the questions of how high the average yield of shale gas wells is over their entire lifetime, and of how frequently refracking measures are required. Both parameters are important with regard to specific extraction costs. Uncertainty regarding production costs is even higher in other regions of the world, particularly in Europe. In most cases only rough estimates are available. The IEA (2012a, p. 54) estimates operating and drilling costs in Europe to be 30 % to 50 % higher than US levels. These cost differences can be partially attributed to the extraction industry in Europe not yet being as developed as in the USA. In addition, further technical advances can be expected to open up potential for cost reductions in general.

Last but not least, the question arises of what mid-term and long-term market equilibrium will be established in the individual gas markets by the interaction of supply and demand. For instance, it is being hotly debated whether the current low price level in the USA can be sustained. On one hand, the low price drives up demand. On the other hand, the rising demand puts upward pressure on the price. This applies to the increased use of natural gas in the electricity sector as well as to large-scale reindustrialisation. Growth to date in consumption in the power plant sector however has apparently not yet resulted in a price increase. Nevertheless, adjustments can also occur on the supply side. For example, as described in chapter 1.2, current prices do not (fully) cover costs for all sources on the supply side. It can thus be assumed that, at least expensive dry gas sources (sources that are almost pure methane) will not be redeveloped

34 According to EIA estimates, shale gas reserves almost tripled between 2008 and 2010. More current official statistics from the EIA were not available at the time of writing, but updated figures are expected in July 2013. See http://www.eia.gov/naturalgas/crudeoilreserves/index.cfm. Oil & Gas Journal estimates assume sharp declines in reserves of over 40 % in 2012 (though still remaining at a high level). See http://www.pennenergy.com/articles/pennenergy/2012/01/u-s--shale-gas-reserve.html.

35 See also our remarks in the following section “Impact on the supply situation in Europe”.

as long as prices remain at current levels.[36] However, one also has to take into account the occasional additional sources of revenue found in the liquid hydrocarbons that also arise from shale gas production. Given high oil prices, these can significantly increase the profitability of shale gas sources. In extreme cases, methane gas production is only a by-product. In these cases gas production can of course only cover a part of the investment costs. As long as oil prices remain at their current levels the cost effectiveness of natural gas production can be ensured, even with low gas prices.

The adjustment mechanisms of the global energy market also play a role in this context. Indirect effects can however arise as well. For example, as previously described, the increased share of electricity generated by natural gas has been at the expense of hard coal, i.e. in the USA, the use of coal in the generation of electricity is declining. This fall in demand has released quantities of coal that would have otherwise been sold, thus exerting downward pressure on coal prices, which also influences the market for coal in Europe.

Once these uncertainties are taken into consideration, only general possible scenarios can be described in relation to future developments. On one hand, there are scenarios in which prices for natural gas in USA and Europe reconverge. This could take place if prices in the USA increase again, for example if the current price level does not cover the costs of opening new production sites, or if demand rises more rapidly than supply. Alternatively, this could also take place if prices in Europe fall, for example if the extraction of unconventional gas deposits is more heavily pursued.

It is however also possible that the price differences will be permanent. This would particularly be the case if the optimistic forecasts in the USA come to pass, while gas prices in Europe remain high. The impact of such a scenario is presented in the following section.

36 In connection with this, we refer to the memorable quote from the Exxon Mobil Corporation Chairman and CEO Rex W. Tillerson, who, on 27 June 2012, at the invitation of the Council on Foreign Relations (CFR 2012), said: “And what I can tell you is the cost to supply is not $2.50. We are all losing our shirts today. You know, we’re making no money. It‘s all in the red.” It should however be noted that this was said in connection with an ongoing discussion regarding the export of shale gas, in which US gas producers have a natural interest in times of relatively low prices.

Description of a possible scenario

It is quite probable that gas production in the USA will continue to grow in the coming years and decades. In the World Energy Outlook 2012 (IEA 2012b, p. 138) the IEA estimates gas production in the USA increasing by 1.1 % every year from 2010 to 2035. In absolute figures this corresponds to annual production of 604 billion m^3 in 2010, increasing to 747 billion m^3 in 2020 and further to 784 billion m^3 in 2030.

Although gas consumption in the USA will also increase (WEO 2012 projection: 0.5 % p.a.), its lower rate of growth compared to growth in production will decrease the need for imports, and the previously described demand driven upward pressure on price is relatively low in this scenario. According to these forecasts, the USA will already be a net exporter of natural gas before 2020 (although the IEA also notes the ongoing political debate in the USA on this issue). Should the USA deviate from this course and ban exports in significant quantities, or at least limit them, this would further decrease gas prices in the USA in relation to Europe.

At the same time, it is not unlikely that the price level for natural gas in Europe will remain high in the long-term. Suppliers in Europe can demand margins due to strategic market power, and the stricter-than-average environmental protection constraints mean that the potential of unconventional energy sources cannot be tapped, or tapped in only a limited fashion. Irrespective of this, the supply structure in Europe is completely different from that in the USA. In contrast to the almost completely self-sufficient USA (and Canada), European countries are largely dependent on imports, which are supplied over 5,000 km of pipeline, or delivered as LNG over even longer distances.

Impact on the supply situation in Europe

In future, shale gas can also play a role in Europe. Although some production is conceivable, the estimates of reserves and the production conditions are not sufficiently known to make reliable predictions. There are also considerable concerns from an environmental perspective in a number of important potential producing lands, including Germany in particular. France has already underpinned its negative stance through statutory prohibitions. In contrast, a number of other countries appear relatively open to the idea of shale gas production and have already lifted or relaxed restrictions regarding shale gas (for example, Great Britain or Romania). East European countries in particular, especially Poland, have focussed on the opportunities shale gas production presents instead of the risks, which may also be explained by their high dependence on imports from Russia.[37] At least in the short to medium term, supply is more likely to be influenced by the USA. In principle, these three options seem most likely:

1. The direct export of shale gas from the USA to Europe
2. Re-export by US importers[38]
3. Redirection of LNG exports from third countries who previously planned to supply quantities the USA (see Figure 1.8)[39]

The first option is particularly interesting with respect to the global market for LNG, as it involves new quantities for which new liquefaction capacities have to be established. Imports from the USA and redirection of these quantities to other regions do not however require an expansion of liquefaction capacities. From a price perspective, it can be assumed that US companies will not differentiate option 1, based on opportunity cost considerations. Both supply options are measured against the Henry Hub price and correspondingly valued, even if the actual procurement costs differ between 1 and 2, as well as within the individual options (depending on origin or production site).

Option 3 will not be further examined in this article. Almost all relevant LNG suppliers to the USA that currently have to deal with reduced quantities (actual, when contracts are not concluded, or potential, when planned capacities are not intended for US deliveries) already deliver to the European market (for example, Egypt, Algeria, Qatar, Nigeria, Norway, or Trinidad and Tobago), or do not deliver substantial quantities due the transport costs involved (Peru). This can bring a certain quantity dynamic to the market, but it is open to question if the existing suppliers will price the additional quantities differently to the previous (considerably larger) quantities, and by doing so cannibalise themselves.

37 Current overviews of the position of various European countries are provided by Deutsche Bank (2013), WEC (2012) and GIS (2013).

38 US companies buy up gas from LNG suppliers, but sell it on to Asia or Europe instead of the domestic market.

39 The difference to 2. is primarily of an industrial economic nature: the suppliers from third countries in 3. already deliver to the European market and have less occasion to reduce prices with additional quantities (see below).

A number of questions arise with regard to potential shale gas deliveries:

1. What quantities can or may American producers export?
2. How much will actually be supplied to Europe and to Germany?
3. What prices will the Americans offer in Europe and Germany?
4. What effects could this have on price levels in the market as a whole?

Considerable uncertainty currently surrounds quantities exported from the USA. This arises not only from the significant uncertainties regarding exploration and production but also from political and business considerations. In future, self-sufficiency will be an important part of American energy strategy. Exports should only be approved in quantities that rule out future import dependency. In practise, only one terminal (Sabine Pass[40]) has so far obtained all the necessary approvals.[41] EIA forecasts also demonstrate scepticism that considerable exports will take place. The US agency estimates a maximum realistic volume of between 20 billion to 25 billion m^3/year.[42]

It also remains to be seen what share of total exports will be supplied to Europe and what share to Asia.[43] Given hypothetical volumes in the order of 20 billion to 25 billion m^3/year, and assuming the extreme scenario that all of these would be supplied to the European market, it would increase LNG supply from the current level of 90 billion m^3/year to between 110 billion and 115 billion m^3/year.[44] Although this is a considerable increase in and of itself, growth of up to 25 billion represents less than five percent of the total market volume of 520 billion m^3/year

40 See http://www.cheniere.com/lng_industry/sabine_pass_liquefaction.shtml.

41 An overview is provided by BNP Paribas (2012).

42 See EIA (2012)

43 Shipping costs to Europe from the Sabine Pass and from the American East Coast or Gulf Coast in general, are cheaper than those to Asia. This cost advantage can however be reduced by future use of the Panama Canal. In addition, prices in the Asian market (especially Japan) are traditionally higher than in Europe. Depending on price structure, this can potentially justify the higher shipping costs involved.

44 This scenario is in the upper limits, given that commercial agreements amounting to 10 billion m^3/year have already been concluded with Asian importers (KOGAS/South Korea and GAIL/India) for the Sabine Pass. See BNP Paribas (2012).

(Europe, including Turkey, but excluding the former Soviet Union). Even given these assumptions, the question remains of how significant the influence on the European market would be.

Taking into consideration previous LNG trade flows, the additional American volumes would most likely be supplied to Spain or Great Britain. Both countries have sufficiently large LNG import capacities as well as major gas markets. Although Germany doesn't currently possess its own LNG regasification terminals, by taking advantage of the existing pipeline infrastructure, it is still possible to accept LNG imports through Belgium (Zeebrugge) and the Netherlands (Rotterdam). Volumes would however be limited, as the total capacity of both terminals would barely exceed 30 billion m^3/year, even after taking into consideration possible terminal expansions. After deducting capacities that have already been reserved (largely in Zeebrugge), even the best case scenario would only result in 10 billion m^3/year reaching Germany.

In addition to volumes, assumptions regarding the price of potential American LNG deliveries are of decisive importance for any evaluation of the impact on Europe. This issue doesn't arise with the oil or coal markets, as there is already an integrated world market for these products. This is not currently the case with gas, as differing approaches to pricing are applied in the individual regional submarkets (differing approaches are also applied in parallel even within the European market). The American market is organised in purely competitively manner, meaning that prices are determined in the same way as for oil, by supply and demand. In contrast, the Asian market is dominated by long-term supply contracts, where the prices are usually linked to trends in crude oil prices. In the European market approaches range from having prices determined by pure competition, as is the case in Great Britain, to having all prices indexed to oil or oil products, as is the case in Eastern Europe. A hybrid of both approaches can currently be observed in Northwestern Europe (especially in Germany, the Netherlands and Belgium). Even if it can be assumed that prices will be determined by competition for these regions in future, it is not clear how long such a transformation will take. Given the occasional long duration of existing contracts, as well a certain insistence demonstrated by non-European suppliers with regard to adhering to existing pricing mechanisms, the process could drag on for many years or even decades. During the transformation period both systems will be in competition with each other and offer companies acquiring gas a variety of options (providing the same degree of both opportunities and risks).

In such an environment price projections are subject to a great deal of uncertainty by their very nature. The existing situation with regard to intra-European gas supply is intensified by the previously outlined uncertainties relating to shale gas and possible US LNG exports. The following economic analysis can thus only provide broad guidelines. The supply costs of US exporters can be regarded as the lower limit of prices. The opportunity costs for the suppliers are clearly above the gas prices in the USA (for example, Henry Hub prices). In addition to the opportunity costs for gas in the USA, the transport costs in Europe also have to be taken into account. These include costs for liquefaction and regasification as well as the costs purely for shipping. Depending on the import country, these can be estimated at around 5 to 6 USD/MBtu.[45] At current Henry Hub prices, US exports could then be offered at around 8 to 9 USD/MBtu.[46] These figures would be competitive with current prices of 10 to 11 USD/MBtu in the European market, but not the degree that the high price difference between the continents would suggest. At the same time, this defines a price threshold, below which no LNG from the USA would enter the market. A further question is whether the Americans would actually determine prices based on supply costs, or if they would to the greatest extent possible (at least indirectly) apply the principles of indexation.

The expected impact on European price levels in various countries (where price differences still exist) depends not only on supply costs and the price setting behaviour of US exporters, but also on the composition of the respective total quantity on offer. An example of the supply curve[47] for Germany should make this clear.

Germany's gas supplies comprise deliveries from various North Sea neighbours, Russia and a share of around eleven percent from domestic deposits. Assuming a purely competitive market, supplies from the Netherlands would be the cheapest, followed by domestic production and supplies from the North Sea (mainly Norway and Denmark). The most expensive supplies come from Russia (West Siberia). In a competitive system, the last required gas unit determines the price for the entire market (the so-called marginal supplier). If American LNG supplies are included in this curve, they would probably

45 See Jensen (2013).

46 Deutsche Bank (2011) and BNP Paribas (2013) arrive at similar figures, even if the breakdown of individual cost components somewhat differs.

47 Such "merit order analyses" are a popular tool in the energy industry. A general overview is provided, for example, by Ströbele et al. (2012). An application of this specifically to issues relating to the international natural gas industry can be found in Seeliger (2006).

lie outside of it, as they would still be more expensive than gas from Russia despite the low Henry Hub prices. As, however, the German market is not organised along fully competitive lines, individual quantities don't correspond to actual costs, rather they are determined in contracts above the variable costs in the supply curve. Without further modification, quantities supplied by the Netherlands would be the most expensive.[48] If individual contracts were enhanced with the already inherent option of flexibility, then Russian supplies would set prices. Given these pricing conditions, American exporters could underbid the marginal suppliers and crowd out other suppliers' quantities. It however remains unclear what effects this would have on prices in Germany. As all potential marginal suppliers command large market shares, although American LNG quantities could capture market share, previous marginal suppliers could potentially remain price setters.[49]

Given the above-mentioned assumptions, no major price effects are to be expected for Germany. This may not be the case for other European countries, especially Spain and Great Britain. In both countries, LNG imports have long been an inherent part of the supply curve. The marginal providers vary from year to year, and generally command a small market share. Spain stands out in particular with regard to its diverse purchasing portfolio, which occasionally falls back on exotic and (from an Spanish perspective) comparatively expensive suppliers such as Peru, Malaysia or Australia.[50] Here even small quantities from the USA would be sufficient to make cheaper prices possible (at least hypothetically: currently the principle of indexation is largely dominant in Spain). Although Spain still presents a quite isolated regional market within Europe, Great Britain is relatively tightly connected with the other countries in Northwestern Europe (including Germany). Depending on the degree of market integration, indirect effects on German prices could result, even if no deliveries are made to Germany. However, given the scale of the northwest European market in comparison to the isolated British market, this effect could be negligible. In addition, despite the degree of integration there are still capacity restrictions, and the previously described differences in pricing mechanisms fuel further uncertainty.

Despite all uncertainties, our economic analysis confirms in principle the comments of the previous section: although under certain circumstances prices may somewhat converge, without considerable domestic production of shale gas, current American prices will remain largely out of reach for Europe.

48 Trade journals such as Heren European Gas Markets or Argus regularly report the (estimated) quoted price from various contracts.

49 The Netherlands exports around 24 billion m^3/year, and Russia over 30 billion m^3/year to Germany. Even in the unrealistic case that all potential US LNG exports were supplied to Germany, it wouldn't be (hypothetically) possible to crowd out one of these suppliers. The same is true for Norway, with around 28 billion m^3/year.

50 For political reasons there is a legally prescribed diversification in purchasing in Spain. From a technical and (in particular) economic perspective, it would be possible to supply the entire Spanish market through pipelines and LNG from Algeria.

1.7 Conclusion

This article illustrates the influence of unconventional gas deposit production on the energy industry and the investment climate in the USA and Europe. From a gas industry perspective, the increasing shale gas production can more than compensate for declines in conventional production, improving the balance of trade in natural gas despite increasing gas consumption. The addition supply of gas exerts downward pressure on gas prices, which have significantly fallen in recent years. The low prices have encouraged growth in gas consumption, especially through rapid growth in the application of natural gas in electricity generation. The low gas prices have thus also led to declining electricity prices.

In addition to these consequences for the energy industry, the increased production of shale gas and the associated fall in gas and electricity prices has resulted in continuous improvement of investment conditions for energy-intensive industries in the USA. This development has not been concurrently observed in Europe (or in Germany in particular). As a result, the USA's attractiveness as a location to do business has improved in comparison to Europe.

Although these competitive advantages have not (yet) impacted electricity and gas consumption in the US industrial sector, it seems likely that they will. This is especially the case as prices for gas and electricity in Germany will probably remain higher than in America in the long term. This will cement the competitive advantages in the USA, particularly with regard to the establishment of energy-intensive industries. In addition to the psychological components that always play a role with investment decisions, a long-term price difference will also increase the belief in continuing price advantages in the USA. In such a case, it can be assumed that investments that would have been made in Germany or Europe will instead be made in the USA.

This development can be countered by improving investment conditions for industry in Europe. Increasing the supply of energy can similarly result in falling energy costs in Europe. To achieve this, a positive investment climate has to be first established in the energy sector. An environmental policy which, in compliance with European climate and energy policy objectives, does not position energy sources like unconventional natural gas in a less favourable position than other energy sources would also play a role here. This can also take place in other fields of business, such as moderate wage agreements, technology and (energy) efficiency measures, or through reducing bureaucracy.

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Energy in the World

2

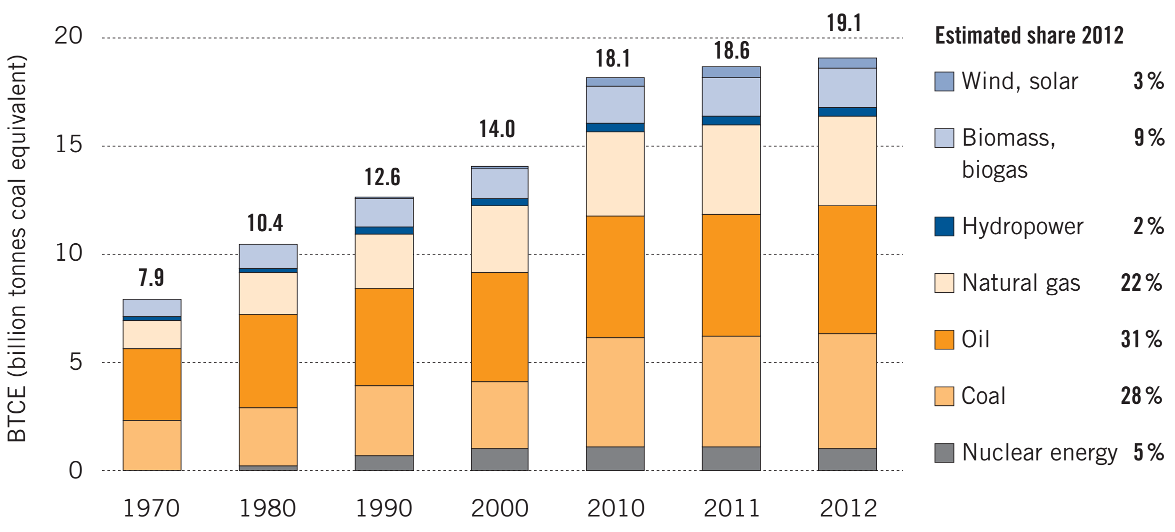
2.1 Facts & figures

2012 was a year of change in the international energy markets, triggered by the strong growth in unconventional gas supply in North America. The impact of this development on consumer regions varies around the world. In Germany and Europe, relatively inexpensive coal from the USA has entered the market, having been pushed out of its domestic market. This, in combination with sustained low carbon prices with respect to electricity production, has resulted in price advantages for coal in comparison to conventional natural gas. At the same time, the decades-old link between gas and oil prices is loosening. High energy demand in Asia, especially in China, India and the Middle East, has ensured that the prices there remain comparatively high.

Growth in world energy consumption, provisionally estimated at around 2.2 %, was slightly above the previous year's level. The global increase in consumption can primarily be attributed to the continuation of relatively strong economic activity in Asia in contrast to reserved growth in the USA and the recessive tendencies recorded in Europe. In the second half of 2012, energy consumption slowed in Asia and the USA due to a cooling of the global economy. Energy consumption in the traditional industrialised countries is on the whole stagnant, although there was an increase in energy consumption in the first half of 2012 due to strong economy activity and the cold spell in the Northern Hemisphere. In Europe, energy consumption even shrank for the year as a whole. This was caused by the effect of the ongoing financial and sovereign debt crisis on the real economy, the statistical effects of the development of renewables, and higher energy efficiency. Increased electricity prices, especially in Germany, are a major driver for the higher energy efficiency. In contrast, the US economic recovery has led to increased energy consumption associated with the high availability of inexpensive energy (unconventional gas) and declining CO_2 emissions. The situation in the Middle East has escalated as a result of the nuclear issue in Iran, the aftereffects of the "Arab Spring", and the civil war in Syria. The resulting fear of an oil shortage pushed crude oil prices at times over USD 120 per barrel. The G8 industrialised nations decided to fall back on strategic reserves in the event of an increasing trend in scarcity. At the same time OPEC reacted and dampened prices by lifting its production quotas. The global economic downturn in the second half of 2012 however led to a decline in oil and gas consumption, and a fall in gas prices in the USA. This impacted the upstream businesses of the major international oil and gas companies, where results were down for 2012.

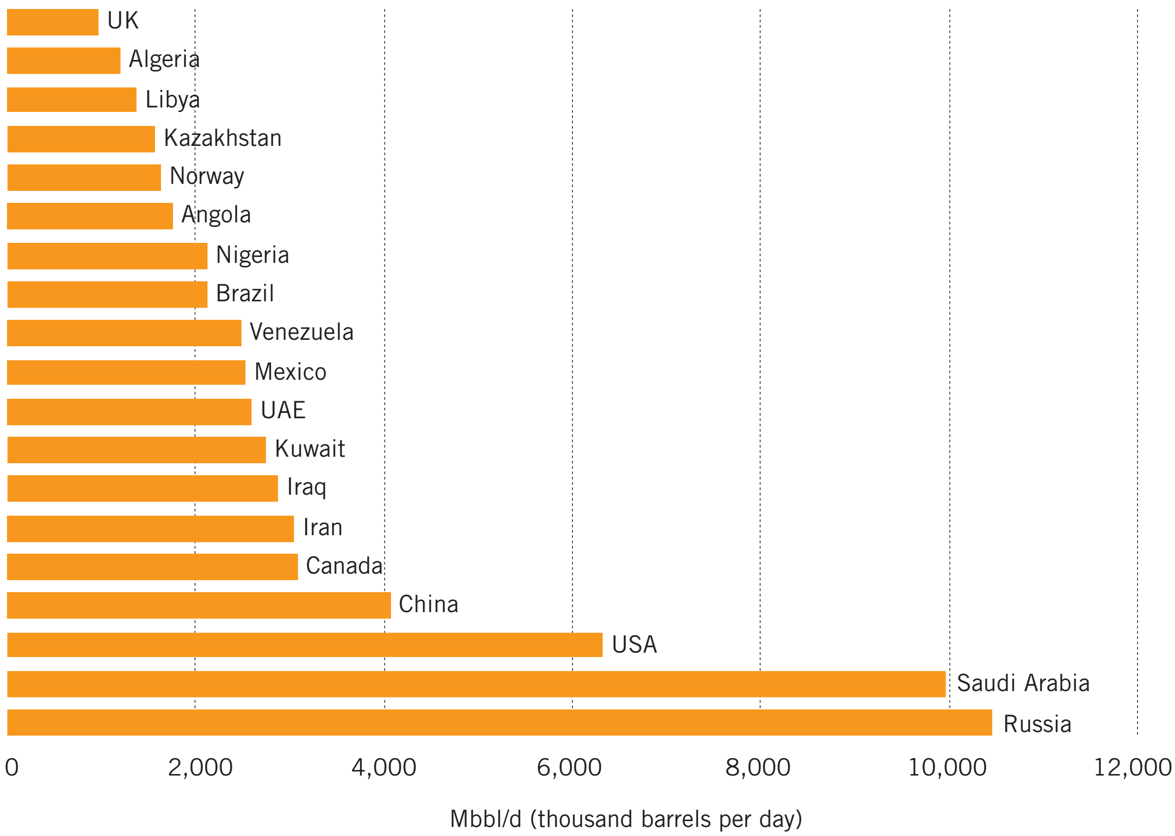
In total, world economic growth fell to 3.2 % from a previous year level of 3.9 %. In 2012, German gross domestic product grew by only 0.7 %. At the same time, primary energy consumption rose by 0.8 %. Renewable energies recorded growth of almost 8 %, and significant increases in consumption compared with the previous year could also be observed with lignite (+5 %) and hard coal (+3 %).

Figure 2.1: Global primary energy consumption 1970-2012, by energy source (in BTCE)



Sources: BP Statistical Review of World Energy 2012, IEA World Energy Outlook 2012, EIA International Energy Outlook 2010, Weltenergierat – Deutschland estimates

Figure 2.2: Daily production of the most important oil producing countries in 2012



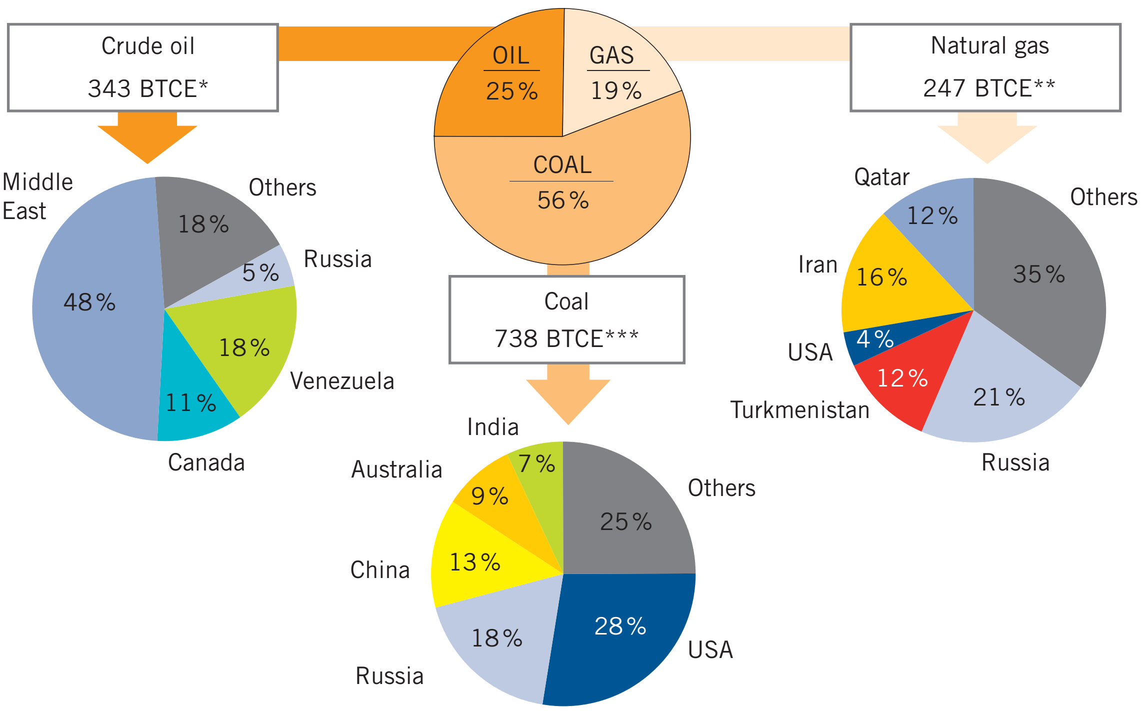
Source: IEA, Oil & Gas Journal, 2012

On the other hand, there was almost no change in oil and natural gas consumption, and nuclear energy was cut back according to plan (-8 %). The reasons for this lie in the energy transition and its consequences, as well as the prevailing weather conditions. In contrast, at the international level, varying degrees of economic growth were responsible for an increase in energy consumption. China once again recorded the largest growth in gross domestic product (+7.8 %), although this was 1.5 % lower than the previous year's figure. At the same time energy consumption in China increased by only 3.9 %, indicating a decoupling of the two variables. The economies of the Southeast Asian countries Indonesia, Malaysia, Singapore, Thailand, Vietnam and the Philippines grew around 6 %, considerably more than the previous year. GDP in the developing and newly industrialised countries increased in total by 5 %. In India, economic growth slowed to around 4.5 % from a previous year level of 8 %, indicating that India's hunger for energy will not grow in the unchecked manner that China's has. The reasons for this lie in India's efforts to promote modern technologies and advanced energy systems more vigorously. Economic growth in other industrialised countries was around 2 % (e.g. USA +2.3 %, Japan +2 %, Canada +2 %). Only the Eurozone fell short of expectations, with growth of -0.4 %.

A moderate increase in global primary energy consumption of around 19.1 BTCE in 2012, despite the significant slowing of growth and crisis in the euro area, can be largely attributed to the continuing economic upturn in Asia and the strength of continuing economic recovery in the USA.

Individual energy sources recorded different rates of growth with respect to their share of global energy consumption: coal (+3.3 %), natural gas (+2.4 %), oil (+0.7 %), renewable energy (+2.9 %) and nuclear energy (+1.9 %). Global coal production grew last year more strongly than other energy sources, increasing by around 3.3 % and recording absolute production of 5.3 BTCE.

Figure 2.3: Global reserves of energy sources



*) equivalent to 1,653 billion bbl, **) equivalent to 208 trillion m³, ***) equivalent to 861 billion tonnes

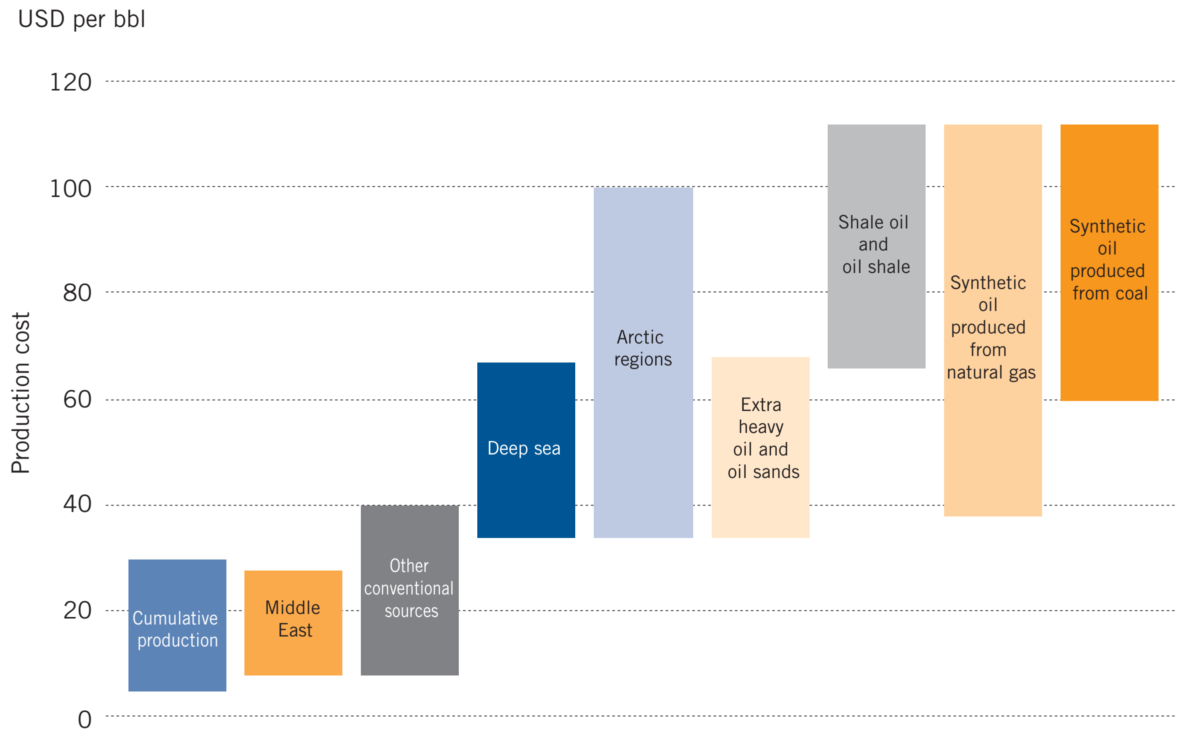
Source: BP Statistical Review of World Energy, 6/2012

China is still the world's largest consumer of coal, where it accounts for slightly more than 50 % of production and consumption. In terms of absolute quantity, oil is the most important energy source worldwide, with global consumption of 5.9 BTCE. Sufficient supply of oil is accordingly important. Despite some concerns, the OPEC member countries (Algeria, Iran, Kuwait, Libya, Iraq, Nigeria, Qatar, Saudi Arabia, the UAE and Venezuela) raised production levels in 2012, from a previous year quantity of 28 million barrels per day to 31 million barrels per day. The decreased oil price in the second half of 2012 indicates that the situation in the oil market has relaxed considerably as a result.

Natural gas consumption significantly increased to 4.1 BTCE, driven by the gas hype in the USA. In total, fossil fuels constitute around 80 % of global energy consumption, but the renewable energies of hydropower, wind, biomass and solar energy are catching up. In 2012, the 2.7 BTCE of renewable energy consumed already comprised a share of over 14 % of total global energy consumption. Although nuclear energy still achieved some limited growth, signs indicate that the nuclear industry is losing importance worldwide due to the "Fukushima effect". According to the most recent status report, within the last 18 months a total of 21 nuclear facilities have been shuttered (this includes the six Fukushima reactors), while progress on planned new construction projects is dragging on, raising doubts that these will be completed.

Questions of security of supply with regard to energy and raw materials occupy governments and businesses worldwide, but approaches to the issue vary greatly. The industrialised nations have thus far left it to the private sector to establish security of supply and to act in an accordingly forward-looking manner, but are increasingly putting in place environmental and energy policy conditions. In contrast, major energy projects and plans relating to raw materials are state controlled in most newly

Figure 2.4: Production cost of oil by deposit and stage of development



Sources: IEA, WEO 2011: BGR, Energy Study 2012, Energy Resources 2009

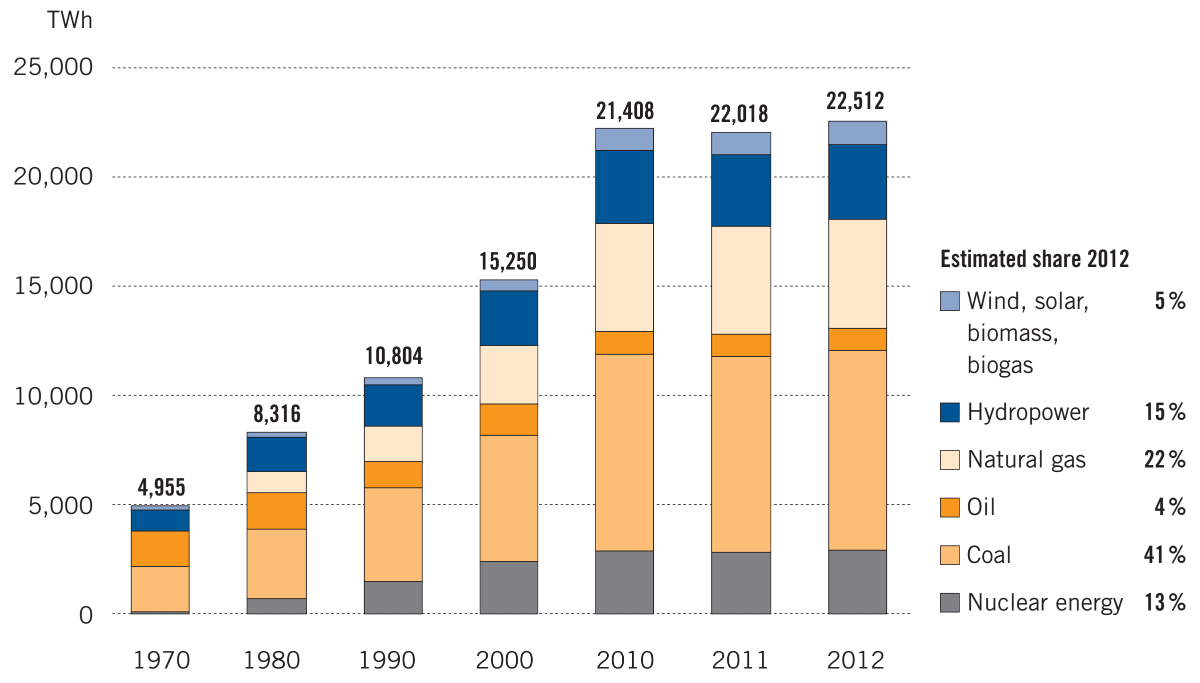
industrialised countries. China provides a good example of active political efforts to secure in the long-term the supply of energy resources.

Fossil fuels vary according to geographical distribution and quantity. Coal has the largest reserves by far, followed by oil and gas. The deposits are geographically concentrated to varying degrees. Whereas conventional crude oil deposits are concentrated in the Middle East, coal deposits are located principally in the Northern Hemisphere – in the USA, Russia and, as mentioned, in China. Natural gas deposits are distributed across various regions, and are frequently associated with oil deposits. The increasing development of unconventional oil and gas deposits has resulted in a shift in geographical and geopolitical focus. With the bulk of energy resource consumption shifting from OECD countries to non-OECD countries, interest in exploration, production and processing projects also shifts. This creates new, very different regional markets which can differ significantly with regard to production costs and the application of environmental and social standards. A comparison of production costs for oil illustrates the differences depending on the nature of the deposit (see Figure 2.4).

There is still a considerable imbalance for individual energy resources with regard to the ratio of consumption to reserves, even if conventional sources are increasingly being complemented by unconventional oil. Gas is in a similar situation. It remains likely in the coming years that natural gas will be increasingly utilised across many parts of the world, due to its inexpensive price and environmental advantages. Low natural gas prices influence many other production and infrastructure projects throughout the entire energy sector.

In 2012, electricity consumption and electricity generation increased globally in pace with total demand of energy. Secure supply of electricity is of paramount importance for prosperity, growth and social security. This is especially true for regions of the world that do not yet have complete electricity coverage. A global population growing at an estimated rate of 70-80 million people a year results in a steadily increasing need for electricity.

Figure 2.5: World net electricity generation 1970–2012 by energy source, in TWh



Sources: BP Statistical Review of World Energy 2012, IEA World Energy Outlook 2012, Weltenergierat – Deutschland estimates

According to the first preliminary estimates, global electricity generation increased by around 2.2 % in 2012.

The fossil fuels coal and natural gas slightly increased their share of global energy production in 2012. Generating 41 % of global electricity, coal is still in first position, far ahead of natural gas in second position with its share of 22 %. Renewables also increased their share compared to the previous year, with hydropower, wind, solar and bio energies comprising around 20 % of global electricity generated. This can largely be attributed to an increase in electricity generated by biomass and biogas, as well as the "new" renewable energies such as wind power and photovoltaics. Nuclear energy's contribution to global electricity generation (13 %) didn't increase as much as the previously mentioned energy sources did in comparison to the previous year. Electricity generated by oil, which still plays a role in many countries, decreased slightly in 2012.

2.2 COP-18 in Doha

All-in-all, although no visible progress was made towards a new international climate regime at the climate change conference in Doha in autumn 2012, the conference was not a complete failure. The decisions made in Doha generally confirm the decisions made in Durban in 2011, and the road map adopted in Bali in 2007. This is however in line with expectations in the run-up to the COP 18. The climate conference participants indicated that the present voluntary reduction commitments of individual countries to 2020 under the Durban platform are insufficient to limit warming to 2.0 °C or 1.5 °C.

Overview of the Outcomes

KYOTO-PROTOCOL: The 27 EU countries along with ten further countries extended the Kyoto Protocol to the end of 2020 through binding fixed reduction targets (see Table 2.1). The EU wishes to reduce its greenhouse gases by 20 % by then (from the base year of 1990). Excluding Australia, the remaining ten countries are not major emitters: the current Kyoto Protocol covers fourteen percent[1] of global greenhouse gas emissions. The extension of the Kyoto Protocol has the advantage that the already agreed methods of measurement and reporting of emissions will be kept, as well as the complex implemented and proven procedures. This can then provide the basis for future negotiations, if other countries follow suit.

1 Source: CDC climate research: All greenhouse gas emission data for 2008 from the EDGAR model.

Japan, New Zealand and Russia no longer have internationally binding targets in the Kyoto Process. Canada has withdrawn. Although the USA signed the 1997 agreement, it has never ratified it.

EMISSIONS TRADING (Emissions Trading Scheme ETS): The EU ETS can be integrated in a yet-to-be-established international regime with an internationally uniform carbon price. In addition to market-based instruments, carbon taxes are being given more consideration as instruments.

GREENHOUSE GASES: Nitrogen trifluoride (NF_3) has been added to the six previously recognised greenhouses gases. It is used in the production of flat screens and solar cells, and as a substitute for fluorocarbons. As a greenhouse gas it is more than 17,200 times damaging to the climate than CO_2.

FINANCES: From 2020, USD 100 billion per year shall be made available to the Green Climate Fund[2], and industrialised countries (including Germany) have already provided USD 4.554 billion for the administration. The mandate for the provision of long-term finance has been extended to the end of 2013. This has once again post-

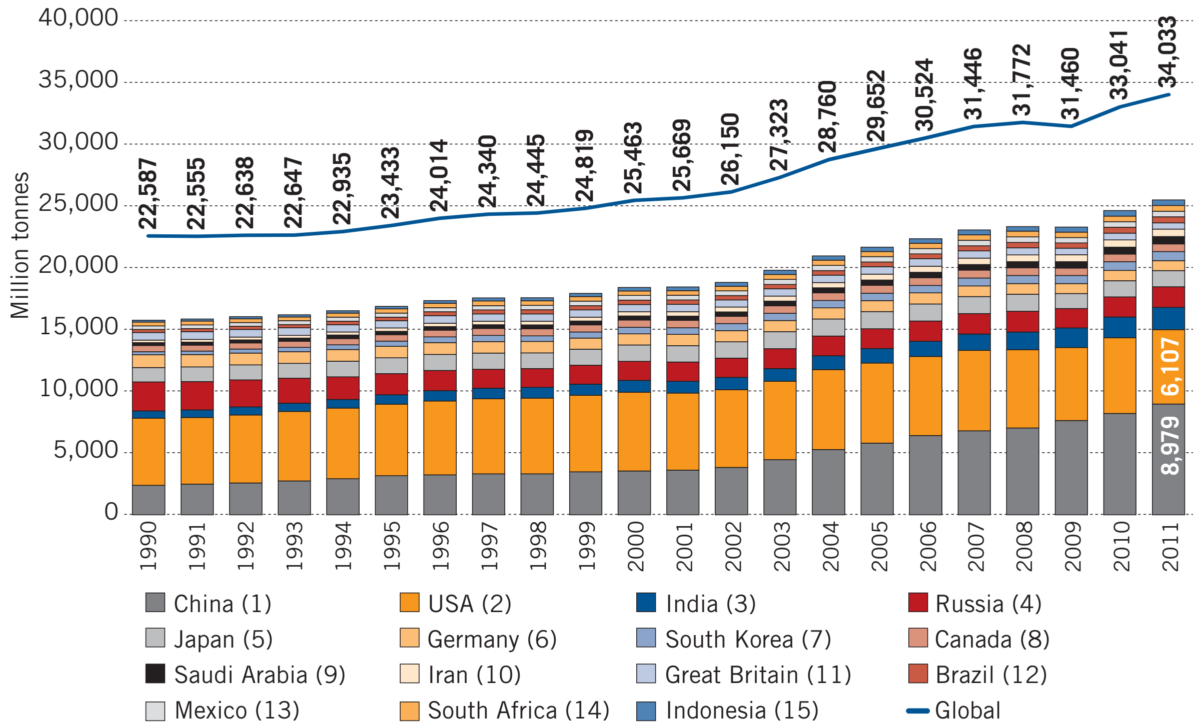
2 The Green Climate Fund (GCF) was first mentioned in 2009 in the Copenhagen Accord, and was formally established in 2010 in Cancun. In 2011 in Durban the GCF was recognised as an operating entity of the UNFCCC's financial mechanism, and it was decided that it should be provided with rules and policies by the COP 18 in 2012, so that it can begin its work. Incheon in South Korea was selected as host of the GCF.

Table 2.1: The Kyoto commitments and 2020 targets for the EU-27 and ten further countries

Country	Emissions in base year (in $MtCO_2eq$)	Reduction commitment for 2008-2012	Reduction target for 2013-2020
Australia	548	+8 %	–0.5 %
EU-27	5,772	–7.9 %	–20 %
Iceland	3	+10 %	–20 %
Kazakhstan	360	n/a	–5 %
Croatia	31	–5 %	–20 %
Liechtenstein	0.2	–8 %	–16 %
Monaco	0.1	–6 %	–22 %
Norway	50	+1 %	–16 %
Switzerland	53	–8 %	–15.8 %
Ukraine	921	0 %	–24 %
Belarus	139	n/a	–12 %
Total	**7,878**	**–6 %**	**–18 %**

Source: CDC climate research

Figure 2.6: Global CO_2 emissions



The 15 largest emitters are responsible for almost three-quarters of global CO_2 emissions. As at 2011.
No EU member country is in the top five.

Source: BP, Statistical Review of World Energy 2012

poned decisions regarding the financial contributions of industrialised countries to the Green Climate Fund.

GLOBAL CLIMATE TREATY: A roadmap to negotiate a comprehensive climate treaty by 2015 was agreed upon. The treaty should be completed in 2015, so that it can come into effect in 2020. The USA will also take part in the negotiations. The signatories to the Framework Convention of 1992, all countries including the USA, confirmed the principles adopted in the 2007 Bali Action Plan, namely that industrialised countries should submit measurable and verifiable mitigation options, including quantitative emissions reductions. Developing countries should also develop measurable and verifiable national mitigation options.

The international community had already decided in Durban that a legally binding outcome should be agreed by 2015 and come into effect by 2020. However, a plan with milestones to reach this goal was not defined either in Durban or Doha. Thus it essentially falls to the next two COPs to bring the UN process to a successful conclusion. However, this will not be easy:

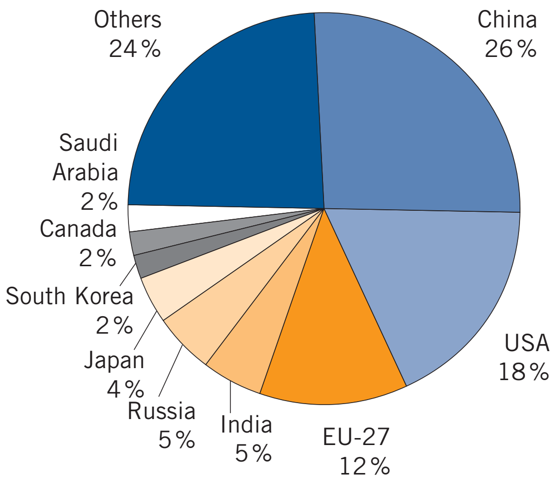
- The differing positions of China and the USA will remain in the coming years, or barely converge.

- In the decade between 2000 and 2010, global CO_2 emissions grew by 30 %, significantly faster than in the previous decade (1990-2000), where they grew by 13 %.

There is no common consensus in the EU regarding the future path to be taken.

Between 1990 and 2001, global CO_2 emissions rose by almost 51 %, from 22.6 billion tonnes to 34.0 billion tonnes. The growth in emissions originates largely from the economically prospering countries of China and India. During this period of time, emissions in China increased by 6.6 billion tonnes (+276 %), and in India by 1.2 billion tonnes (+209 %). Emissions also increased in the USA, by 0.6 billion tonnes (+11 %). On the other hand, the IEA expects that emissions from the USA will actually decrease in future, as gas is being increasingly used in electricity generation and goods transportation.

Figure 2.7: Individual country share of CO_2 emissions



Source: BP, Statistical Review of World Energy 2012

Among the major emitters in 2011, only three countries reported reductions in comparison to 1990. Russia leads the field, with a reduction of 0.675 billion tonnes (-29 %), followed by Germany with 0.228 billion tonnes (-22 %) and then the United Kingdom with 0.111 billion tonnes (-18 %). In total, the three countries achieved reductions of 1.013 billion tonnes in this timeframe, though this is less than the growth in India alone for the same period of time.

The COP 19 will take place from 11 November to 22 November 2013 in Warsaw (Poland). A South American country shall be selected to host the COP 20.

2.2.1 Global Greenhouse Gas Emissions Trading Systems

Although the December 2011 Durban negotiations between the parties with regard to a global emissions trading system from 2020 onwards were disappointing, there are some countries or regions outside the EU that make use of emissions trading systems, or plan to introduce them. The setting of absolute emissions caps allows emissions trading systems to achieve climate protection objectives with a great deal of accuracy.

The introduced European Emissions Trading System (EU ETS), binding since 2005, now includes direct greenhouse gas emissions from larger plants in the industrial and energy industries in the 27 EU Member States. Currently the non-EU countries Norway, Iceland and Liechtenstein are bilaterally linked to this agreement. Switzerland already possesses its own emissions trading system alternative to a carbon tax, and, according to the German Federal Ministry for the Environment, could join the European system in 2014. Covering around 2 billion tonnes of carbon dioxide equivalent (CO_2eq), the EU ETS is the largest emissions trading system in the world, even if it only represents around 3-4 % of global emissions.

Emissions trading systems are in operation or are being prepared in other regions of the world. They are however very differently structured with respect to their methodology and scope, and thus of limited compatibility.

In the USA, the RGGI has covered energy production in the US states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont since 2009. Covering less than 200 million tonnes of CO_2eq, it is considerably smaller than the EU ETS. Although the US House of Representatives approved the American Clean Energy and Security Act in June 2009, the bill for the national emissions trading system was defeated in the US Senate. Irrespective of this, California has recently implemented its own emissions trading system covering 170 million tonnes of CO_2eq. California plans to establish an emissions trading system together with the Canadian provinces of British Columbia, Manitoba, Ontario and Quebec as part of the Western Climate Initiative (WCI). This emissions trading system would cover around 800 million tonnes of CO_2eq annually. The establishment of a national, standardised system is relatively unlikely also during Obama's second term.

New Zealand has also had its own emissions trading system for a number of years, covering around 100 million tonnes of CO_2eq. The inclusion of additional sectors in 2013 has made the system more extensive. In the summer of 2012, the EU Commission delivered a surprise when a linking of the EU ETS with the Australian ETS was agreed upon in bilateral negotiations with Australia. The Australian emissions trading system covers around 360 million tonnes of CO_2eq, and although it hasn't officially commenced, Australian companies will be able to buy EU emission allowances to satisfy their obligations from July 2015. From mid-2018 at the latest, EU companies will also be able to purchase emission allowances from Australia.

Emissions trading systems are also being established in Asia. Japan is currently conducting preliminary work to establish a Japanese emissions trading system. Japanese climate policy has however become difficult to predict after the tsunami in 2011 and the change of government at the end of 2012. South Korea plans to develop the existing target setting system with industrial companies into a national emissions trading system. This is intended to limit greenhouse gas emissions to 812 million tonnes of CO_2eq within two three-year phases, from 2015 to 2020. In Kazakhstan the first trading period is scheduled to begin following a pilot phase from 2013 to 2015. This will last to 2020 and cover 155 million tonnes of CO_2eq.

Activity can also be seen in China, the world's largest CO_2 emitter. As part of its five year plan from 2011 to 2015, China intends to develop a work plan for the control of greenhouse gas emissions. Pilot projects are to be drafted for emissions trading systems in five cities and two provinces (Beijing, Tianjin, Shanghai, Chongqing and Shenzhen, as well as Hubei and Guangdong). In addition to the central objectives of monitoring emissions and target setting, the pilot projects should develop their own objectives for specific targets and for the industries, plants and trading platforms covered. The pilot projects cover less than one billion tonnes of CO_2eq, and have a planned implementation date in 2014. National introduction will later be decided on, based on the experience of these projects.

Linking different emissions trading systems is possible as trade always takes place using the same unit (CO_2eq). This is economically desirable as it incentivises the cheapest reduction measures. A prerequisite for linking national and regional systems is that emissions are reliably monitored and verified.

However, political decision makers may be reserved about linking emissions trading systems with each other, depending on, for example, differing levels of ambition, generous use of alternative measures (offset measures) and the scope of use of project certificates from third countries (CDM, JI). European governments and businesses will closely observe to what extent European companies will have competitive disadvantages hardened by national governments' generous allocation of emission allowances to competing companies. Nevertheless, a strategy of linking emissions trading systems early on is to be recommended, as it accelerates the gradual convergence of ETS regulations.

Establishing and linking regional emissions trading systems reduces obstacles to achieving a global climate treaty for the period after 2020. This treaty should be agreed upon (at latest) at the 21st Conference of the Parties on Climate Change in 2015. Emissions trading systems are thus of particular importance in the rapidly industrialising and dynamically developing newly industrialised countries, which have, up to now, not had to observe any upper limit to emissions. Methodologically speaking, there are no workable alternatives to an absolute limit to global greenhouse gases (especially CO_2) in the pursuit of effective protection. The active use of the cheap coal, oil and gas deposits known today alone suffices to raise global temperatures many times over the 2 °C maximum agreed by the international community. Without binding global emission limits, these fuels will be used without restraint, and their emissions released.

2.3 Global renewable energy supply

In pre-industrial times, the world's energy supply was largely based on renewable energy sources: water power and wind were used in mills; biomass (wood, dung, etc.) were converted to heat. In the course of the industrial revolution, fossil energy fuels, and later also nuclear energy, easily overtook the renewables. Slightly more than half of the renewable energy produced in the world (around 8.5 % of global energy requirements) still comes from the "traditional" renewable energy sources, primarily biomass such as gathered wood, agricultural waste and by-products or dung.

The "modern" renewable energy sources are of similar importance to the "traditional" sources, covering 8.2 % of global energy requirements. Only a decade ago this figure was less than 3 %. If the importance of renewable energies in global energy supply is increasing, this can be attributed to the modern renewable energy sources such as hydropower, wind power and solar energy but also the use of modern biomass and biofuels.

According to the Renewable Energy Policy Network, two-fifths of modern renewable energy sources are converted to heat (including biomass, solar thermal energy and geothermal energy). Another two-fifths come from electricity generated in hydroelectric power plants. The remaining fifth of global modern energy sources comes from electricity generated by wind, sun, biomass or geothermal sources, as well as a small share generated by biofuels.

Electricity generation with renewable energy

By the end of 2011, the amount of electricity generated globally by means of renewable energy amounted to 1,360 GW. This was equivalent to more than 25 % of global power plant capacity, which produced more than 20 % of the world's electricity for the year.

More than 70 % of electricity generated by renewables currently comes from hydropower (970 GW). The largest capacities, totalling 380 GW, can be found in the BRICS countries. China alone generates more than 200 GW.

At the end of 2011, wind turbines generated almost 240 GW, and accounted for a 17.5 % share of global renewable power plant capacity. These are located primarily in the European Union (94 GW), followed by China (62 GW) and the United States (47 GW).

Installations generating electricity from solar power had a global capacity of almost 72 GW at the end of 2011. This is equivalent to around 5 % of global renewable electricity capacity, or an increase of around 75 % on the previous year's figures. The most important solar technology is photovoltaics (70 GW). Solar thermal energy contributed a comparatively minor amount. More than a third of global photovoltaic capacity was installed in Germany (25 GW), and almost a fifth in Italy (13 GW) by the end of 2011.

Biomass is directly converted into heat or electricity, as well as liquid fuels. In addition, the production of wood pellets as an intermediate product for heat and electricity generation has increased in importance in recent years. At the end of 2011, installations converting biomass into electricity summed to 72 GW globally. These plants are concentrated in the United States, Brazil and Germany.

Geothermal energy is a renewable energy source of enormous theoretical potential. It could cover the world's energy needs 100,000 times over. At the current level of technology however, only a small portion of locations with geological anomalies are viable. At the end of 2011, plants converting geothermal energy into electricity had a capacity a little over 11 GW, with most of these located in the United States. The conversion of wave or tidal energy into electricity is not at a globally significant level.

Outlook

The importance of renewable energy in global energy supply will further increase. The International Energy Agency (IEA) expects that renewable energy's share of global power production could increase from today's level of 20 % to slightly more than 30 % by 2035 (New Policies Scenario). Regional differences could however be considerable. For example, in 2035 renewable energy could cover more than 40 % of electricity requirements in the European Union, but less than 30 % in China, and only just over 20 % in the United States.

According to these projections, hydropower will remain the most important renewable energy source. The IEA expects that 500 GW of new hydropower facilities will be constructed in the next 20 years, mainly in Asia and Latin America.

The IEA further expects that installed global wind power capacities will also increase sharply. Development could occur primarily in the European Union, but also, for example, in the United States, China and India. Installed wind power capacity could increase to 1,098 GW by 2035, with 175 GW being installed offshore.

Installed photovoltaic capacity could also increase strongly to more than 600 GW by 2035.

Opportunities and challenges

The development of renewable energy throughout the world is supported by policy with incentives of every kind. These should, for example, achieve lower emissions of the so-called greenhouse gases and air pollutants. That aside, economic policy is also a factor in support for renewable energy, with the objective of becoming independent from (imported) fossil fuels, or creating jobs by investing in renewable energy.

The IEA expects that renewable energy across all sectors will actually avoid more than 4 gigatonnes of greenhouse gas emissions up to 2035. Electricity generation will contribute the most here, avoiding 3.6 gigatonnes, particularly through the use of wind power. Around 5 million jobs have been created in the renewable energy sector. This is approximately equivalent to all of the jobs in a small industrialised country, like the Czech Republic. 1.6 million of these jobs (around a third) have been created in China.

These advantages contrast with the generally high investment costs and low contribution to secured capacity involved with renewable energy.

According to the IEA, more than 60 % of investments made in electricity production up to 2035 could be allocated to renewable energy. This would total more than USD 6 trillion (inflation-adjusted). Just over a third of this could be invested in wind power, around a quarter in hydropower and a bit over a fifth in photovoltaics. Industrialised countries would contribute around USD 3 trillion to this, as would the developing and newly industrialised countries.

Investments of this scope can however only be made when the public sector continues to financially support development of renewable electricity generation. In 2011, electricity producers using renewable energy sources (excluding large-scale hydropower) received subsidies and other support totalling USD 64 billion globally. The majority of this went to photovoltaics (USD 25 billion) and wind power (USD 21 billion). The European Union spent the most money on support of renewable energy – almost USD 40 billion was paid in financial support for renewable electricity generation just in 2011. Only just over USD 10 billion was spent in the United States in the same period of time.

The IEA estimates that the amount spent on financial support for photovoltaics will increase to almost USD 80 billion (inflation-adjusted) by the end of the coming decade. At the same time there will be regions where photovoltaics are competitive without state support. Funding for wind power on land will further increase up to 2020, and then fall again at an inflation-adjusted rate of USD 14 billion per year, as wind power on land becomes competitive.

The cost competitiveness of individual renewable energy sources does not however solve the issue that wind and solar power capacity is dependent on changing weather conditions. Wind and solar power make only a small contribution to covering the annual peak load. This shortfall could be mitigated in future by additional storage, links to controllable hydropower or bioenergy sources, as well as improving load management. Nevertheless, the IEA estimates that 300 GW of additional conventional plant capacity must still be created and maintained by 2035 to provide sufficient electricity at any time.

Table 2.2: Global renewable electricity generation, in GW

Electricity generation with	Year	Global	EU-27	BRIC(S)	China	USA	Germany	Spain	Italy
Hydropower	2011	970	120	383	212	79	4	20	18
	2035	1,685	169	732	420	113	n/a	n/a	n/a
Wind power	2011	238	94	80	62	47	29	22	7
	2035	1,098	288	441	326	161	n/a	n/a	n/a
Offshore component thereof	2011	4	4		0	0			
	2035	175	70		46	18			
Biomass	2011	72	26	18	4	14	7	1	2
Solar power	2011	72	52	4	3	5	29	6	13
PV component thereof	2011	70	51	4	3	4	25	5	13
	2035	603	146	209	113	68	n/a	n/a	n/a
CSP component thereof	2011	2	1	0	0	1	0	1	0
	2035	72	12	19	14	11	n/a	n/a	n/a
Geothermal energy	2011	11	1	0	0	3	0	0	1
	2035								
Other	2011	0	0	0	0	0	0	0	0
	2035	15	9	0	0	1	n/a	n/a	n/a

Sources: Renewable Energy Policy Network, Renewables 2012 Global Status Report; IEA, World Energy Outlook 2012

2.4 Turning point in Japan's electricity supply?

By Hiroshi Sasamata, A.T. Kearney Tokyo and Jochen Hauff, A.T. Kearney Berlin

In 2011, important decisions regarding Germany's energy transition were significantly influenced by the events in Japan. This article offers a brief review of the consequences of the devastating earthquake of 11 March 2011 on the Japanese electricity sector, and provides a short overview of the energy policy scenarios currently being debated in Japan.

Japan's electricity sector, before and after Fukushima

The impact on the Japanese electricity sector can still be clearly felt two years after the tsunami catastrophe, with its immeasurable human tragedy. Since the disaster and safety shutdowns of all nuclear reactors, capacity bottlenecks have threatened during the high consumption summer months. The projected reserve capacity available for the summer of 2012 was only 0.3 % of the expected load.[3]

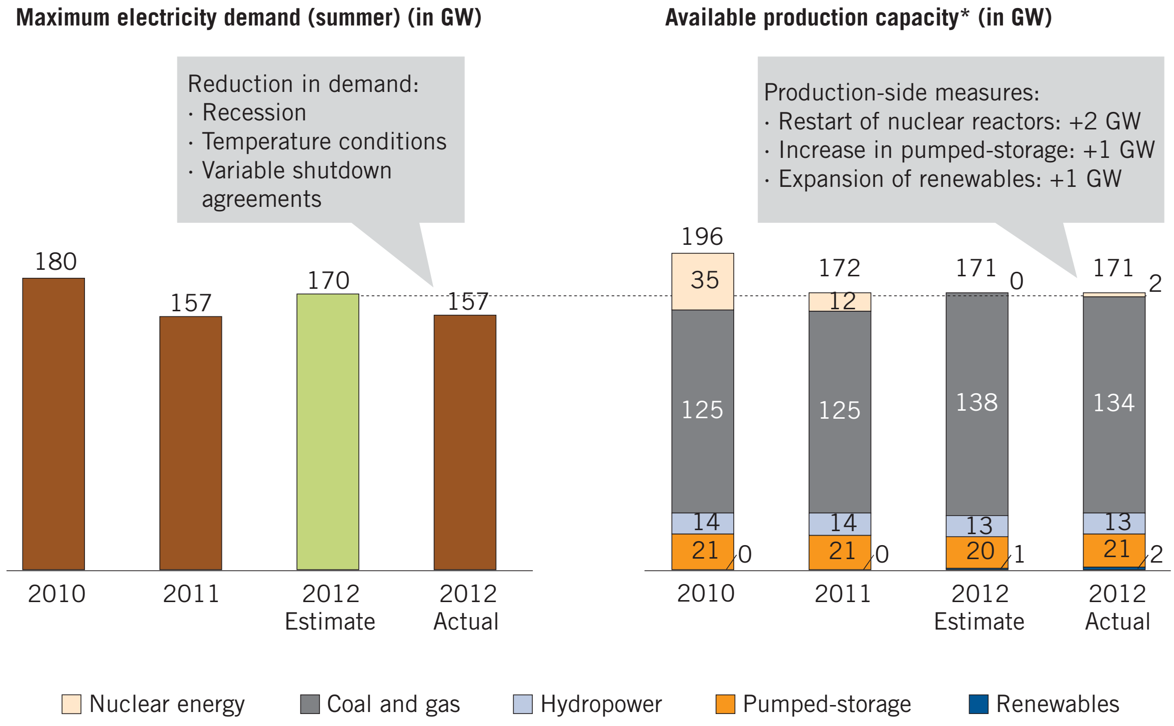
In addition to reduced production in the export industry as a result of the catastrophe, liquefied natural gas (LNG) imports in particular have resulted in a decrease of 44 % in the current account balance from 2010 to 2011, and a negative balance at the beginning of 2012.[4] Imported volumes of LNG increased by around 14 % from the 2nd half of 2010 to the 2nd half of 2011. At the same time, the price for LNG increased so strongly that costs for LNG imports in 2011 were over 35 % higher than in 2010.[5]

3 The Electricity Supply-Demand verification Committee.

4 Statistics Bureau, Monthly Statistics, Table F 09.

5 Ibid., Table N 01; See also IEEJ: Japan Energy Brief, No. 18, March 2012.

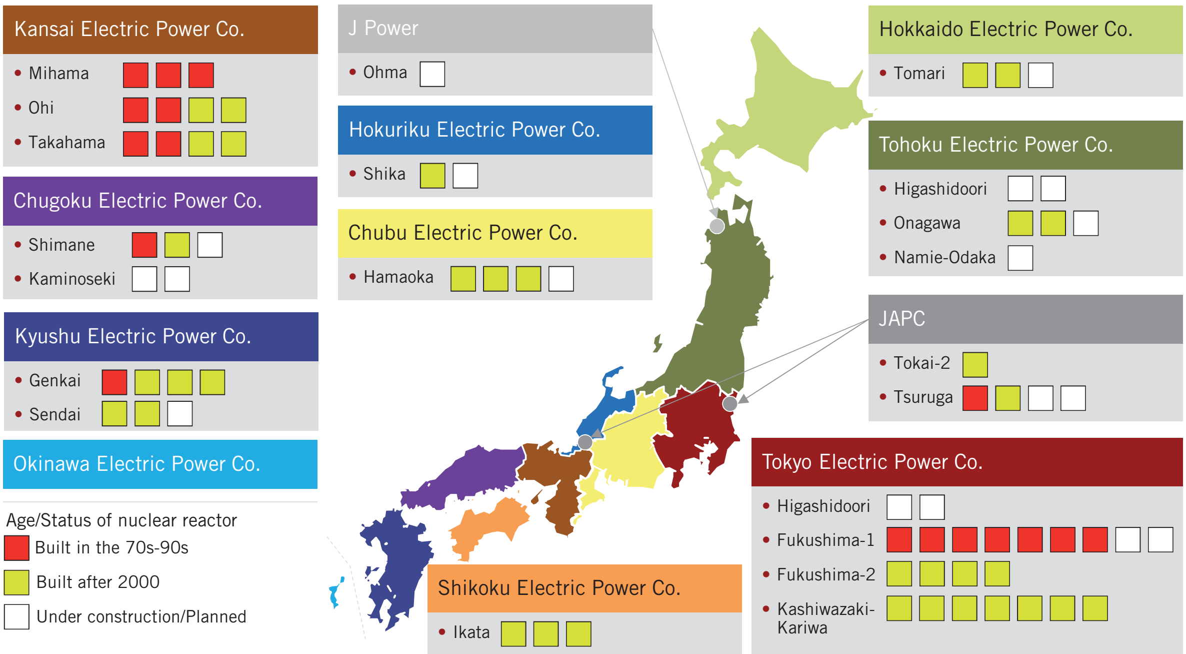
Figure 2.8: Capacity situation of Japanese electricity supply in summer, 2010-2012



* Spring 2012 Projections made by the Commission as well as the actual development, including the restarting of the Ohi 3 & 4 reactors.

Source: The Electricity Supply-Demand verification Committee. Quoted in: Nagatomi, Institute for Energy and Economics in Japan (IEEJ) January 2013

Figure 2.9: Energy supply company coverage areas and nuclear power plant portfolios



Source: GENI: http://www.geni.org/globalenergy/library/national_energy_grid/japan/japanesenationalelectricitygrid.shtml; Japan Energy Brief No. 17, January 2012

Oil fired plants were also reactivated, which resulted in around a doubling of fuel consumption in 2011 as compared to 2010.[6] In total, the value of all imported energy sources increased by almost 39 % between 2010 and 2012, amounting to around €200 billion in 2012. This comprised more than 30 % of all goods imported to Japan.[7]

The financial situation of Japanese energy supply companies has deteriorated significantly, as government and the public put significant pressure on companies to limit electricity price increases. In addition to foregoing revenue from the shuttered nuclear power plants, the plant operators face claims for compensation and have to conduct considerable investments in new safety measures or dismantle plants that have been permanently shuttered. As a result, significant price increases were announced for end customers in 2013.

The summer capacity situation for Japanese electricity production illustrated in Figure 2.8 shows, for 2010, 196 GW of available capacity to cover a maximum demand of 180 GW, representing a significant reserve margin of over 8 %. In 2011, the safety shutdowns of numerous nuclear plants reduced capacity by 24 GW. A similar fall in demand of 23 GW meant there were no national capacity bottlenecks. Regional bottlenecks were able to be managed through the cooperation of energy supply companies.[8] The regional distribution of the Japanese electricity sector illustrated in Figure 2.9 shows the differing importance of nuclear energy from region to region.

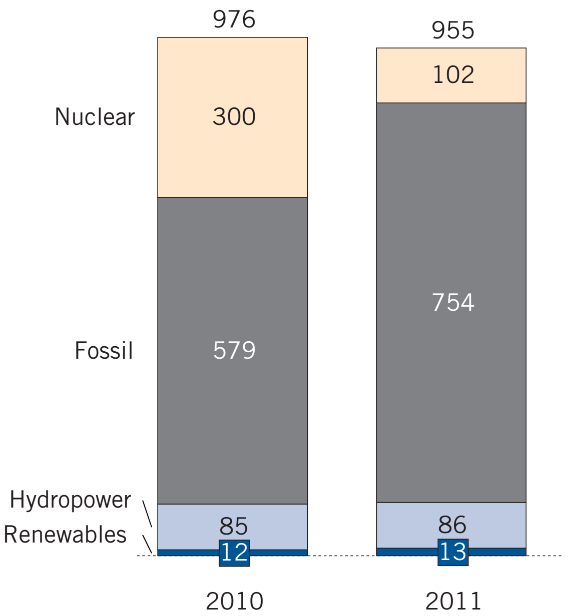
This massive fall in demand can be partly attributed to the slowdown in industrial production. In addition to this, voluntary and binding savings measures were introduced. For example, air conditioning in public buildings and offices was strictly controlled. This resulted in a total decline in electricity production of about 2.2 %, from 976

6 JEPIC, Operating and Financial Data.

7 WEC Japan, Fukushima Report No. 7. March 25, 2013; see also Japan External Trade Organization (JETRO) Japan's Trade and Investment Statistics, www.jetro.go.jp.

8 Hayashi, M., Hughes, L. The policy responses to the Fukushima nuclear accident and their effect on Japanese energy security. Energy Policy (2012).

Figure 2.10: Electricity generation, by technology
in TWh



Source: Agency for Natural Resources and Environment, "The white paper on energy usage 2012"

TWh in 2010 to 955 TWh in 2011.[9] Figure 2.10 demonstrates how the starting up of conventional gas and coal power plants was able to compensate for the collapse of electricity generation from nuclear energy. In preparation since 2009, a renewable energy bill was finally passed in August 2011. Under this bill, photovoltaic systems over 10 kW receive very high feed-in-tariffs equivalent to €0.39/kWh over 20 years. Systems less than 10 kW even receive an equivalent of €0.41/kWh, but only for a period of 10 years. With this heavy subsidisation the government achieved an expansion of 1.3 GW in photovoltaics in 2011[10], and around 2 GW in 2012.[11]

In the spring of 2012, a capacity bottleneck for the following summer was predicted, and further demand and supply side measures were taken. Supported by favourable temperatures and the ongoing recession, bottlenecks in supply were avoided in 2012 as well. However, regional differences (not displayed in Figure 2.8) proved problematic. It was, for example, necessary to decree the restarting of the Ohi 3 and 4 reactors to overcome the bottleneck in the Kansai region, where interruption-free supply could not be secured despite supply from other grid areas.

In September 2012, against the background of having successfully overcome the bottlenecks of summer 2012, and the results of official surveys indicating that 47 % of the population favour a complete phase-out of nuclear energy,[12] the Noda cabinet made the landmark energy policy decision to prospectively phase out nuclear energy. The "Innovative Strategy for Energy and the Environment" set forth by the Noda cabinet has been criticised by the new Prime Minister, Shinzõ Abe. In contrast, he has not ruled out the restarting and even development of new nuclear reactors.[13] These demands now find themselves in a difficult political environment and today most commentaries expect only a restart of reactors that have passed safety checks by the independent safety authority. Figure 2.11 describes the fundamental scenarios for future development.

The probabilities of the scenarios occurring are subject to considerable uncertainty due to the highly dynamic political environment in Japan. The role of local and regional administrations is especially hard to evaluate. As a rule, these have a say in the restarting of shuttered nuclear plants after safety tests have been conducted. The new construction of plants or further investment in an established location is also unlikely without the approval of regional administrations. The results of national surveys and the energy policy decisions of the administration in Tokyo are, as in Germany, only one of many factors involved in an energy transition in Japan.

According to our evaluation, the sequence of scenarios 1 and 2 presented in Figure 2.11 seems likely. The early return of a policy directed towards further development of nuclear energy (as was the case prior to Fukushima) and presented in scenario 3, is unlikely. On one hand, as responsibility for nuclear regulation has only been recently taken on by a new body, safety checks are progressing slowly.[14] In addition, it can be expected that numerous

9 GENI: http://www.geni.org/globalenergy/library/national_energy_grid/japan/japanesenationalelectricitygrid.shtml; Japan Energy Brief No. 17, January 2012.

10 Kaizuka, I. Net billing schemes and evolution to net export FiT – experience from Japan. IEA PVPS Workshop, Frankfurt, September 2012.

11 EPIA Market report 2012.

12 Inajima, T. and Okada, Y. Japan citizens favour zero nuclear in debate over energy options. Bloomberg, 22. August 2012. http://www.bloomberg.com/news/2012-08-22/japan-finds-47-of-citizens-support-zeronuclear-power-option.html.

13 Abe: New plants to be built. Daily Yomiuri, 1 January 2013.

14 See also: Murakami, T. Developments and issues in restarting nuclear power stations. IEEJ e-Newsletter No. 9, December 2012 and No. 12, March 2013.

Figure 2.11: Scenarios for future development in the Japanese electricity sector

1	**Nuclear plants not restarted, or only restarted in isolated cases. Full focus on development of coal, gas and renewables** • Newly established Nuclear Regulation Authority refuses operational approvals following safety tests due to, among other factors, insufficient local approval. • Accelerated development of conventional and renewable capacities, and significant efforts to increase energy efficiency	**Probable in the short-term**
2	**Partial restart of tested nuclear power plants, but plants granted a limited service life, thus achieving a long-term (beyond 2030) phase-out of nuclear energy** • Presupposes strong growth in conventional and renewable capacities, as well as demand-side measures • Resistance expected in some locations, but, generally speaking, the restarts will relatively broadly accepted by public opinion	**Probable in the long-term**
3	**Reinstatement of a growth initiative for nuclear energy, including further investment in existing locations and construction of new plants within the next 10 years** • Accompanied by a moderate development of renewable capacity and further energy efficiency measures • High levels of uncertainty with respect to feasibility and costs.	**Unlikely**

Source: A.T. Kearney

plants will be permitted to restart only once new safety measures are implemented. In consequence, it is unlikely that further reactors will be started within the next 1-2 years. Exceptions could only occur as an emergency measure for individual cases to deal with regional capacity bottlenecks, as was the case with Ohi 3 & 4 in 2012. Restarts seems even less likely in the medium term if new suppliers and improved conditions for LNG can be found, and at the same time improvements in energy efficiency are made as well as further development in renewables. These measures will be pursued as high priorities, making it quite likely that Japan will have its own sustainable energy transition in the medium to long term.

Energy in the European Union

3

3.1 Facts & figures

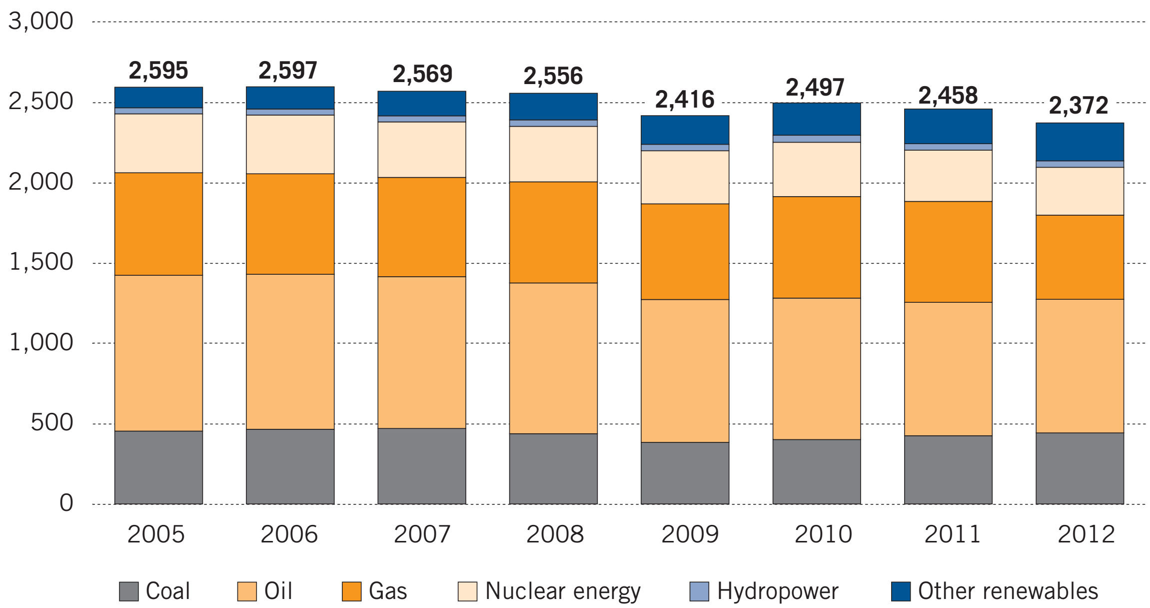
Primary energy consumption

Up to 2008, primary energy consumption in the EU-27 was relatively constant, totalling around 2.6 BTCE per annum. In 2009, the economic crisis resulted in a drop in consumption by around 5 %, to 2.42 BTCE. The industrial sector felt the main impact, due to its direct link with economic growth, whereas business and households were only slightly affected. Primary energy consumption had already recovered by the following year of 2010 to 2.5 BTCE, although it did not reach 2008 levels. In 2011 and 2012, primary energy consumption fell slightly once again, with a 2012 level of slightly less than 2.4 BTCE. This can be partially attributed to ongoing economic difficulties as a result of the Eurozone crisis, particulary in the southern EU countries. The reduction in total energy consumption resulting from the continued development of renewable energy also played a role. The substitution of conventional energy sources by renewable energy, especially in the electricity sector, reduced total consumption as the power plants' own consumption is omitted. In addition, the increased efforts being focussed on increasing efficiency in the EU-27 started showing to show their initial effects.

The targets for primary energy consumption remain unchanged – to achieve a reduction of 20 % by 2020 in comparison to earlier projections for 2020. This means a remaining total consumption of around 2.1 BTCE in 2020. The development of primary energy consumption over the last three years is thus generally on course. Further efforts however need to be made to reach the 2020 targets. The fact that the recent fall in primary energy consumption was influenced by the (temporarily) weak economic development in some EU countries also needs to be taken into consideration. This reduction in consumption can potentially be again compensated for in coming years, resulting once more in higher rates of consumption. Progress with respect to energy efficiency was achieved in all EU-27 countries. In addition, not all options for increasing energy efficiency have been exhausted, particularly with respect to building heating and industrial processes. To achieve this, support programmes have to push the corresponding modernisation measures. The new EU Energy Efficiency Directive will certainly further support this process.

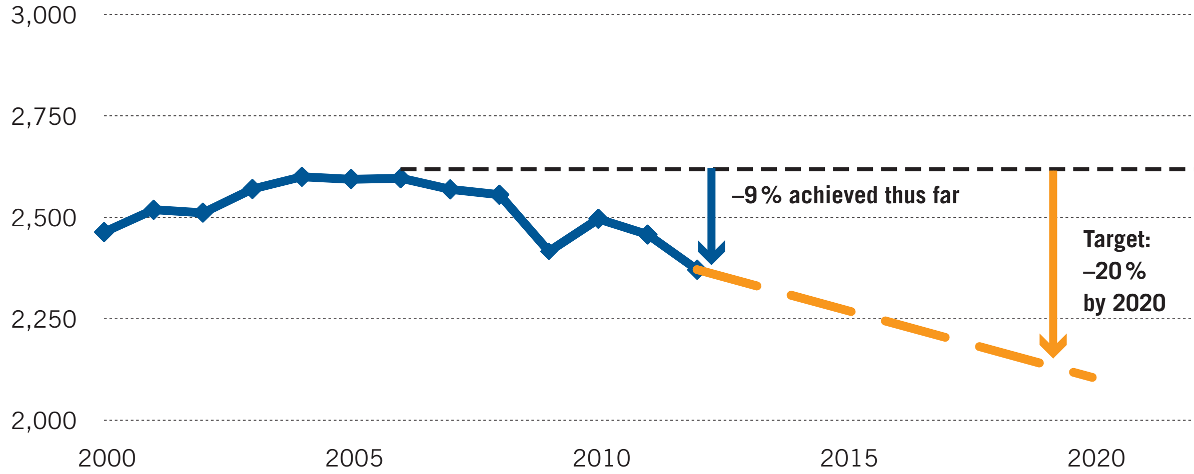
Clear shifts can be seen in the energy mix constituting primary energy consumption in 2012. These shifts were not just with respect to further development of renewable energy, where the share of consumption was increased from around 9 % in 2011 to 10 % in 2012 (excluding hydropower). Development took place largely in the electricity sector, and has thus far focussed on the established technologies of onshore wind power and solar photovoltaics. Offshore wind power will also sharply in-

Figure 3.1: EU-27 primary energy consumption, 2005–2012, in MTCE



Sources: Eurostat, IEA statistics, BP statistics, Weltenergierat – Deutschland estimates

Figure 3.2: EU-27 primary energy consumption, reduction targets for 2020, in MTCE



Sources: Eurostat, IEA statistics, BP statistics, Weltenergierat – Deutschland estimates, EU Energy Efficiency Directive

crease in importance in the future, as planning has started and approvals have already been granted for offshore wind parks in numerous countries, such as Germany, Great Britain and France. In 2012, renewable energy contributed an additional 20 MTCE, taking its total to around 240 MTCE for the year. Despite the development of renewable energy, conventional energy sources (fossil fuels and nuclear energy) are still dominant, constituting around 88 % of the EU-27's energy supply. Fossil fuels alone contribute a share of 76 %.

Amongst the fossil energy sources there was a shift of around three percentage points from gas to coal in 2012. This development in the electricity sector (among other sectors) resulted from both low carbon prices and relatively high gas prices. Both factors together make electricity generation from coal more economic than from gas. Nuclear energy's contribution fell by 20 MTCE from 2011 to 2012, but, given the generally lower consumption, nuclear energy's share remained almost stable. The reduction resulted mainly from the shutting down of nuclear power plants in Germany during 2011. In addition, individual power plants were shut down in Great Britain as they had reached the end of their service life.

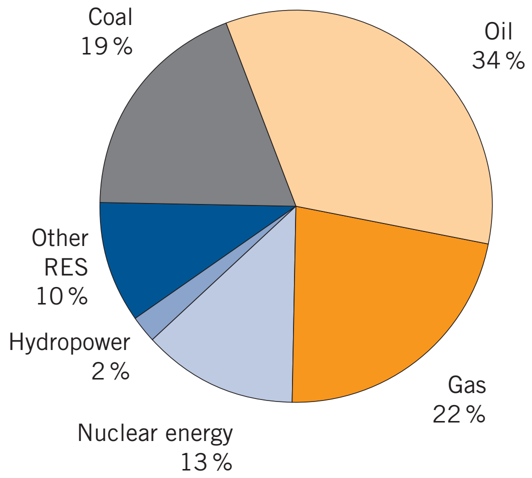
From 2011 to 2012, consumption of the conventional energy sources of coal, oil, gas and nuclear energy demonstrated, at times, very different patterns of development in individual countries. Whereas consumption decreased in almost every EU country, it actually increased in Spain. The 2012 increase in Spain can however be regarded as a "delayed" recovery from the general collapse that occurred in 2009, a recovery which had already taken place in most other countries in 2010 or, at latest, 2011. The changes in energy consumption largely reflect the economic developments in the countries: For example, France and Italy were particularly impacted by economic crises in 2012. In general, the previously described increase in coal consumption at the EU-27 level can be observed in most countries.

Figure 3.5 provides an overview of the very different energy mixes in primary energy consumption for selected EU-27 countries. Fossil fuel's share varies from a minimum of 37 % in Sweden, to a maximum of 89 % in Italy, with the proportion of coal and gas in particular differing sharply. On the other hand, oil's share, driven largely by consumption in the transport sector, is fairly similar across different countries. Poland stands out with its use of coal, as its 54 % share is way above the EU average. As it is well known, nuclear energy is strongly dominant in France. Nuclear energy is also one of the most substantial pillars of energy supply in Sweden, in addition to hydropower and oil. Renewable energy, including hydropower, constitutes a share of around 8-11 % on the whole. Exceptions here are Sweden, with 34 %, and Austria with 56 %, due to hydropower's large share. Great Britain presents an exception on the other side of the scale, where renewables have so far only accounted for 3 % of the energy mix. These very different mixes in energy are determined on the one hand by the respective resource situation in the various countries, and on the other hand by their energy policy orientation. The individual countries energy policies are based on different assessments of fuel and carbon price developments, security regulations for nuclear power and support of renewable energy. The different rationales of the various EU countries will pose challenges for a common energy policy within the EU-27 also in the future, but also offers options for national optimisation of the energy mix on the path to an EU-wide, secure, environmentally friendly and economic supply of energy.

Electricity

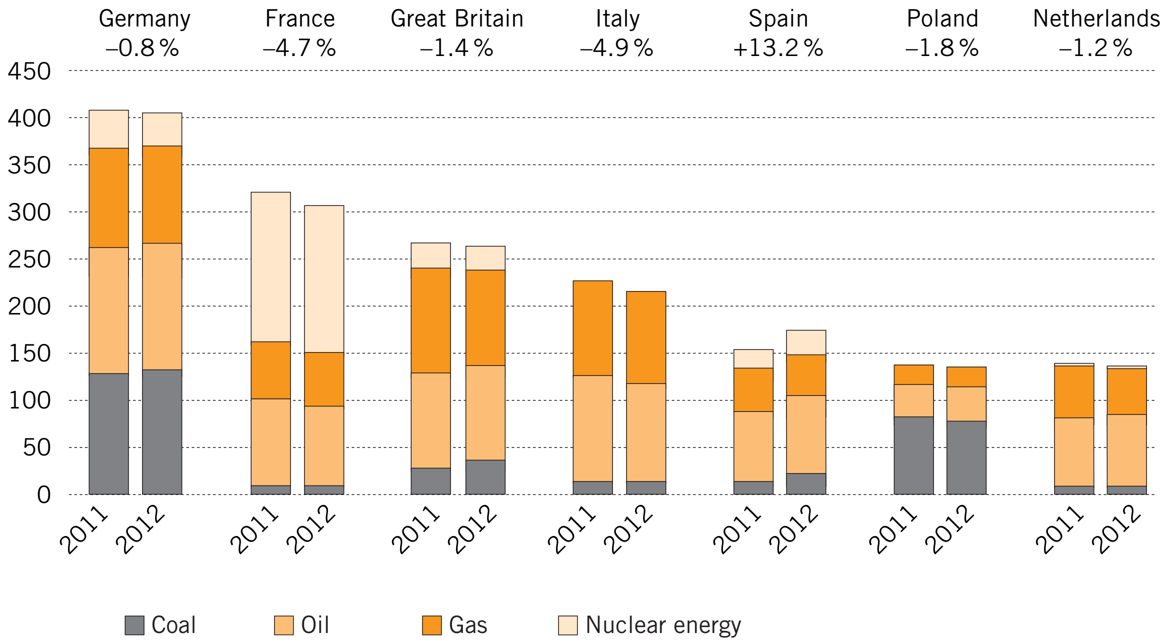
Gross electricity production in the EU-27 has been relatively flat in comparison to other geographic regions, and its development is very similar to that of primary energy consumption. The record level was between 2006 and 2008, at around 3,340 TWh, but in 2009 production fell to less than 3,200 TWh due to the economic crisis. Electricity production was however less impacted by the economic crisis than primary energy consumption, and production had already almost returned to pre-crisis consumption levels by 2010. Nevertheless, over the last three years, electricity production has fallen continuously, but moderately. In 2012, gross electricity production was around 3,270 TWh, representing a fall of 0.3 % on the figures from 2011. The relatively constant consumption of electricity in contrast to falling primary energy con-

Figure 3.4: Structure of EU-27 primary energy consumption, 2012, 2,370 MTCE



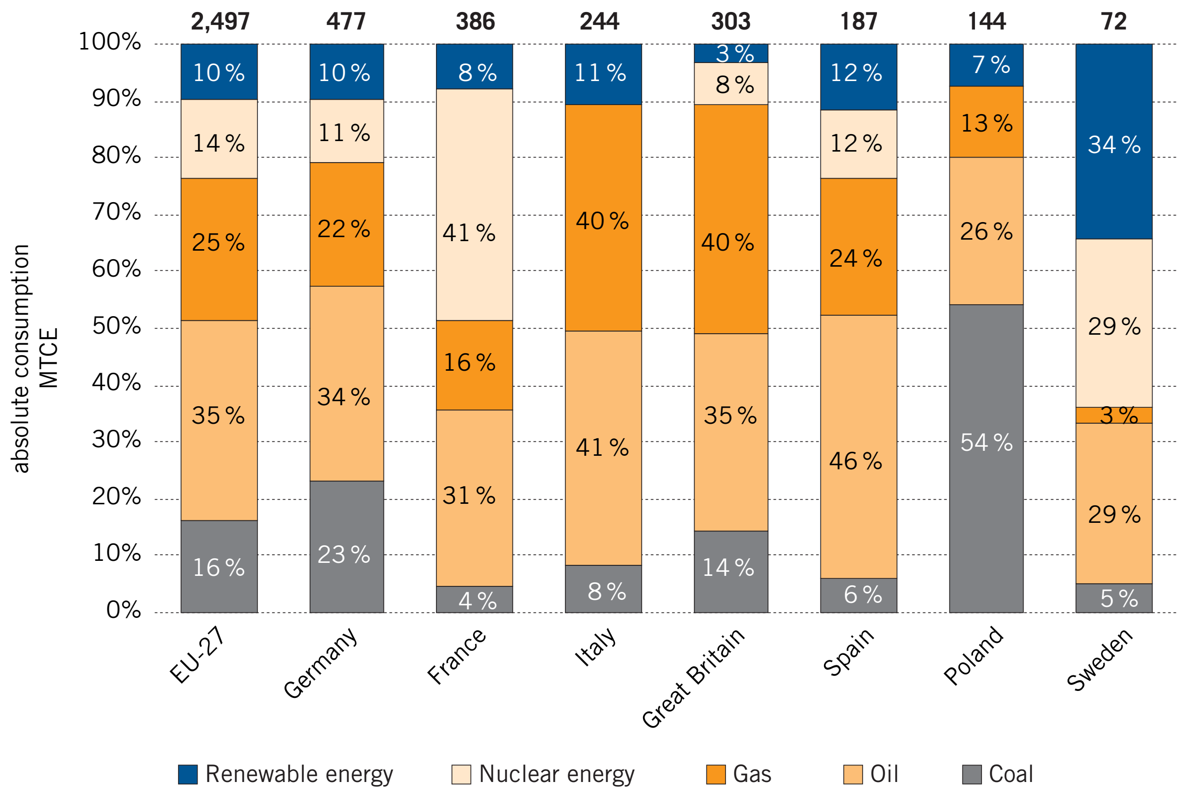
Sources: Eurostat, IEA statistics, Weltenergierat – Deutschland estimates

Figure 3.3: Conventional primary energy consumption (coal, oil, gas and nuclear energy) in selected countries, 2011 and 2012, in MTCE



Sources: Eurostat, Weltenergierat – Deutschland estimates

Figure 3.5: Primary energy mix in the EU-27 and selected countries, 2010



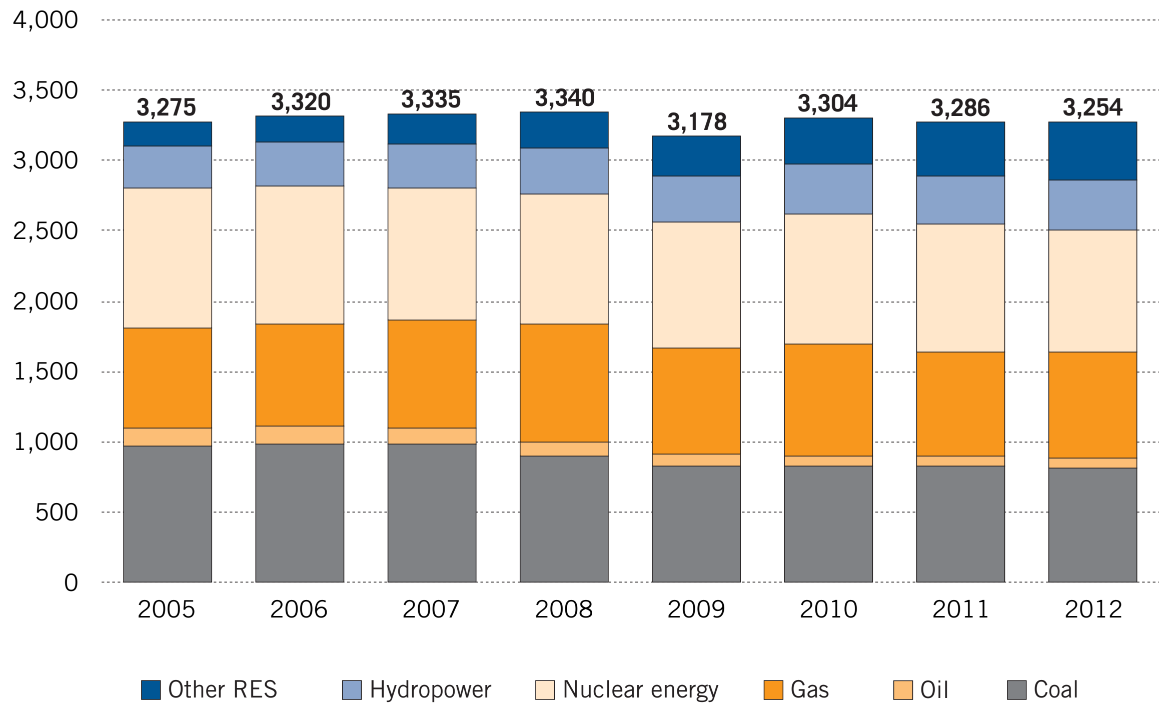
Sources: Eurostat, IEA statistics

sumption reflects the trend of increasing electricity-consuming industries in place of primary energy-consuming heavy industry. In addition to this, electricity consumption rose in households and public services.

The energy mix in electricity production is shifting continuously in the direction of renewable energy. Whereas during 2005 renewable energy (including hydropower) still accounted for a 14 % share, in 2012 it had increased to more than 23 %. Its share rose by a further percent point even in 2012, despite numerous countries curtailing support measures. New installations of wind and photovoltaic facilities suffered barely any losses resulting from the financial crisis. Photovoltaics in particular were able to reach a new record in 2011 and 2012 against a background of falling system prices and the announcement of cutbacks in support. Renewable energy's contribution to electricity generation varies sharply across the individual member countries of the EU-27. The largest share of production from renewable energy is reported by countries with traditionally high production from hydropower, such as Austria, Sweden and Latvia, where renewables contribute 60-70 %. Once hydropower is excluded, Germany, Spain, Italy and Great Britain lead in terms of having the highest absolute generation of electricity from wind power, photovoltaics and biomass.

Despite the further significant development of renewable energy, fossil energy sources are still dominant in electricity generation, maintaining their 50 % share in 2012. Among the fossil energy sources, coal and gas are virtually neck and neck, contributing respective shares of 25 % and 23 %. In recent years, a shift from coal to gas could be observed, but this trend was interrupted in 2012. The increased electricity production from renewable energy tended to be at the cost of gas power plants. In many countries within the EU, negative "spark spreads" (the difference between the wholesale electricity price and the variable production costs) could be observed for gas-fired power plants. Nuclear energy's share dropped from around 28 % in 2011 to around 27 % in 2012. The main cause for the decline was the 2011 clo-

Figure 3.6: Development of EU-27 gross electricity generation, 2005-2012, in TWh



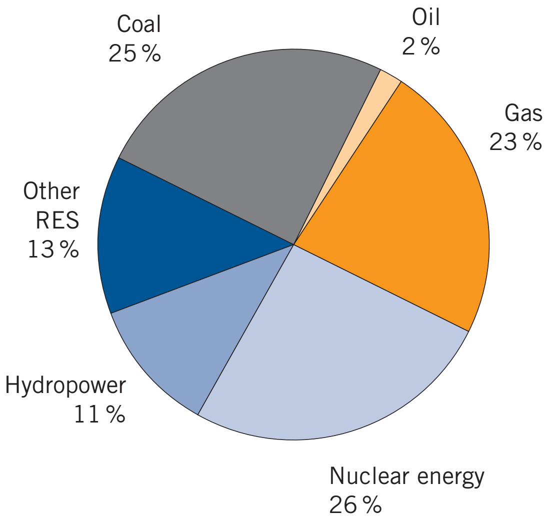
Sources: Eurostat, IEA statistics, Weltenergierat – Deutschland estimates

sure of eight nuclear power plant units in Germany as a consequence of the decision to phase out nuclear energy following the accident in Fukushima. In addition to this, a number of older plants were decommissioned in Great Britain.

Hydropower continues to be clearly dominant among renewables, with a share of 11 %. Once hydropower is excluded, wind power claims the lead, with a share of more than 6 % of total production. Up to now, this has primarily come from onshore wind farms. However, offshore wind parks are expected to increase in the coming years. Wind power is followed by biomass, with a share of around 5 %. Electricity produced from solar energy has demonstrated the fastest growth in recent years, but its share in electricity production across the EU up to now has been confined to less than 2 %. In 2012, almost 30 GW of new photovoltaic capacity was installed around the world, 7.6 GW of this in Germany alone. The EU-27 had by far the greatest global share of new installations once again in 2012. However, due to the prospective decrease in support for these systems in numerous EU countries, it can be expected that expansion will no longer reach these record figures in future.

Whereas electricity production demonstrated a flat development from 2005 to 2012, installed power plant capacity increased continuously over this period. Conventional power plants with high capacity factors are being increasingly complemented by renewable energy plants with significantly lower load factors dependent on natural resources. This is particularly pronounced with photovoltaic systems, which in the EU-27 produce an annual mean of around 1,000 full load hours. In 2012, installed EU power plant capacity totalled more than 1,000 GW. This is equivalent to around one fifth of global power plant capacity. Fossil fuels contributed around 500 GW to this, nuclear energy 128 GW, hydropower around 150 GW, and all other renewable energy sources almost 190 GW. From 2010 to 2012, solar photovoltaics recorded the strongest growth by far, with annual growth of around 25 %. This was followed by onshore wind power, which recorded annual growth of around 7 %. Strong future growth is expected for offshore wind power as this technology is ready for commercial application. Decreased production could be observed with oil-fired and nuclear power plants.

Figure 3.7: Structure of EU-27 electricity production, 2012, 3,260 TWh



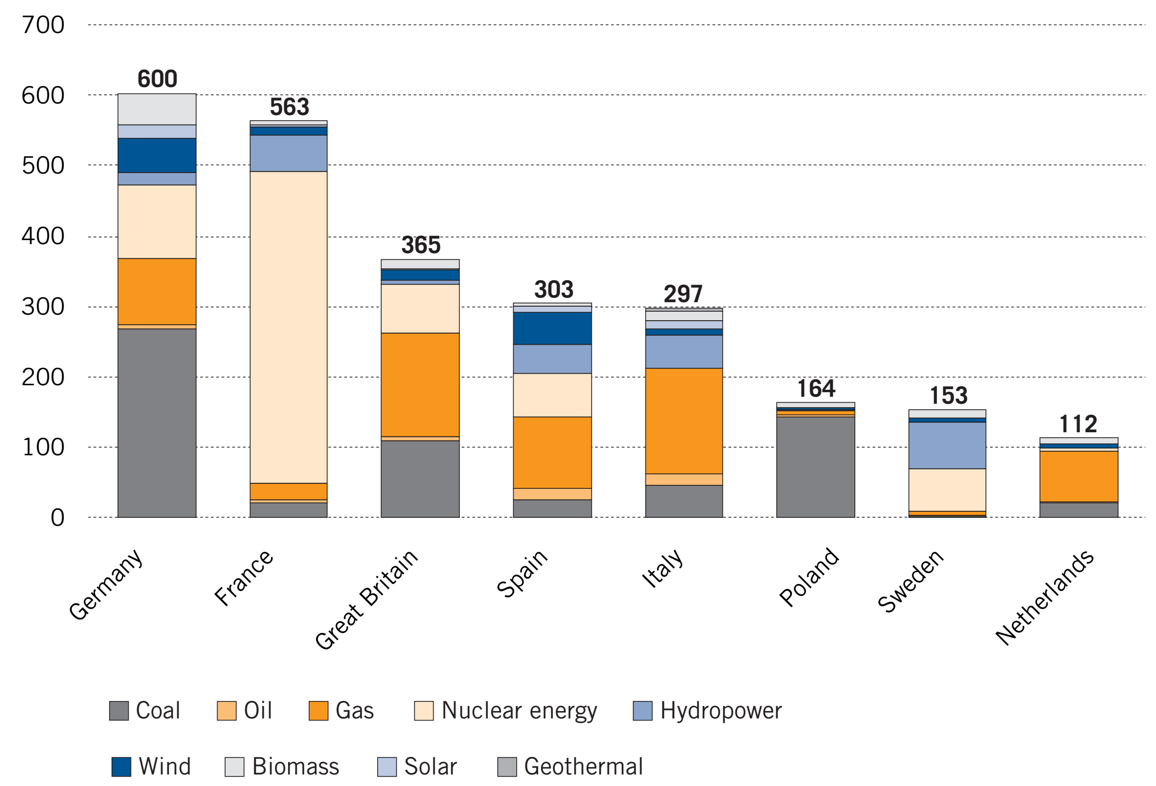
Sources: Eurostat, IEA statistics, Weltenergierat – Deutschland estimates

Summary – Outlook

Primary energy consumption has recently demonstrated a downward trend. Electricity consumption has remained largely stable. It should however be noted that consumption is still affected by the economic crisis and the Eurozone crisis. It is difficult to ascertain exactly what share of savings can be attributed to decreased economic activity, and what share of genuine savings are due to shifts in the energy mix from conventional to renewable energy (elimination of conversion losses) or improvements in energy efficiency.

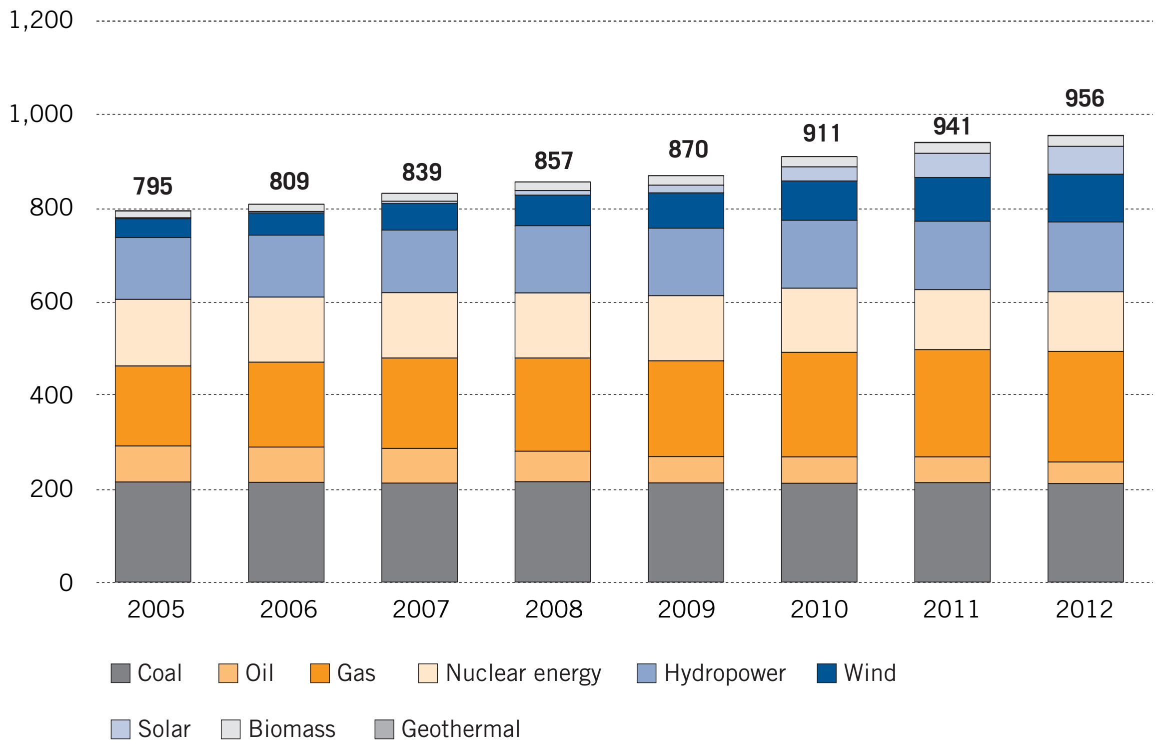
The realisation of the 2020 targets regarding reducing energy consumption, and the connected CO_2 emissions are dependent on this. New renewable energy installations have not yet suffered due to the economic crisis, or the following Eurozone crisis. On the contrary, installations of new solar photovoltaic systems were at record levels in 2011 and 2012. Although this development helps in achieving the targets, it is limited primarily to the electricity sector. Progress to date in the transport, indus-

Figure 3.8: Structure of electricity production for selected countries, 2011, in TWh



Sources: Eurostat, IEA statistics

Figure 3.9: EU-27 installed power plant capacity, 2005–2012, in GW



Sources: IEA statistics, Weltenergierat – Deutschland estimates

trial and building heating sectors is still quite limited, and requires further support and incentives.

The efficiency of renewable energy has significantly improved recently, particularly with respect to photovoltaics. Nevertheless, these energy sources will remain dependent on incentives for the foreseeable future. Opportunities for state support are however becoming increasingly limited, due to the problems numerous European governments face with budget deficits. Refinancing of feed-in tariffs by means of a reallocation charge on electricity prices is also reaching its limits, as the charges already comprise a significant share of the electricity price. Numerous countries (such as Germany, Spain and Italy) thus introduced limits on further solar photovoltaic systems in 2012. Greater focus has to be placed on costs with regard to the development of renewable energy.

The future development of nuclear energy is very differently evaluated within the EU-27. Whereas in Germany and Belgium the use of nuclear energy will be phased out in the foreseeable future, other countries (such as Switzerland and Spain) reject the construction of new reactors but advocate the extension of the service life of existing plants for an additional one to two decades. In addition, countries such as Great Britain, France, Finland and possibly also Poland plan new construction. Nuclear energy will thus also remain a future component of the energy mix in electricity generation among EU-27 countries.

In addition to the development of electricity generating plants, it can be expected that the development of electricity networks and storage facilities will increase in importance. In order to accomplish this, significant additional financial resources will be required. A pan-European, coordinated energy and electricity system offers advantages with respect to total costs in comparison to individual national solutions. The main policy challenges here are to push forward the move from uncoordinated national approaches to a pan-European solution. In addition to the development and integration of renewable energy, this also concerns the development of unconventional fossil fuels. These cannot be completely excluded from the EU even in the future, for reasons of security of energy supply.

3.2 Current focus of European energy policy

Adjustments to the European Emissions Trading System

On 12 November 2012, the European Commission submitted a proposal for a so-called "backloading" as a short-term response to the fall in carbon prices in the European Emissions Trading System (ETS). According to this, 900 million certificates would first be issued in 2019/20 instead of 2013/14/15. The Commission expects to be able to postpone the auction independently, as this approach would leave the total budget for emission allowances untouched. Nevertheless, the Directorate-General for Climate Action proposed an amendment to the Directive, according to which such interventions would be approved by the European Parliament and the Council of the European Union. The European Commissioner for Climate Action, Connie Hedegaard, regards the proposal as a test to see to what degree the European Parliament and the Council of the European Union will accept further structural measures. The first round of voting in the European Parliament indicated not insignificant scepticism from the members of parliament with regard to the requested intervention rights for withholding the allowances. Delaying the issue of allowances alone would only have a minor effect on allowance prices. Many market participants however expect that the withheld quantity will be permanently retained in the course of later structural measures, resulting in a smaller quantity of available certificates on the market and increasing prices.

In addition, the EU Commission published a report on the state of the European carbon market, in which six options are outlined for structural measures to support emissions trading:

a) increasing the EU's greenhouse gas emissions reduction targets for 2020 from 20 % to 30 % below 1990 levels;
b) permanently retiring a specific number of allowances;
c) revising the annual linear reduction factor;
d) bringing more sectors into the ETS;
e) limiting access to international credits; and
f) introducing price management mechanisms.

The proposals form the basis for a broad public debate and were published for consultation in February 2013. Options a) to c) are the most relevant. Option a), increasing the 2020 target, would have limited influence on investment decisions made by companies, as any plants currently being decided on would scarcely be in operation before 2020. As it is also unclear if the EU will successfully reach a global climate agreement, there is currently no direction for the years after 2020.

It would be much more sensible to set long-term reduction targets for the emissions trading sector for at least 2030.

Germany plays a decisive role in determining the position of the Member States. However, up to now, the German Federal Ministry for Economics and the German Federal Ministry for the Environment have not been able to agree on an approach. It can be expected that the current Commission will not submit any legislative proposals for structural measures in the emissions trading system. This step will likely be taken by the next EU Commission, which will come into power following the European Parliament elections taking place from 22 to 25 May 2014.

Completion of the EU internal energy market

On 15 November 2012, the European Commission published its (non-legislative) report on the internal energy market and announced further initiatives aimed at its completion. According to the Commission, the internal market is not an end in itself. The objective is an efficient, interlinked and flexible European internal market which "serves" the customer.

The most important announcements in the report are:

1. Member State consultation on capacity mechanisms by 7 February 2013,
2. new end user measures (the concept of the "vulnerable consumer", smart meters, price comparison tools, etc.),
3. the discrimination-free awarding of concessions,
4. the pursuing of infringement procedures against Member States who have not fully transposed the Third Energy Package directives (content on liberalisation of the electricity and gas markets),
5. revision of guidelines on State aid for environmental protection together with the Directorate-General for Competition,
6. supporting measures to make consumption more flexible,

7. the examination of the role of distributed network operators, as well as the phase out of regulated prices.

At the same time, the European Commission made the decision to formalise the “Electricity Coordination Group”. This group consists of high-level representatives from Member States, national regulators, ENTSO-E (European Network of Transmission System Operators for Electricity) and ACER (Agency for the Cooperation of Energy Regulators). The group has met since 2011 to discuss issues relating to cross-border electricity trade, network stability and security of supply.

The consultations on capacity mechanisms, which could lead to guidelines for their introduction in Member States, are highly relevant to Germany. The present capacity mechanisms in Ireland, Spain, Italy and Scandinavia, and the mechanisms announced for Great Britain and France, as well as the reservations of smaller neighbouring countries such as the Netherlands and Austria, show that the impact of connected markets in neighbouring countries should not be underestimated, and have to be assessed in implementation.

The revision of the guidelines for State aid for environmental protection can have direct impacts on EEG support. In this context it should also be noted that the Directorate-General for Competition initiated a state aid control process against Germany in November 2012, covering the special equalisation scheme provided for by the EEG, and the exemption of major electricity customers from network charges.

Despite the linking of Member States markets, the internal energy market is far from being a single market. Currently, of 27 Member States, only nine don’t have regulated end customer prices (Austria, the Czech Republic, Germany, Finland, Luxembourg, the Netherlands, Slovenia, Sweden and Great Britain). This not only obstructs competition for end customer sales, but is also a reason for the distorted competitive situation faced by electricity-intensive industry in the EU.

Germany is still attested with a relatively well developed electricity market in the report, but as the north-south network bottleneck demonstrates, undesired load flows to neighbouring states can be triggered. The Commission also recommends that Germany assesses the connections between electricity and gas demand, especially on cold winter days. Both are however points that the German Federal Government has itself already addressed.

3.3 European security of energy supply in change

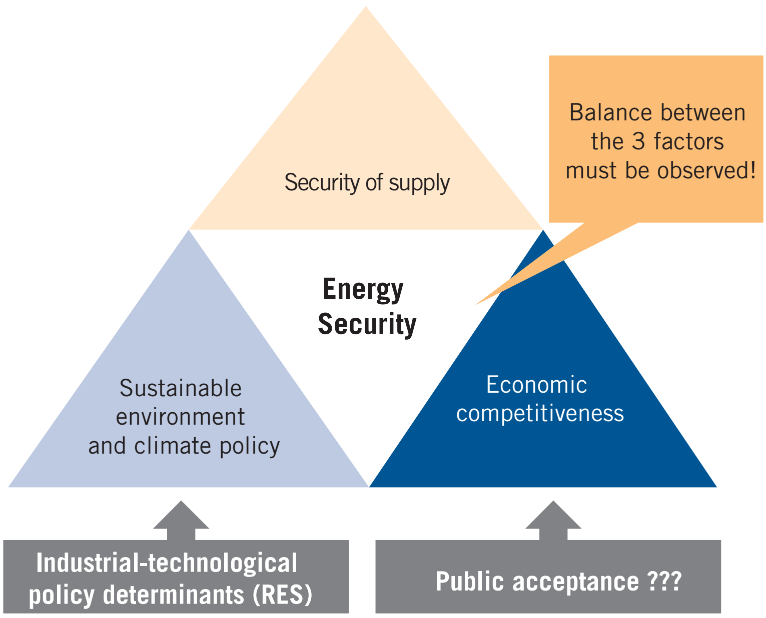
Challenges for the security of energy supply in the EU

The political revolutions in Arabic countries in spring 2011 and the resulting ongoing regional instability have placed the issue of security of energy supply more firmly on the global political agenda. This applies not least to Europe, as Middle East and North Africa are of major strategic importance for the security of both oil and gas supply. Particular attention has to be given to Algeria in this context, as it is the third largest supplier of natural gas to the EU, as well as Italy and Spain, who are the largest importers of oil and gas from North Africa in the EU-27. The disruption of 47 billion m^3 of pipeline gas from Algeria, and 10 billion m^3 from Libya in the spring and summer months of 2011 however caused no major supply problems, as they were compensated for by alternative imports of liquefied natural gas (LNG). Still, as these supplies cover 12 % of EU gas consumption and over 26 % of non-European imports to the EU, a longer-term disruption of Libyan and (especially) Algerian gas would have caused greater problems in the winter of 2011/12, where energy consumption was higher. Algeria still accounts for over 30 % of Italy's gas requirements, and around 20 % of Spain's.

Libya is the 12th largest oil producer in the world, producing 1.6 million barrels of crude oil per day (MMbbl/d). It has the largest oil reserves in Africa, and accounts for 2 % of global production and 7 % of German oil imports. Nevertheless, the disruption in Libyan production and exports was compensated for by other oil producers. However, if instability in Arab countries (particularly in the Gulf region) were to increase and persist, this could result in major interruptions to supply. If Saudi Arabia, in its capacity as the world's largest oil producer and exporter, were impacted by major domestic instability, a world oil crisis could in no way be excluded.

The explosion of the Deepwater Horizon oil platform in the Gulf of Mexico in April 2010 didn't just cause the worst natural disaster in America's history; it also raised the issue of the security of global oil supply. This is as today's conventional oil reserves only have a life expectancy of around 54 years, making the issue more highly charged than with other fossil fuels, such as natural gas (64 years, but up to 250 years with the inclusion of unconventional gas) and coal (112 years). The global transport sector is considered to be the primary driver of further increasing global demand for oil, as it is entirely dependent on oil or petrol and diesel and accounts for around 50 % of consumption. In addition to this, oil is used as a raw material in the production of all fuels and lubricants, and, in the form of naphtha, also in the production of plastics, pharmaceuticals, dyes and textiles. In the coming years and decades, global crude oil production can however still be

Figure 3.10: Energy triad/Energy trilemma – the three determinants of energy security



Source: Dr Frank Umbach

ensured by more extensive exploitation of unconventional oils (from tar sands, oil sands and oil shale, extra heavy crude, etc.) and through more expensive and technically complex deep sea drilling for oil, or also in future, drilling in Arctic waters. These approaches however come with new and, at times, more significant production and environmental risks. The era of “cheap oil” is indeed at an end.

In Europe, the issue of security of supply has gained profile since 2006, during the Russian-Ukrainian and Russian-Belarusian gas and oil conflicts. However, in the political agendas of Germany and many other EU Member States outside of official and conceptual energy policy, the factor of security of supply has at most only been of declaratory value in the “energy triad”. In terms of concrete implementation, it has not been attributed the same level of importance as environment and climate protection, or economic competitiveness. The German Federal Government’s energy policy concepts from September 2010 and July 2011 also need to be critically examined in this context, as both of them fail to effectively address the global energy policy challenges and shifts in international power. Germany is dependent in the long term on energy and other raw material imports from politically unstable regions of the world. Even the increasing dependency on gas imports is not sufficiently investigated in either of the Federal Government’s energy concepts.

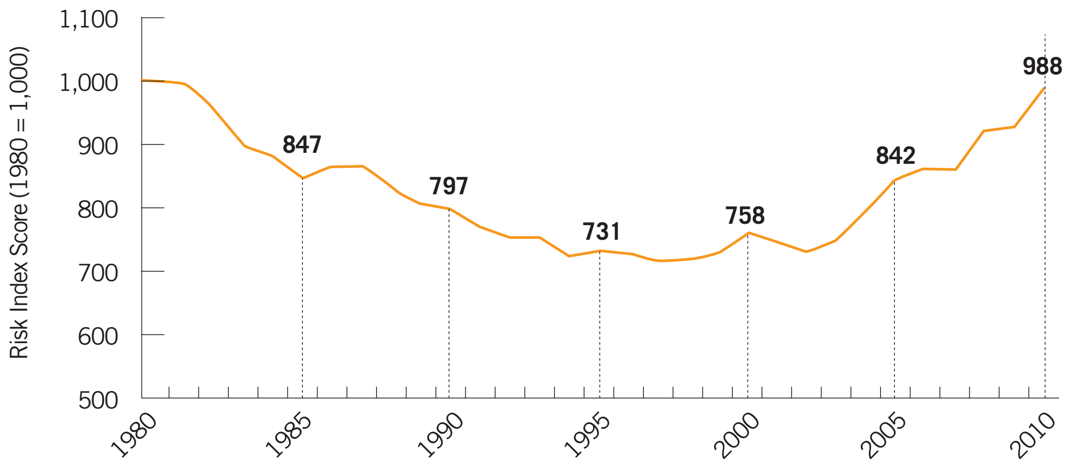
In contrast, the European Commission Directorate-General for Energy and Transport had already warned in its November 2000 green paper on the future of the security of energy supply that the North Sea oil and gas resources would run out within the next twenty years, and the EU would become increasingly dependent on oil and gas imports from unstable supplier countries and regions.

Germany’s integrated energy policy and energy markets today require increasingly European solutions while encompassing ever more global thinking and strategic vision. A national electricity market is today already history. Larger infrastructure investments are already taking place primarily in transnational energy infrastructure, as can be seen in the numerous gas and electricity interconnectors currently under construction. These will fulfil the physical and infrastructural prerequisites for a unified and liberalised EU-27 energy area by 2014. Germany’s energy transition is only realistic and economically feasible if a coherent national energy policy is based on close cooperation with Brussels and EU partners, rather than being directed against them.

European energy security in times of intensified global competition for resources

In line with the EU’s 20/20/20 energy strategy, renewable energy was able, based on a stable level of subsidisation, to increase its share of the European energy mix from 7 % in 2008, to a current level of 13 %. Nonetheless, the 20 % target for energy efficiency appears less realistic for the time being. A further aspect of the triad of energy policy

Figure 3.11: OECD average risk index for security of energy supply, 1980–2010



Source: Institute for 21st Century Energy, 2012 International Index of Energy Security Risk targets, the economic competiveness of the EU, is currently jeopardised by the significantly lower gas prices in the USA (around a quarter to a third of European prices) resulting from the shale gas revolution. This revolution has considerable geoeconomic and geopolitical repercussions. It has strengthened the security of supply in the USA, which will become a net gas exporter by 2015/2017. In addition, in the long-term, past 2020, the probability of energy self-sufficiency seem increasingly realistic thanks to a growing shale oil revolution. In contrast, it is expected that the EU will become increasingly more dependent on energy imports. Imports currently cover around 55 % of energy requirements, 84 % of demand for oil and 64 % of gas consumption in the EU. In 2011 the EU paid €410 billion for fossil fuel imports, and this is expected to increase to at least €490 billion by 2035. The EU is already the world's largest importer of energy. Increasing energy imports cast doubt on its future competitiveness as well as the security of its energy supply.

According to the IEA, the world faces a time of "unprecedented uncertainty" with regard to its energy supply due to the dramatic increase in demand and new geopolitical risks. One of the significant causes for concern is that more than 70 % of the world's remaining oil and more than 40 % of conventional natural gas deposits are concentrated around the Persian Gulf and Caspian Sea.

China's future energy policy is probably the most important key determinant of the future of global energy systems. China's energy requirements will increase by 60 % by 2035. Its share of global energy demand is currently 17 %, and, given sustained high rates of growth, will reach at least 22 % by 2035 and be solely responsible for 33 % of global growth in energy demand. In 2035, China's energy requirements will be 77 % higher than the USA's, although per capita energy consumption will also be 52 % lower than in the USA.

There are also concerns that future energy and resources conflicts cannot be ruled out if secure access is denied to resources that are of central strategic importance in maintaining domestic political stability and the survival of political systems. The security effects on stable shipping lanes resulting from increasing energy dependency already form today the rationale for the increased building up of maritime forces, as can be currently seen with the development of blue-water naval capabilities by China and India.[1]

1 National Intelligence Council 2008.

China's dependency on crude oil imports has increased within three years from 33 % in 2009 to 55 % in 2012, and will increase to more than 60 % by 2015. In addition, China became a net importer of coal in 2009, despite having the third-largest coal reserves and being the world's largest producer of coal. The "Middle Kingdom" and India are largely responsible for the reality that coal has been the world's fastest growing energy source for 10 years, a fact often discounted in Germany and Europe.

In recent years, new empirical quantitative analyses on international, European and German energy security have confirmed the results of numerous qualitative analyses. These have all concluded that the security of energy supply has deteriorated and is increasingly at risk.

The EU's Common Energy Policy: Progress and setbacks

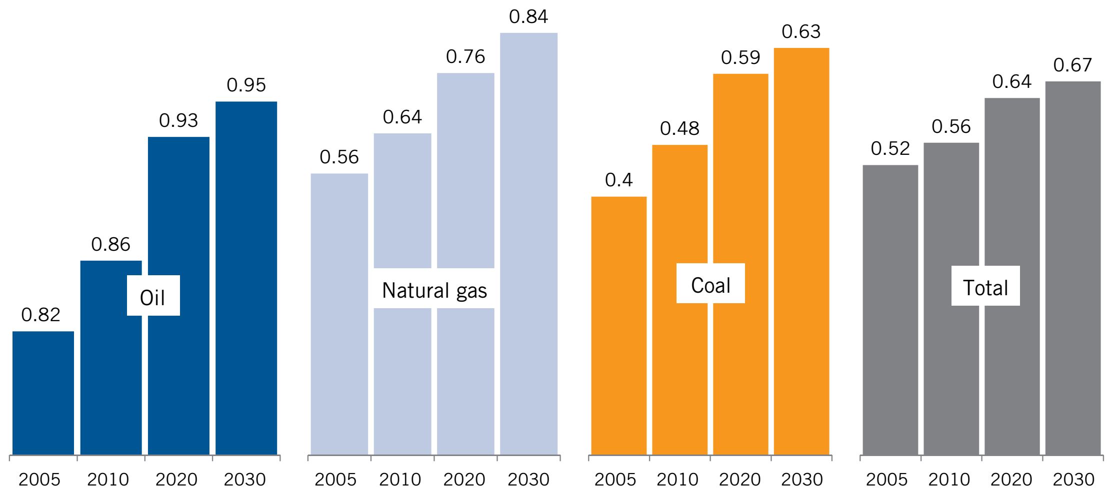
At the spring European Council held in March 2007, the heads of states and government in the EU passed an "integrated climate and energy policy" with an "energy Action Plan" and "the 20/20/20 strategy". Due to the growing dependency on fossil fuel imports from outside the EU and thus also from energy exporters, the EU planned a proactive common "external energy policy" (officially termed "external relations") for EU countries.

The EU's energy strategy serves to ensure the stable supply of energy at competitive prices, with a sustainable environment and climate policy. In addition, it is intended to push the liberalisation measures of Member States' energy policies, so that a genuine internal energy market is established by 2014. This should ensure that, after 2015, no EU Member State is sealed off from the European gas and electricity network, or has its energy security jeopardised by lack of appropriate connections.

Reform of the EU internal energy market is thus closely connected in a number of ways with the attempts to diversify energy imports (particularly with regard to gas). In accordance with this, the attempts at energy policy reform of neighbouring countries, such as those in Southeastern Europe (as members of the "European Energy Community"), are actively supported in order to promote further harmonisation of the EU internal market.

The three classic objectives (clean, affordable and reliable) of the energy triad (energy trilemma) are mostly anchored in the EU common energy policy and the energy strategies of individual Member States. However, in reality

Figure 3.12: Increased EU import dependency, 2005–2030



Source: Dr Frank Umbach, based on Euroacoal, An Energy Strategy for Europe: Importance and Best Use of Indigenous Coal, Brussels 2009, p. 1, and official figures of the European Commission

these objectives are not given equal attention in German energy policy. Up to now, environment and climate have instead commonly been given higher priority, and had a determining influence on the other two factors, usually at the cost of security of supply. In addition, the lack of public acceptance has led not only to national energy policy concepts and major infrastructure projects being called into question, but has also resulted in a questioning of the EU common energy policy and jointly approved transnational energy infrastructure projects, such as gas pipelines and electricity networks.

Despite attempts to form a common external energy policy, since 2007 the EU energy policy has focussed mainly on the challenges of the internal market. The Commission has recognised the necessity of close cooperation with energy partners as a component of proactive external energy policy. This is intended to take better account of the close connections between geopolitical stability and the security of energy supply, the increasing dependency of the EU on energy imports and the growing mutual dependency between producers, transit countries and consumer countries.

Although the common energy policy of the EU is far further developed than many other policy areas, in recent years Member States have often attached greater importance to national solutions at the expense of the energy policy of neighbouring states and the common energy policy, instead of preparing themselves for the numerous major global challenges. Common (external) energy policy thus depends to a large degree on political solidarity and the long-term strategic interests of the major EU Member States, such as Germany.

In 2012, the European Council decided that the Commission should be informed of all new and existing bilateral agreements maintained by Member States with countries outside the EU. The Commission estimates that there are around 30 intergovernmental oil agreements and twice as many natural gas agreements in existence.

With the September 2011 announcement of the new strategy for external energy policy (“The EU Energy Policy: Engaging with Partners beyond our Borders”), the Commission took an important step towards strengthening reporting requirements and transparency and extending these to all intergovernmental agreements relating to the internal energy market or security of energy supply. This applies to natural gas, oil, electricity and renewable energy. Up to now, the bilateral energy agreements of EU Member States, conducted without any Commission consultation, have led to an increasing fragmentation of the internal market instead of developing the energy supply and competitiveness of the EU, in effect conflicting with the objectives of the EU common energy policy.

European gas sector – progress in security of energy supply

The European gas market is currently undergoing fundamental structural change. This change can be attributed to the result of changes in global gas markets resulting from the development of the liquefied natural gas (LNG) market share against a background of faster growing global demand for gas, as well as the development of unconventional gas resources (particularly shale gas) primarily in the USA, but also now in Australia, Canada and other countries.

Against the background of the global recession from 2008, and the resulting lower rate of global growth of regional gas markets, the European gas market has recently changed from seller's market to a buyer's market. The sudden flood of gas on the market, with a LNG spot price that, at times, was up to 40 % lower than the pipeline gas price from Russia and Norway, was also influenced by the European economic crisis and the rapid development of renewable energy. These factors caused a steady reduction in gas demand from 2009 on. This has resulted in a decoupling of the gas price from the oil price also in Europe, and called into question the traditional long-term contracts between a limited number of large suppliers and purchasers and their "take-or-pay" clauses.

At the same time, LNG has also increased its market share in Europe as compared to pipeline gas. Today it constitutes around 20 % of gas imports and around 15 % of total gas consumption (in 2010 in the EU: 15 %). In addition, in 2011, only around 56 % of long-term contracts in Europe with a duration of up to 25 years were indexed to oil prices (2009: 68 %; 2010: 59 %), while the spot market share increased steadily from 27 % in 2009 to 37 % in 2010, and 40 % in 2011.

The IEA no longer expects an increase in EU gas demand. Instead, 2010 levels of gas consumption will be reached and exceeded only in 2020. Despite the decoupling of gas prices from oil prices in Europe, gas-fired power plants are currently not competitive with coal-fired power plants. This is due to the low carbon prices in the EU emissions trading system (ETS: fallen from €30 per tonne in 2008 to €4.25 in the spring of 2013), cheap US coal exports (+24 % to Europe in 2012) resulting from the shale gas revolution in the USA, and Russia adhering to the principles of oil price indexation (despite some price reductions of 10-15 %). Contrary to the EU climate policy objectives, gas demand not only stagnated, but fell a further 7 % in 2012, while coal consumption in the EU-27 increased by 4 % in 2011 and 7 % in 2012. European gas prices would have to fall about 40 % from current levels to again be competitive with coal. In the medium term, the subsidised promotion of solar energy poses a greater threat than coal to the future of gas in electricity production. By 2035 it is expected that electricity production by renewables will already exceed 50 % in most EU countries, and gas power stations will at best serve as a back-up to secure base load (if the technical and commercial issues involved with electricity storage remain unresolved). In the long-term, Europe's gas demands will only increase strongly after 2020, if the transport sector (vehicles and ships) increasingly shifts from using oil to using gas.

The strategic change in the European gas market is also a consequence of an active EU policy to sustainably strengthen the security of gas supply, by means of: energy saving measures following both Russian-Ukrainian gas crises of 2006 and 2009, diversifying imports (such as by expanding LNG import terminals and the Southern Gas Corridor project involving direct imports from Central Asia and the Caspian region), construction of transnational gas interconnectors between Member States allowing bi-directional transport capability, as well as the liberalisation measures of the "Third Energy Package".

Security of critical energy infrastructure

The 2013 attack by Islamist terrorists on the gas facility near the Algerian town of In Amenas and the following hostage crisis is recognised by security experts as a turning point for the North African and global energy industry. It is the most serious attack in the 150-year history of the industry on an oil and gas facility. The attack has forced other companies to review their security measures. There are concerns that the threat of attack could deter potential investors.

In March 2013, gas production was interrupted by battles between local militia groups near the Mellitah gas complex, 60 km west from the Libyan capital Tripoli. Since 2001, attacks have significantly increased on installations involved with gas supply (such as pipelines) in many other regions, including the Middle East, Africa, Eurasia, South American and South Asia. This is partly a result of the further expansion of infrastructure, such as pipelines, production facilities and electricity networks. The most recent attacks are indicators that terrorist groups will increasingly target critical energy infrastructure. This in-

Cyber attacks on critical energy infrastructure:

- **2012** – The total amount of "incidents" identified and directed against critical infrastructure (CI) in the USA increases by 52 % on 2011 levels.
- **2012** – The primary target was the energy sector, where 41 % of all cyber attacks took place.
- **December 2012** – First confirmed attack on a European transmission system operator, the German 50Hertz Transmission GmbH. The attack lasted five days.
- **2012** – The virus known as "Shamoon" attacks the world's largest oil producer, Saudi Aramco, as well as RasGas and the state-owned company Qatar Petroleum.
- **2012** – The "Flame" virus, recognised as espionage software, attacks Iran and its nuclear technology facilities.
- **2011** – The "Duqu" malware is identified. It appears to be related to Stuxnet and Flame, and designed to spy on confidential data and assets.
- **2010** – The "Stuxnet" superworm is discovered, designed to attack Iran's uranium enrichment process.
- **2009** – The energy industry is targeted by the "Night Dragon" attacks, allegedly originating from China.
- **2009** – Viruses are discovered in the US electricity network that appear to have originated from China and Russia.

Source: Dr Frank Umbach

cludes installations and networks involved with energy production, as well as oil and gas production, storage facilities and refineries, LNG terminals, nuclear power plants, dams, and transport and distribution networks.

In 2006, Islamist suicide attackers assaulted the Abqaiq oil refinery in Saudi Arabia. With a capacity of seven million barrels a day in 2006, it is one of the largest oil processing facilities in the world. The attack failed at the last line of defence inside the facility. As a consequence of the assault, the Saudi government established a 35,000 strong unit to defend the oil and gas facilities of the Kingdom.

Although the industry already has a certain amount of experience in dealing with violent attacks, the increasing amount of attacks on critical energy infrastructure originating from the Internet constitute a new threat to security. There is no comparable expertise or experience with respect to this.

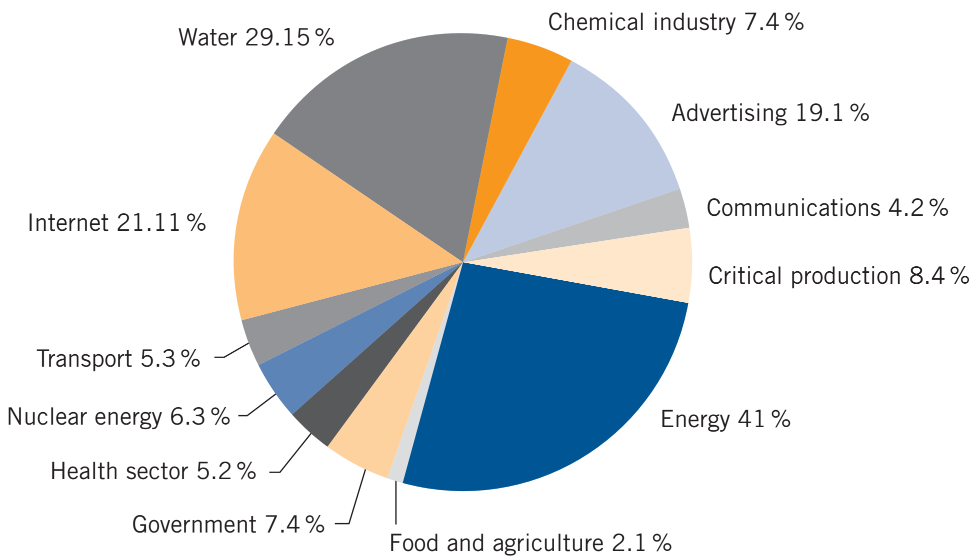
In the summer of 2012, cyber attacks were carried out against the world's largest oil producer, Saudi Aramco, and RasGas, a joint venture between ExxonMobil and the state owned Qatar Petroleum. The "Shamoon" virus used in these attacks compromised around 30,000 Aramco workstations, and RasGas had to shut down their website as well as a number of internal servers as a result of the attacks. In 2009, viruses were discovered in the US electricity network that appears to have originated from China and Russia. According to a January 2013 report by the US Department of Homeland Security,[2] cyber attacks and infiltration of areas of critical energy infrastructure increased from 2011 to 2012 by 52 % – an alarming degree. 41 % of cyber attacks conducted in the USA were reported to have occurred in the energy sector.

All critical infrastructure is dependent on two conditions: a stable internet connection and secure supply of electricity. Security experts regard "critical infrastructure" as particularly at risk, as it is of vital importance for the survival of the state and the maintenance of vital state functions. Critical infrastructure includes information and telecommunications systems as well as the sectors of transport and traffic, energy supply, health, finance and other sensitive services. These critical sectors are characterised to a high degree by their internal complexity and high mutual dependence, as well as their vulnerability. The more networked an industrial society and its critical infrastructure are through the internet, the greater the potential risks and vulnerabilities.

Widespread blackouts can lead to interruptions in the functioning of all other components of critical infrastructure, as they are all dependent on a stable supply of electricity. This includes critical food supply for the population, the security of the health system and its low security standards, water supply, sewage, the mobility and transport sector as well as financial services and the maintenance of communications systems. It is possible, or at least cannot be excluded, that the complete collapse

2 U.S. Department of Homeland Security, Industrial Control Systems (ICS)-Cyber Emergency Response Team (CERT)-Monitor, October-December 2012, Washington D.C., January 2013.

Figure 3.13: Cyber attacks on US economic sectors in 2012 – annual total of 198 cyber attacks



Source: US Department of Homeland Security

of public life and state order could follow within a week. A widespread blackout could deeply destabilise an entire country for an extended period of time.

Summary and outlook

Numerous new empirical-quantitative and qualitative analyses conducted on the security of international energy supply have shown in recent years that this has increasingly deteriorated and will be at even more risk in future. The reasons for this lie in the increasing global energy requirements, the finite nature of fossil fuels (conventional oil in particular), the concentration of remaining conventional oil and gas resources in the politically unstable area of the world known as the Strategic Ellipse, the end of the era of cheap oil, the time-critical massive global investments that need to be made in new energy infrastructure (including oil and gas production), and the increasing physical and cyber attacks conducted on critical energy infrastructure as well as the growing dependence of many countries on imports. The concerns regarding last factor focus not only on intensified economic competition, which has led to a global renationalisation of energy sectors since the end of the 90's, but also increased competition for energy resources, which could potentially culminate in major violent conflicts.

Renewable energy also faces new problems of dependency and energy supply risks, as the construction and maintenance of installations is dependent on the import of critical raw materials. At the moment, the most serious issues lie with the rapidly increasing dependency on "rare earths" (especially the heavy rare earth elements), which are finding increasing application in, for example, battery storage, magnets for wind turbines, and electromobilty. China controls 95 % of global production, effectively giving it a production and export monopoly. In recent years, Beijing has increasingly used this for political benefit not just in industrial policy conflicts, but in diplomatic conflicts as well.

For the EU to maintain and strengthen the security of energy supply, today's constantly changing global energy markets demand not only a diversification strategy with regard to the energy mix and energy imports, but also appropriate coordination and a unified approach, both at the national level and between the 27 Member States. The truism that the EU is only as strong as the Member States allow it to be still applies to both common EU energy policy and the security of energy supply.

This also applies to completely new threats to security, such as attacks on critical energy infrastructure. Western security experts largely agree that future cyber attacks should probably be regarded as the greatest of the various threats to security for European energy supply and critical energy infrastructure. At the moment, energy control centres with their SCADA systems for controlling and monitoring energy supply should be regarded as particularly vulnerable and sensitive.

Demands on international security are rising not just due to traditional geopolitical risks, but also as the danger to critical (energy) infrastructure is increasing, both quantitatively and qualitatively, and has to be completely re-evaluated by governments and businesses. This applies not just to fossil fuels and their production and transport sectors, but also with growing urgency to electricity infrastructure and the increasing "electrification of energy production" resulting from the development of renewable energy and new key technologies (such as smart grids, metering systems and super grids). Although these can improve EU energy security, they also pose new security challenges.

The "globalisation of energy security" will thus further increase in topicality as these requirements and the understanding of energy security change, and new conceptual approaches have to be developed to address this in terms of cross-sector "networked energy security" (analogous to a networked security policy). In future, macroeconomic and security policy interdependencies and the functional chains of critical (energy) infrastructure have to be understood and taken into consideration more than ever. However, at the same, new opportunities and positive prospects arise for stabilising the future security of energy supply in the EU from the American shale gas revolution and its global influence on regional gas markets, the EU liberalisation and infrastructure policy as well as from the global development of renewable energy.

Energy in Germany

4

4.1 Facts & figures

German energy market key data

In 2012, Germany consumed 469.4 MTCE of energy. This makes Germany the seventh largest energy market in the world, behind China, the USA, Russia, India, Japan and Canada. The per capita consumption of energy in Germany is 5.7 TCE per year. Although this is around double the global average, it is half the comparative figure in the USA. If goods and services produced are taken as the relevant measure, it is clear that energy is very efficiently utilised in Germany. In 2012, energy consumption in Germany was around 177 KgCE per €1,000 of gross domestic product. The global average of for this specific measure of energy consumption is twice the German figure. In between 1990 and 2012, macroeconomic energy efficiency (measured in terms of primary energy consumption per unit of real gross domestic product) improved at an average annual rate of around 1.9 %.

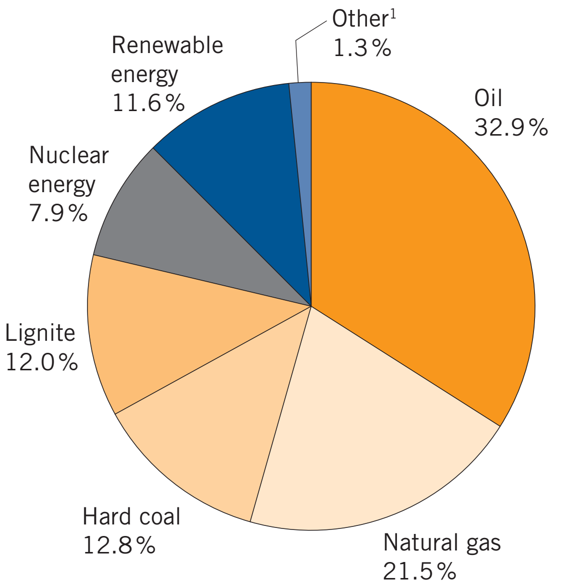
Germany's own energy reserves are limited largely to coal. Its share of global reserves of oil and natural gas is marginal, making Germany heavily dependent on imports of these energy sources.

In 2012, 40 % of energy consumption was covered by domestic energy (including nuclear energy, which is classified as domestic energy due to the large quantities of uranium in Germany). In 2012, coal contributed 68.3 MTCE or 37 % of total domestic production (185.0 MTCE for 2012). This was comprised of both lignite (57.2 MTCE) and hard coal (11.1 MTCE). Coal was followed by nuclear energy with 37.0 MTCE, natural gas/associated gas with 13.3 MTCE, oil with 3.8 MTCE, renewable energy with 53.9 MTCE and energy from other sources with 8.7 MTCE.

Imported energy covered the remaining 60 % of energy consumption. Energy imports are spread over a diverse range of energy sources and countries of origin. Germany's most important foreign energy supplier is the Russian Federation. In 2012, natural gas, crude oil and hard coal from Russia accounted for more than a third of total imported energy in Germany. The next largest importers are Norway, the Netherlands, Great Britain, Libya, the USA, Nigeria and Columbia. The Netherlands supplies Germany with natural gas while Norway supplies both crude oil and natural gas. Great Britain's primary energy export to Germany is oil. Libya and Nigeria both supply Germany with crude oil. The USA and Columbia supply hard coal

In 2012, net energy imports totalled €98.2 billion. Oil imports comprised the largest proportion of these at

Figure 4.1: Primary energy consumption in Germany by energy source, 2012
Total: 469.4 MTCE



1 Other solid and gaseous fuels, as well as imported electricity.

Source: Arbeitsgemeinschaft Energiebilanzen (Working Group on Energy Balances) 07/2013

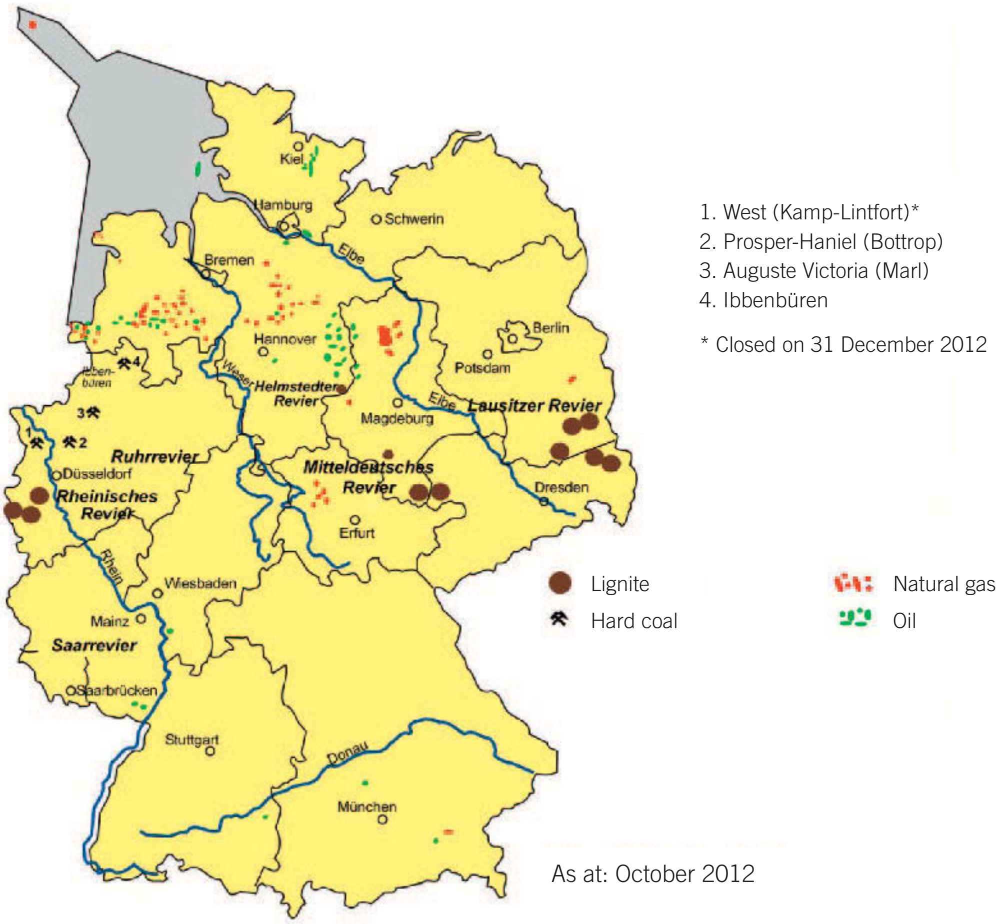
€65.6 billion, followed by natural gas at €29.0 billion and then coal at €5.1 billion. Net electricity exports totalled €1.4 billion, and net uranium imports totalled €0.1 billion.

CO_2 emissions

Germany produced 760 million tonnes of energy-related CO_2 emissions in 2012. Once production-related emissions are included, CO_2 emissions totalled 814 million tonnes. This represents a reduction of 21.9 % on 1990's figures, where national CO_2 emissions totalled 1,041.9 million tonnes.

The commitments made in the 1997 Kyoto Protocol refer to a total of six greenhouse gases. In addition to carbon dioxide (CO_2) these include methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The Kyoto Protocol commitment period is from 2008 to 2012. Germany's target is to achieve a 21 % average reduction between 2008 and 2012 compared with the base year stipulated

Figure 4.2: Key areas of energy production



Source: H.-W. Schiffer, Energiemarkt Deutschland

in the Kyoto protocol (1990) for CO_2, CH_4 and N_2O, and 1995 for the other three greenhouse gases.

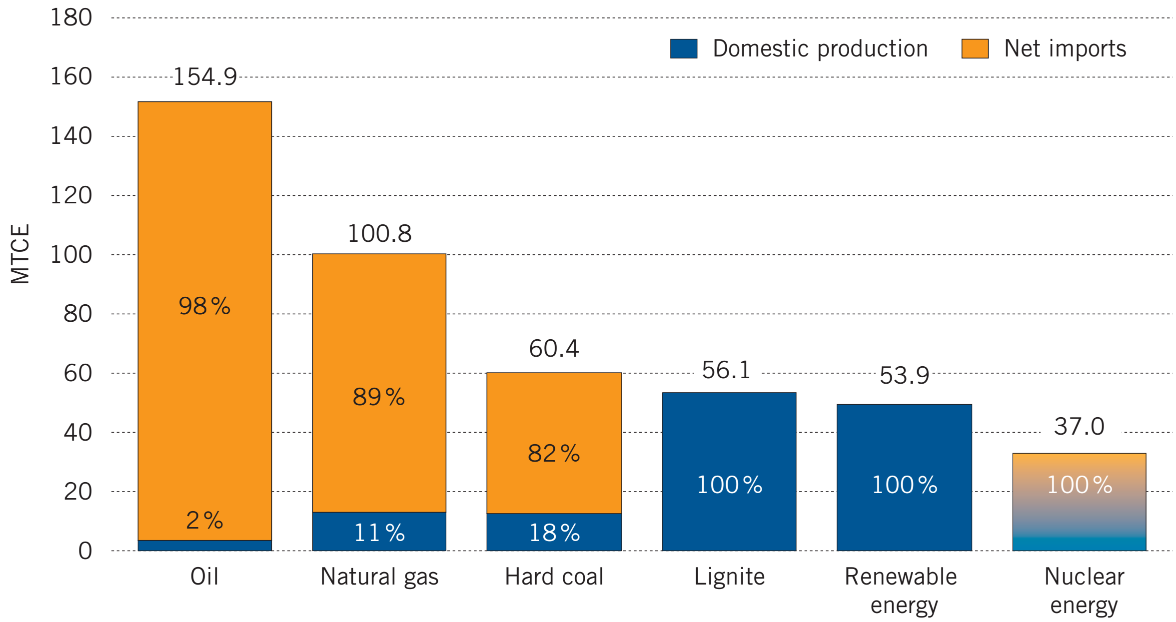
According to the German Federal Environment Agency (UBA), around 931 million tonnes of carbon dioxide equivalent (CO_2-eq) were released in Germany in 2012. The 2012 greenhouse gas emissions were thus 25.5 % lower than the emission reference values specified in the Kyoto Protocol (1,232.4 $MtCO_2$-eq). Emissions for the entire commitment period of the Kyoto Protocol (2008 to 2012) were 192 $MtCO_2$-eq below the emissions budget.

The development of all greenhouse gas emissions from 1990 to 2012 is illustrated in Table 4.1.

Energy taxes and other charges

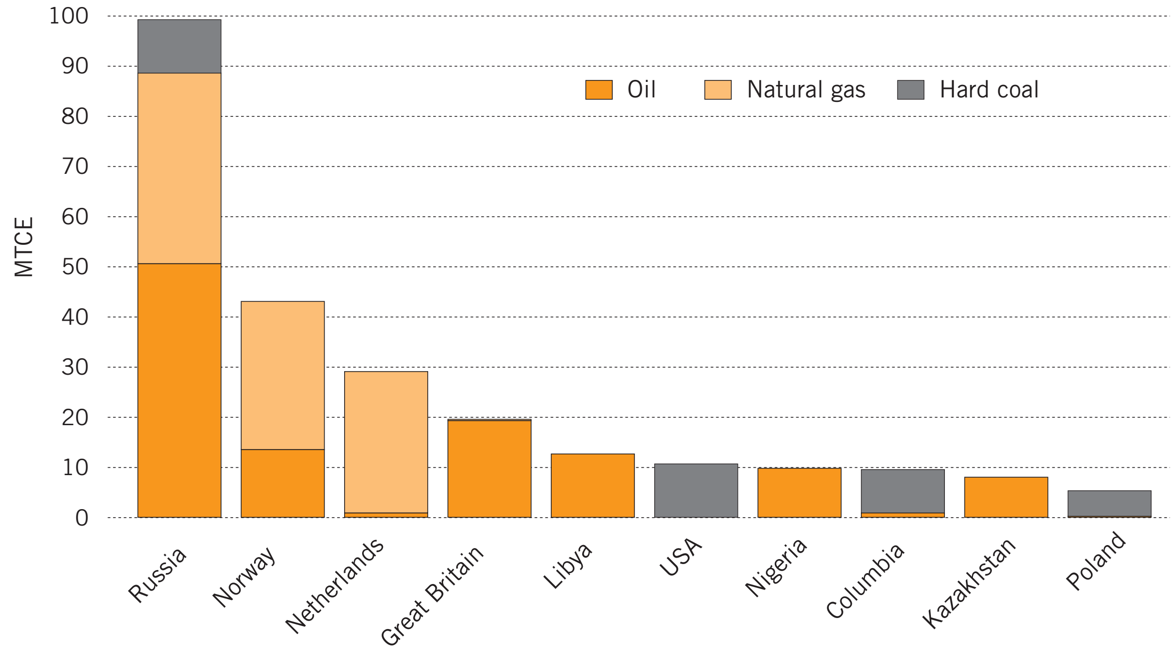
In 2012, the German Federal Government raised €48.8 billion from the imposition of consumption taxes on energy (fuel and electricity tax). This amounts to around half the value of Germany's total net energy imports. Energy consumption tax revenues on fuel totalled €35.2 billion, comprising about 75 % of all energy consumption tax revenues in 2012. Natural gas and electricity tax revenues totalled €2.7 and €7.0 billion respectively. On 1 January 2011, the nuclear fuel tax and the air traffic tax were introduced, and have generated for the Federal Government €1.6 billion and €0.9 billion in respective tax revenues.

Figure 4.3: German energy import dependency in 2012



Source: Arbeitsgemeinschaft Energiebilanzen 08/2013 (percentages calculated as the proportion of domestic production for the respective primary energy consumed); including the figure of 5.9 MTCE from other energies, such as the above-mentioned imported electricity, gives a total primary energy consumption of 469.4 MTCE.

Figure 4.4: Energy suppliers for Germany, 2012



Source: H.-W. Schiffer (based on BAFA)

Table 4.1

Greenhouse gas emissions	Base year*	2000	2005	2010	2011	2012
	million tonnes CO_2-eq					
Carbon dioxide (CO_2)***	1,041.9	891.4	864.7	826.1	798.1	814.0
Methane (CH_4)	109.9	75.1	59.5	50.4	48.8	48.0
Nitrous oxide (N_2O)	86.8	61.7	61.2	54.9	57.1	56.4
HFCs	7.0	7.6	8.6	9.0	9.2	9.4
PFCs	1.8	0.8	0.7	0.3	0.2	0.2
Sulphur hexafluoride (SF_6)	6.8	4.3	3.5	3.2	3.3	3.0
Total emissions******	**1,254.2**	**1,040.9**	**998.2**	**943.8**	**916.8**	**931.0**
Carbon dioxide emissions	**million tonnes**					
Energy-related emissions	**977.7**	**827.8**	**803.2**	**770.6**	**743.4**	**760.1**
Oil	310.4	306.8	277.0	248.1	239.4	238.5
Natural gas & other gases	116.1	158.6	169.0	173.7	152.2	155.3
Hard coal & blast furnace gas	200.7	178.5	164.7	158.6	155.4	160.6
Lignite	342.2	172.1	177.9	168.5	173.9	182.8
Other	8.2	11.9	14.6	21.7	21.1	21.4
Industrial processes	**60.0**	**59.5**	**57.7**	**52.5**	**53.1**	**52.4**
Mineral products	22.7	22.2	19.5	18.3	19.5	19.4
Chemical industry	13.1	16.2	16.4	16.3	16.7	16.6
Metal production	24.2	21.2	21.8	17.9	16.9	16.3
Solvents/product use	2.6	1.8	1.6	1.6	1.5	1.5
Total***	**1,041.9**	**891.4**	**864.7**	**826.1**	**798.1**	**814.0**
Carbon dioxide emissions	**million tonnes**					
Emissions trading sector*******	**	**471.8**	**475.0**	**454.8**	**450.4**	**452.4**
including:						
Energy industry	**	369.3	376.9	357.2	351.3	356.2
Industry	**	102.6	98.1	97.6	99.1	96.2
Non-emissions trading sector	**	**419.6**	**389.7**	**371.3**	**347.7**	**361.6**
including:						
Transport	162.4	181.0	160.4	153.5	155.6	154.1
Private households	129.5	117.9	111.1	105.5	81.9	86.6
Other******	**	120.7	118.2	112.3	110.2	120.9
Total	**1,041.9**	**891.4**	**864.7**	**826.1**	**798.1**	**814.0**

* The base year for CO_2, CH_4 and N_2O is 1990, and 1995 for HFCs, PFCs and SF_6.

** Figures not yet available.

*** Total emissions, excluding CO_2 from land use, land-use change and forestry (LULUCF); the difference between the total and sum of the individual items is due to diffuse emissions that are not individually listed in this table.

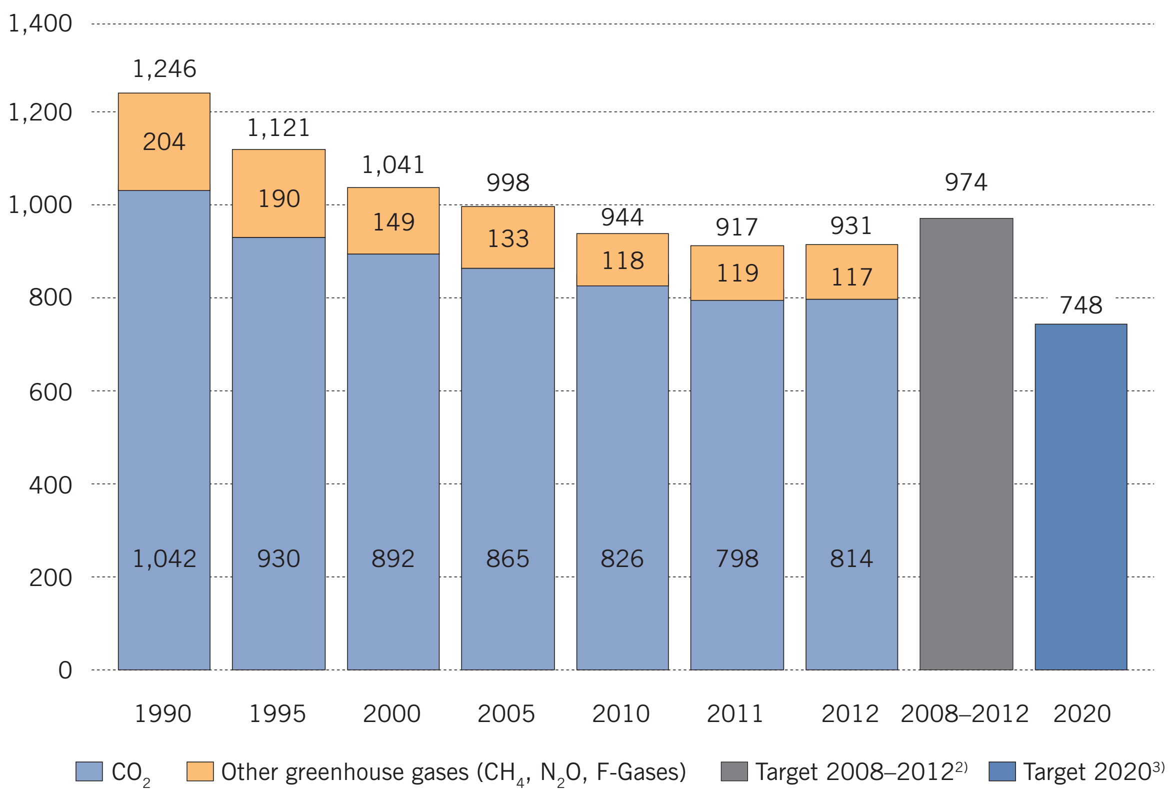
**** The emission reference values stipulated in the Kyoto Protocol total 1,232.4 $MtCO_2$-eq. (Source: Compliance Committee of the UNFCCC, Report of the review of the initial report of Germany, Bonn 2007 (CC/ERT/IRR/2007/24, 13 December 2007).

***** From 2008 includes chemical industry plants and steel processing plants.

****** Includes industrial plants and conversion of energy not involved in emissions trading (e.g. plant furnaces with a rated thermal input less than 20 MW).

Sources: Base year to 2011: Umweltbundesamt, Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol 2013, National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2011, EU Submission, Dessau, 15 January 2013; 2012: Umweltbundesamt, Press Release 09/2013, Dessau, 25 February 2013; for plant emissions subject to ETS see: Umweltbundesamt – DEHSt, Emissions trading: Auswertung der Ersten Handelsperiode 2005 – 2007, Berlin, 19 January 2009 and DEHSt, Kohlendioxidemissionen der emissionshandelspflichtigen Anlagen im Jahr 2008, Berlin, 15 May 2009; as well as DEHSt, Kohlendioxidemissionen der emissionshandelspflichtigen stationaren Anlagen und im Luftverkehr in Deutschland im Jahr 2011, Berlin, May 2012.

Figure 4.5: Greenhouse gas emissions in Germany, 1990-2012[1],
in $MtCO_2$-eq, excluding CO_2 from LULUCF[4]



1) The base year for CO_2, CH_4 and N_2O is 1990, and 1995 for HFCs, PFCs and SF_6. The reference value for reductions required to meet the targets established by Kyoto was set at 1,232,429,543 thousand tonnes of CO_2-eq.
2) 21 % reduction on the base year's figures of 1,232.4 $MtCO_2$-eq.
3) 40 % reduction on 1990 levels.
4) LULUCF= Land use, land-use change and forestry.

Source: Umweltbundesamt, Dessau, 15 January 2013 (for 1990 to 2011); Umweltbundesamt, Dessau, 25 February 2013 (for 2012)

The consumption taxes constitute differing shares of product prices. A fuel tax of 65.45 cents/litre is levied on petrol, while the corresponding figure for diesel (as well as sulphur-free fuel) is 47.04 cents/litre. Once value added tax is taken into account (19 % since 1 January 2007), taxes in 2012 represented a 56 % share of product prices for premium petrol and 48 % for diesel.

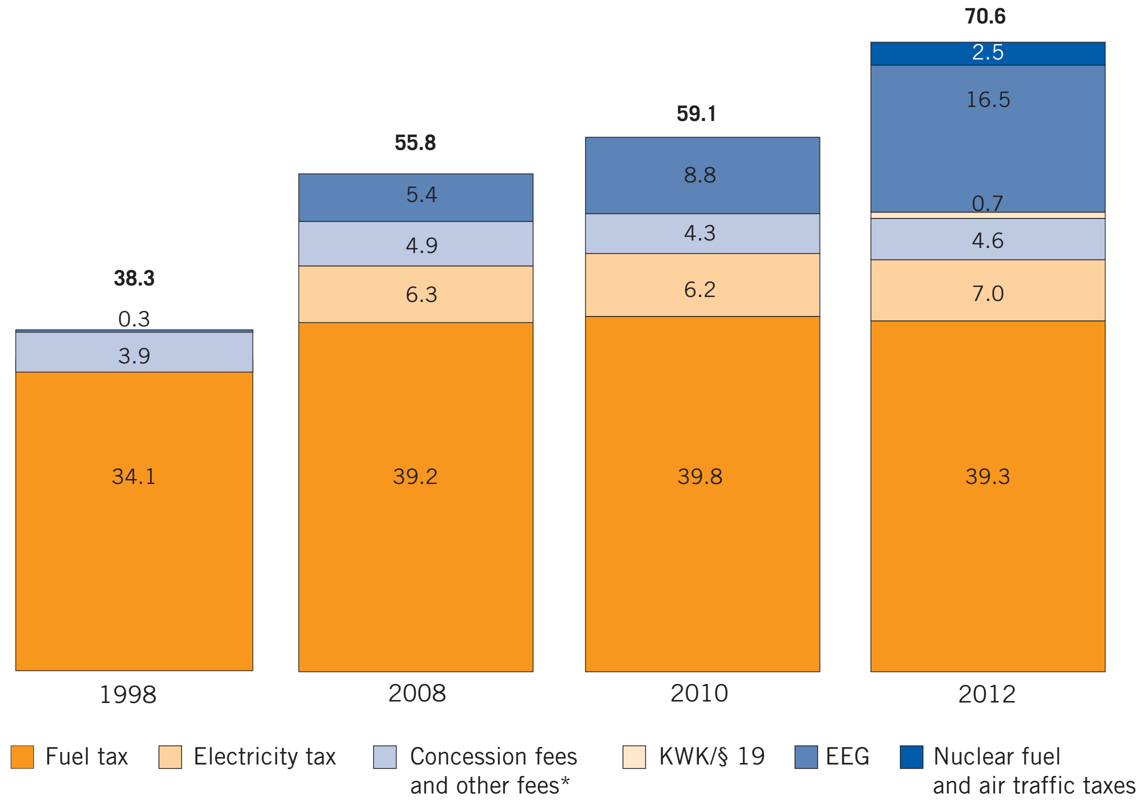
In 2012, tax on light heating oil (consumption and value added taxes) – based on product prices paid by private households – comprised 23 % of the total price. Taxes and charges on natural gas made up around a quarter of household prices in 2012, when concession fees and mining royalties are factored in.

Coal is taxed at a rate of €0.33/GJ. The use of coal as an energy source for electricity generation is exempt from energy tax, as is the use of natural gas.

Under the German Nuclear Fuel Tax Act of 8 December 2010, nuclear fuels used in the commercial generation of electricity are subject to nuclear fuel tax from 1 January 2011 (until 2016). The tax on one gramme amounts to €145 for plutonium 239, plutonium 241, uranium 233 and uranium 235. This represents a tax burden of €15.50/MWh on electricity generated by nuclear energy.

According to the Bundesnetzagentur, the electricity price for private households with an average annual consumption of 3,500 kWh, and an electricity price of 26.06 cents/kWh, can be broken down as follows in 2012 (all figures in cents/kWh):

Figure 4.6: Energy taxes and fees in Germany
in € billion



* Some figures estimated; including: concession fees €3.3 bil/year; oil and natural gas mining royalties: 1998: €0.14 bil, 2008: €1.22 bil, 2010: €0.675 bil, 2011: €0.949 bil and 2012 around €1 bil, as well as the oil stockpiling charge: €0.5 bil in 1998, €0.35 bil in the 2007/08 financial year, €0.37 bil in the 2008/09 financial year, €0.36 bil in the 2009/10 financial year, €0.339 bil in the 2010/11 financial year and €0.317 bil in the 2011/12 financial year (all excluding VAT).

Source: Federal Ministry of Finance as well as BDEW estimates

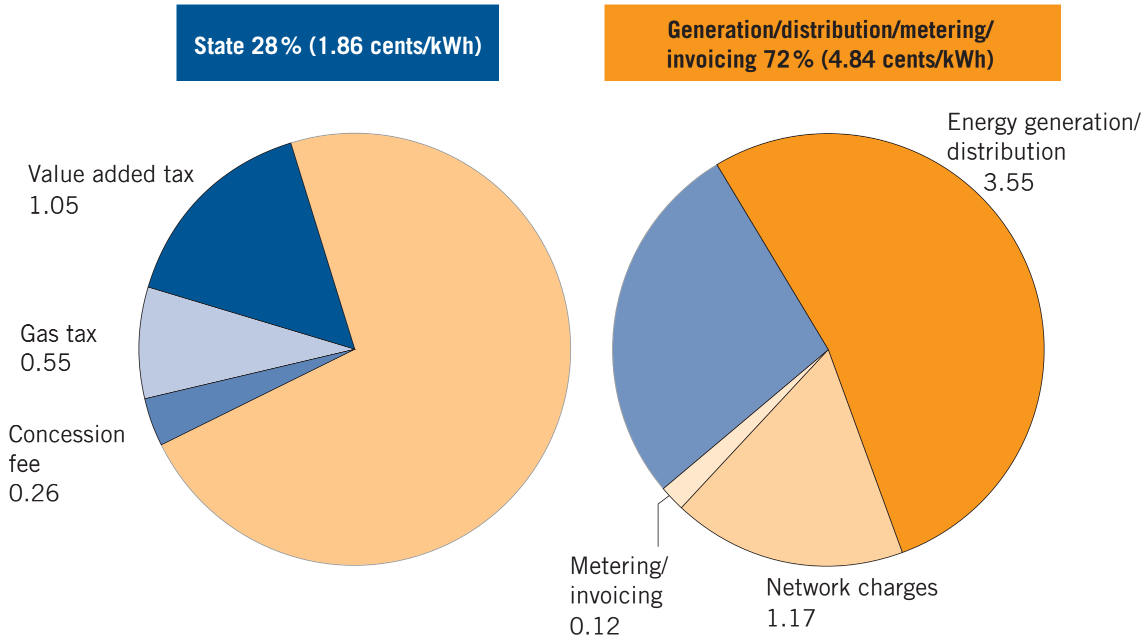
- Generation/transport/distribution: 14.42
- Concession fee: 1.68
- Renewable Energy Act (EEG): 3.592
- Combined Heat and Power Act (KWK-G): 0.002
- § 19 Electricity Network Charges Ordinance (StromNEV) charge: 0.151
- Electricity tax: 2.05
- Value added tax: 4.16

The government's share of household electricity prices in 2012 thus totalled 45 %. As of 1 January 2013, the EEG reallocation charge was raised to 5.277 cents/kWh.

In addition, accordingly to § 17 f of the German Energy Act (EnWG), an offshore liability charge of 0.25 cents/kWh was introduced for non-exempt end customers as of 1 January 2013. Once increased combined heat and power charges (now 0.126 cents/kWh), increased § 19 charges (now 0.329 cents/kWh), concession fees (1.79 cents/kWh), electricity tax (2.05 cents/kWh) and value added tax (4.55 cents/kWh) are included, the state burden on electricity prices totals 14.37 cents/kWh in 2013. According to the BDEW, this is around 50 % of the household electricity price of 28.50 cents/kWh.

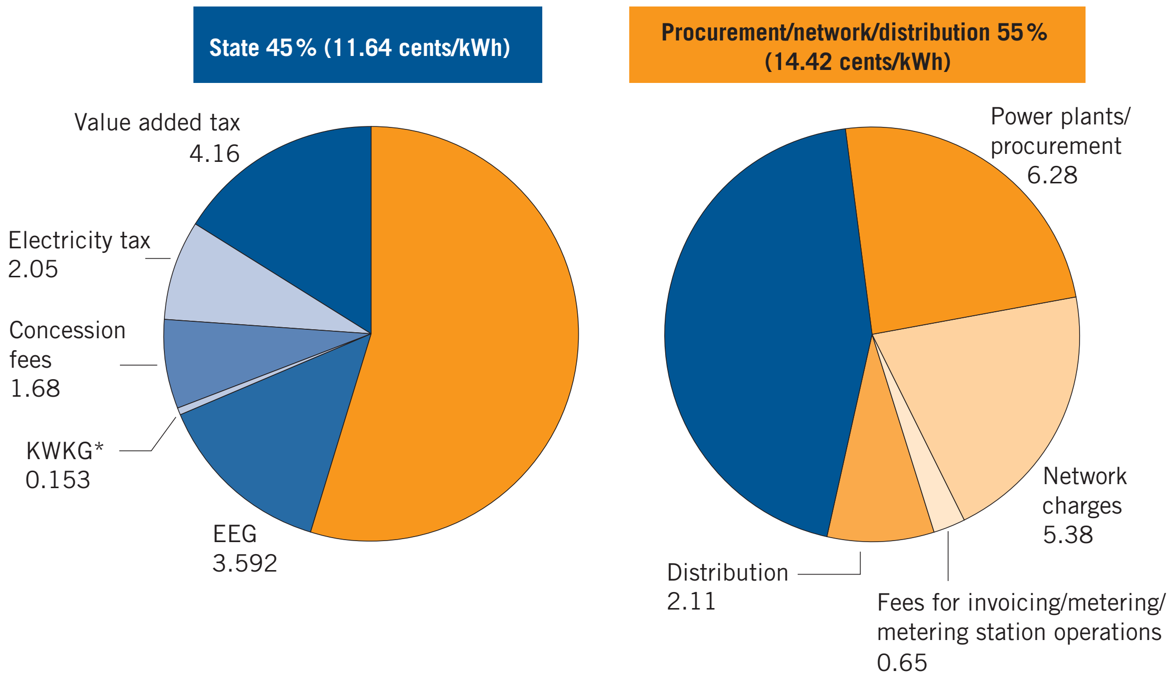
Reduced rates apply to the manufacturing industry and to agriculture.

Figure 4.7: Gas price composition for household supply, 2012 (in cents/kWh)
Total: 6.7 cents/kWh



Source: 2012 Monitoring Report of the Bundesnetzagentur and the Bundeskartellamt, Bonn, November 2012, p. 138

Figure 4.8: Composition of private household electricity prices in 2012, in cents/kWh
Total: 26.06 cents/kWh



* including § 19 charges

Source: Bundesnetzagentur and Bundeskartellamt Monitoringbericht 2012, Bonn, November 2012, p. 138

Oil

Crude oil imports form the basis of supply, as only 2 % of aggregate oil demand can be covered by domestic production. Crude oil imports totalled 93.4 million tonnes in 2012. In addition, 32.3 million tonnes of oil products were imported to cover demand.

In 2012, 26 % of crude oil imports came from Western and Central Europe (mainly the North Sea), 46 % from Eastern Europe/Asia, 22 % from Africa, 4 % from the Middle East and 2 % from America. OPEC countries provided a total of 24 % of all imports.

Thirteen refineries process crude oil and semi-finished products in Germany. In 2012, the oil industry processed around 92.3 million tonnes of imported crude oil, 2.6 million tonnes of domestic crude oil and 11.6 million tonnes of semi-finished products in its refineries, resulting in a total of 106.5 million tonnes processed. Given a crude oil processing capacity of 103.4 million tonnes per year to the end of 2012, refineries were running at 91.8 % capacity.

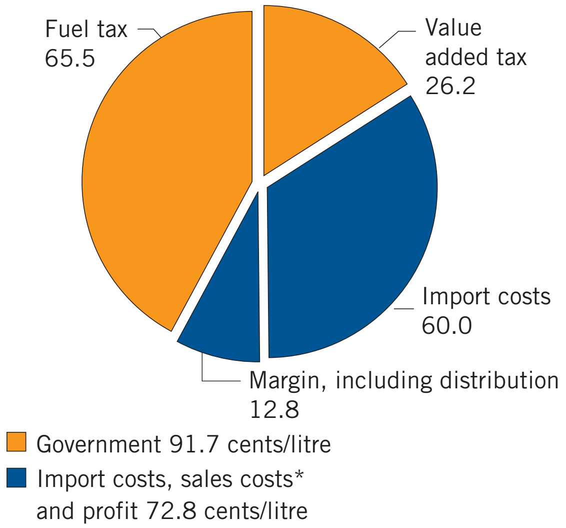
In 2012, domestic sales of oil products reached around 103.0 million tonnes (including 3.6 million tonnes of biofuels). The main products were fuels used for road transport (petrol: 18.5 million tonnes, diesel: 33.7 million tonnes), light heating oil focussed on the domestic heating market (18.7 million tonnes), naphtha, used especially in chemistry (15.8 million tonnes), aviation fuel (8.7 million tonnes) and heavy heating oil (4.9 million tonnes).

In 2012, petrol sales declined for the thirteenth consecutive year. This was due to structural factors, such as a reduced number of cars with petrol engines, the increased proportion of cars with more fuel efficient engines, as well as decreased mileage per car. Bioorganic components are also being increasingly added. In contrast, the further increase in the proportion of cars with diesel engines led to demand for diesel rising for the sixth consecutive year. A slight growth in light heating oil sales was largely due to the cool weather conditions in 2012.

In 2012, the distribution of total domestic sales by area of consumption was as follows:

- Transport: 56 %
- Households and small consumers: 18 %
- Industry: 25 %
- Electricity supplier power plants: 1 %

Figure 4.9: Petrol price 2012, in cents/litre
Government share of 56 %
Average price for premium petrol: 164.5 cents/litre



* Sales costs (inland transport, storage, statutory stockpiling, administration, distribution as well as cost for addition of biocomponents) and profit; as at February 2013

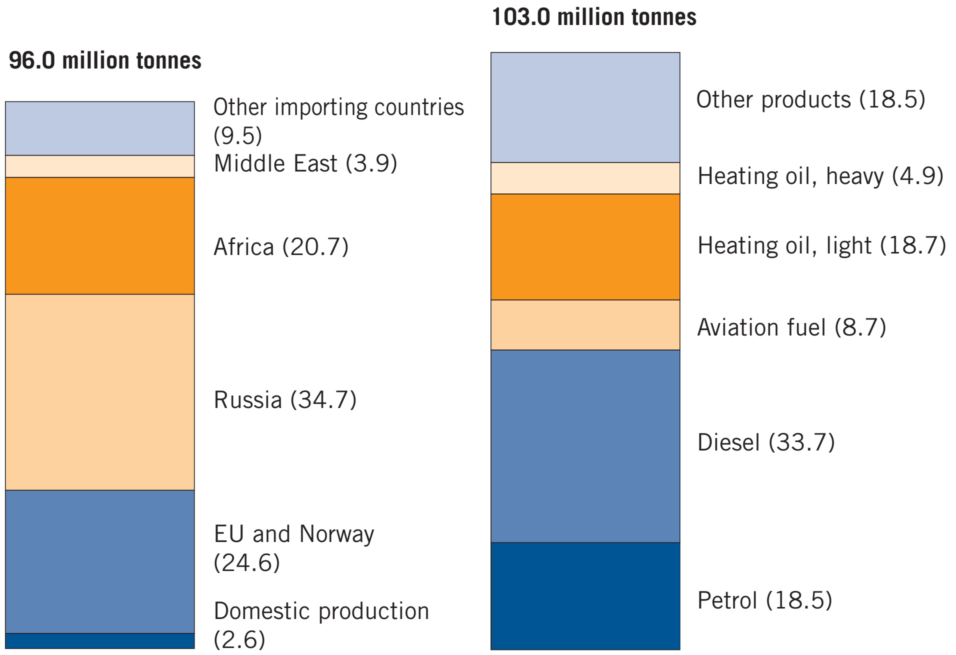
Source: Mineralölwirtschaftsverband (Association of the German Petrol Industry)

Natural gas

Natural gas consumption totalled around 909 TWh in 2012. The household and small consumer sector comprised 44 % of this. One of the driving factors behind this is the large number of gas-heated apartments. At the end of 2012, around 50 % of all apartments had natural gas heating. Industry comprised 41 % of natural gas consumption. The application of natural gas in power plants comprised a further 15 %. 196 TWh were supplied to customers in other European countries.

Natural gas supply in Germany is based on a diversified range of sources. In 2012, 11 % of the total 1,102 TWh of natural gas was domestically produced, and 89 % was imported from a number of different countries: 31 % came from Russia, 24 % from the Norwegian North Sea, 23 % from the Netherlands and 11 % from Denmark, Great Britain and other supplier countries. Supply of natural gas from abroad takes place predominantly on the basis of long-term contracts between the supplier and a number of import companies active in the German market. Given the fundamental changes to market structure (further increasing importance of LNG markets, the divergence of European trading hub prices from oil-linked import prices), the challenge lies in adapting the prices

Figure 4.10: Crude oil supply by origin in 2012 (in million tonnes) — **Domestic sales of oil products in 2012** (in million tonnes)



Source: Bundesamt fur Wirtschaft und Ausfuhrkontrolle

and pricing mechanisms in long-term import contracts to the changed market and competitive conditions.

The transport and distribution of natural gas occurs through an extensive pipeline network of around 450,000 km in length, integrated in the European transport system. An important part of the infrastructure is comprised of numerous underground natural gas storage facilities which have a total maximum available capacity (working gas) of around 21 billion m^3.

Hard coal

In 2012, 11.1 MTCE of hard coal was produced in Germany. Of this, 78.1 % came from the Ruhr mining district, 3.7 % from the Saar mining district, and 18.2 % from the Ibbenbüren mining district.

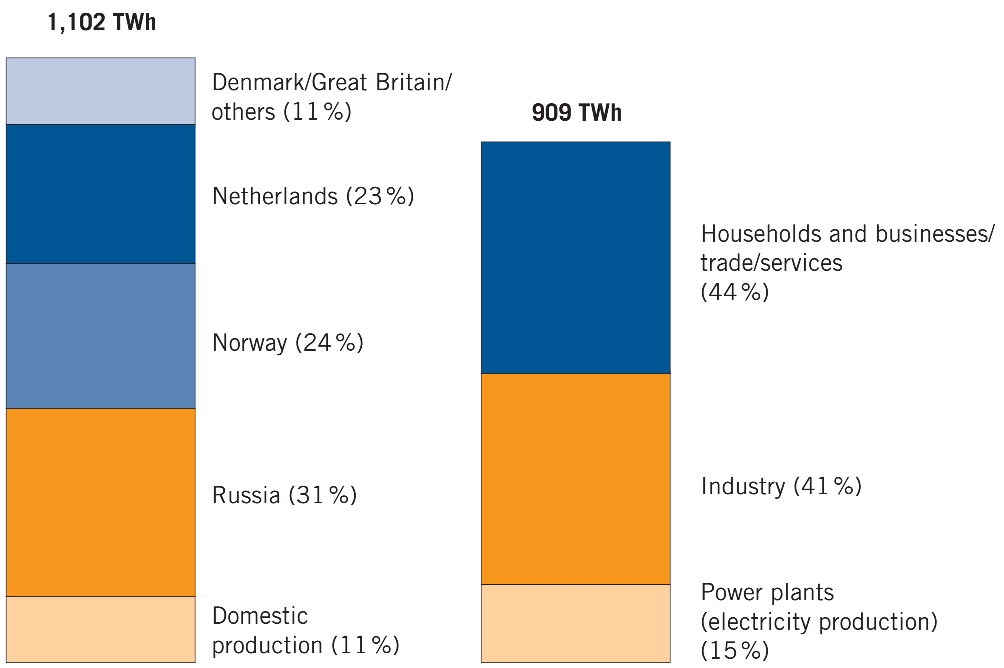
The closure of the Bergwerk Saar coal mine on 30 July 2012 and the Bergwerk West coal mine on 31 December 2012 leaves three mines in operation at the beginning of 2013. These are the Ibbenbüren coal mine, as well as the Prosper-Haniel and Auguste Victoria coal mines located in the Ruhr mining district.

In 2012, hard coal imports covered around 80 % of total hard coal consumption. Five countries were responsible for 89 % of these imports; namely Russia, the USA, Columbia, Poland and Australia.

The German hard coal market had a total volume of 57.0 MTCE in 2012. Power plants consumed 40.1 MTCE, the steel industry consumed 15.4 MTCE and 1.5 MTCE was consumed by the heating market.

The Hard Coal Financing Act on ending subsidised German coal mining by the end of 2018 came into force on 28 December 2007, and the adjustment process continued according to plan in 2012. As a result of this, employment in the industry continued to decline in 2012. The number of employees in hard coal mining declined from 20,925 as at 31 December 2011 by 15.8 %, to 17,613 as at 31 December 2012. The number of employees working underground fell by 2,030 in comparison to the previous year, to a total of 8,386. Mining productivity,

Figure 4.11: Natural gas supply 2012, in TWh **Natural gas consumption 2012,** in TWh



Difference between supply and consumption: exports, storage balance

Source: BDEW

expressed as utilisable production per person and shift, totalled 6,878 kg.

The planned closure of the Auguste Victoria mine is scheduled for 2015 as part of the gradual phase-out process. After this, both remaining mines will be closed by the end of 2018. The approval granted by the EU Commission on 7 December 2011 for the closure plans for German hard coal mining has definitively ensured the phase-out process at the European level.

Lignite

In 2012, around 185.4 million tonnes of lignite were produced in Germany, equivalent to 57.2 MTCE. All of this was produced exclusively by surface mining. Imports totalled 0.1 MTCE. Domestic production thus accounted for 99.9 % of supply.

German lignite is concentrated in four regions: the Rhenish mining district, west of Cologne; the Lusatian mining district, northeast of Dresden; the Central German mining district, near Leipzig; and the Helmstedt mining district in Lower Saxony. In 2012, 54.8 % of total production came from the Rhineland, 33.7 % from Lusatia, 10.4 % from Central Germany and 1.1 % from Helmstedt.

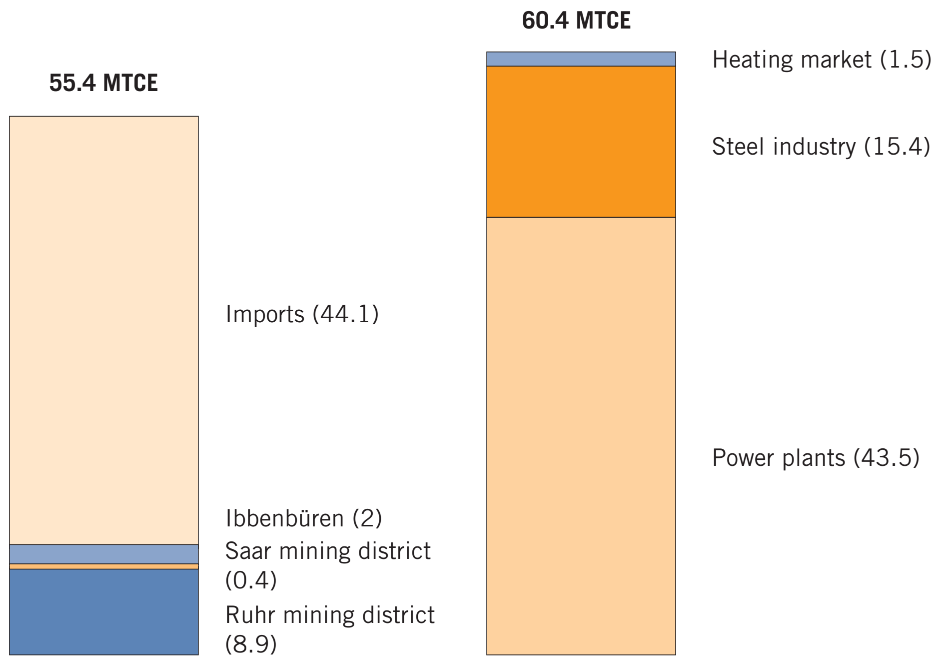
The focus of lignite use is around-the-clock electricity production over the whole year, the so-called base load. In 2012, 166.3 million tonnes of lignite were supplied to power plants providing public energy. This accounted for 90 % of all domestic production. In addition to this, 15.1 million tonnes of lignite were used by lignite mining factories in the manufacture of briquettes, pulverised lignite, fluidised-bed lignite and coke. 3.0 million tonnes were used for electricity production in mine-mouth power plants. Sales to other customers comprised 1.0 million tonnes.

In 2012, gross electricity production from lignite totalled 159.0 TWh. Power plants providing public energy supplied 154.8 TWh, and industrial power plants supplied 4.2 TWh. The gross installed capacity of lignite-fired power plants amounted to 21,507 MW as at 31 December 2012.

Around four-fifths of lignite products produced in Germany are supplied to national customers. Consumers use

Figure 4.12: Hard coal supply 2012, in MTCE

Hard coal consumption 2012, in MTCE



Source: Gesamtverband des deutschen Steinkohlenbergbaus (GVSt), AGEB

the ennobled products for electricity/heat generation or for industrial processes.

As at 31 December 2012, a total of 22,424 individuals were employed in the lignite industry. This figure includes the 5,802 individuals employed in lignite-fired power plants providing public energy. Of this total, 11,241 came from the Rhineland, 8,169 from Lusatia, 2,519 from Central Germany and 495 from Helmstedt. The total figure includes 1,536 trainees.

Electricity

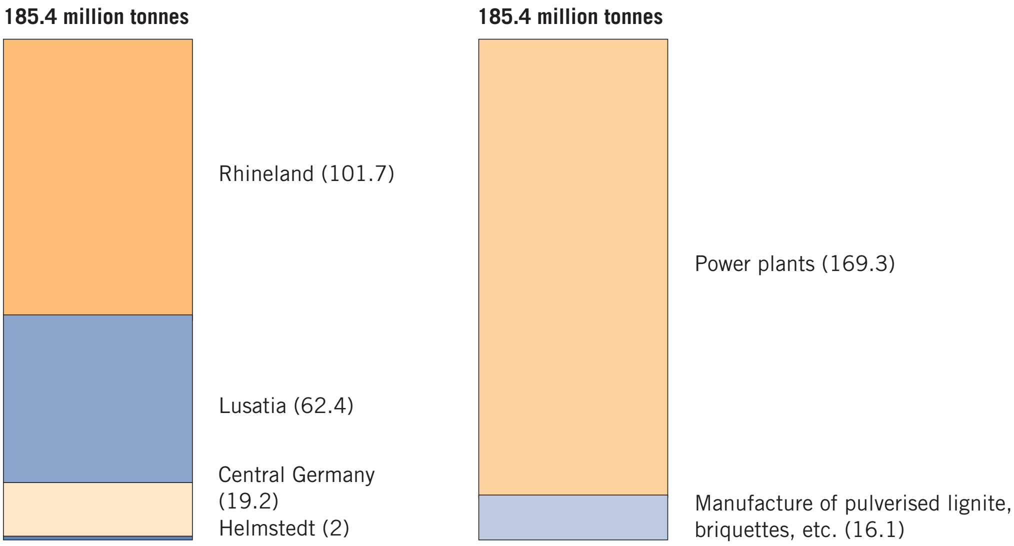
In 2012, gross electricity production totalled 628.7 TWh. Power plants operated by energy suppliers (including those run by third parties) produced 93 % of the total, and 7 % was produced by industry power plants.

After deduction of the power plant's own energy consumption (36.7 TWh), net electricity production amounted to 591.9 TWh in 2012. The structure of net electricity production according to energy source in 2012 was as follows: lignite 25.1 %, renewable energy 23.4 %, hard coal 18.0 %, nuclear energy 15.9 %, natural gas 12.4 %, and heating oil and other energy sources 5.2 %.

Against the background of the nuclear catastrophe in Japan, the German Federal Government and the Premiers of the Federal States with nuclear power plants decided on 14 March 2011 to remove the seven oldest nuclear power plants (all started before or in 1980) as well as the Krümmel power plant from the network for three months and shut them down with immediate effect. The moratorium regulations encompassed eight power plants with a total net capacity of 8,422 MW. The thirteenth amendment to the German Federal Atomic Energy Act (Atomgesetz) of 31 July 2011 stipulated that the authorisation to operate an installation shall expire at latest on 6 August 2011 for the Biblis A, Neckarwestheim 1, Biblis B, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel nuclear power plants. The act further stipulated that electricity generation by nuclear power plants shall be gradually phased-out in its entirety by 2022.

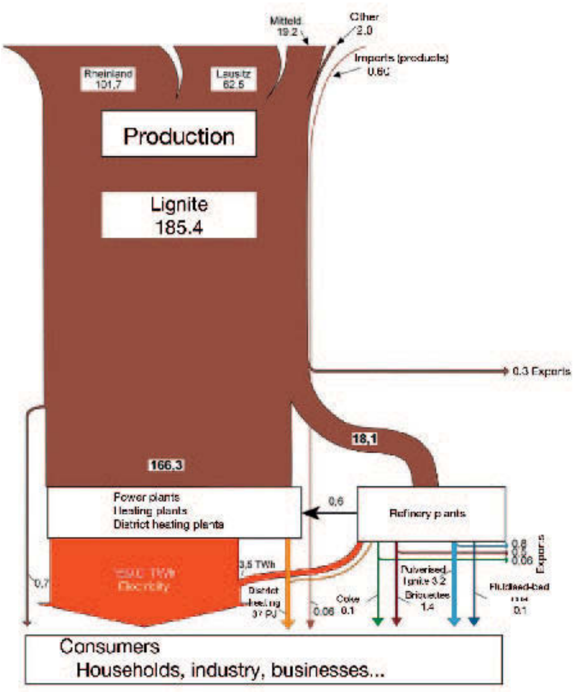
The net bottleneck capacity of electricity producing power plants totalled 178,441 MW as at 31 December 2012. Renewable energy comprised 75,359 MW of this, lignite

Figure 4.13: Lignite production 2012, in million tonnes | **Lignite application 2012,** in million tonnes



Source: DEBRIV

Figure 4.14: Lignite flow chart 2012, in million tonnes



Source: Statistik der Kohlenwirtschaft; as at February 2013

21,507 MW, nuclear energy 12,068 MW, hard coal 26,667 MW, natural gas 25,640 MW and other energy sources (including pumped-storage) comprised 17,200 MW.

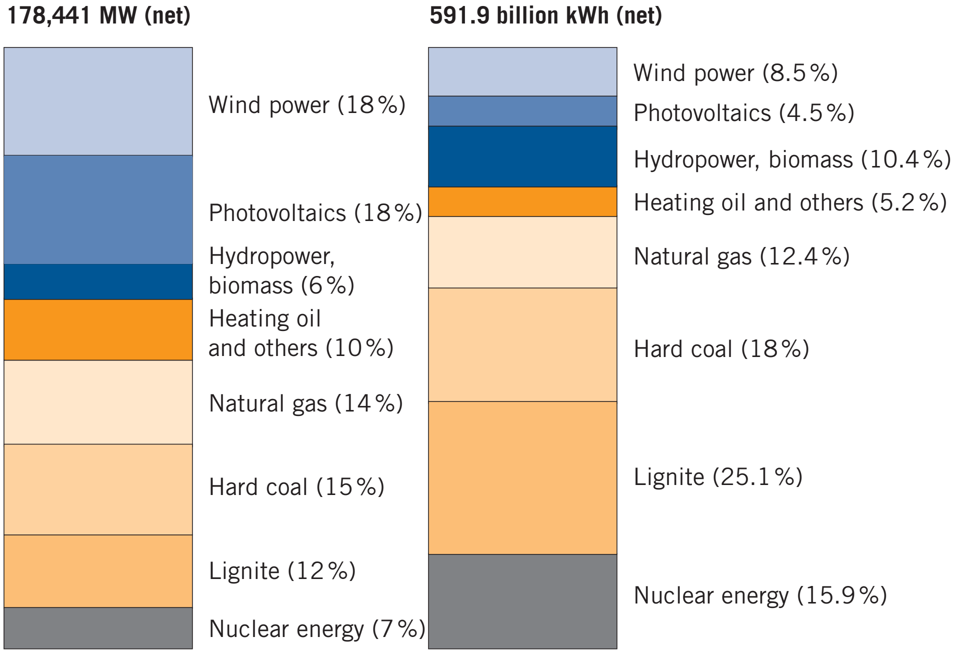
Production at German locations was complemented by electricity imports, which totalled around 44.2 TWh in 2012. Electricity exports amounted to 67.3 TWh in 2012, an increase of 20.2 % in comparison to the previous year. In contrast, electricity imports fell by 11.1 %. The balance of trade for 2012 totalled 23.1 TWh in comparison to 6.3 TWh in 2011. The decisive factor for the increase in electricity exports is the sharp increase of electricity generation from renewable energy.

Gross electricity consumption reached 605.6 TWh. Network losses amounted to 4.5 % of gross consumption – a very low figure by European standards.

In 2012, net electricity consumption of 533.2 TWh (excluding network losses and power plant's own consumption) was comprised of consumption by industry (46 %), private households (26 %), business, trade, public institutions and agriculture (25 %) as well as transport (3 %).

Consumption is expected to remain largely stable in future. In 2012, net electricity consumption totalled 202

Figure 4.15: Share of capacity and production by energy source, in percent



Source: BDEW September 2013

kWh per €1,000 of gross domestic product. Electricity usage will become increasingly more efficient and current intensity will decrease.

Renewable energy

Renewable energy covered 11.6 % of primary energy consumption in 2012. The most significant branch of the economy with respect to the application of renewable energy is the electricity industry.

In 2012, 142.4 TWh of electricity (gross) was generated by electricity suppliers and private operators of plants from renewable energy. Net production for 2012 totalled 138.8 TWh. This was comprised of wind power (50.5 TWh), hydropower classified as renewable (21.4 TWh), biomass (35.1 TWh), photovoltaics (26.4 TWh) as well as waste and other renewable energy sources (5.4 TWh). Net electricity production from renewables accounted for 22.9 % of gross domestic electricity consumption.

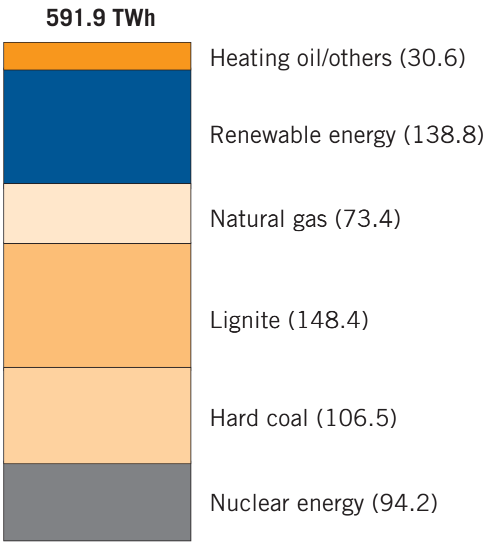
The net installed capacity of all plants totalled 75,359 MW as at 31 December 2012. Plants based on renewable energy thus accounted for 42 % of installed power plant capacity in Germany. Wind power accounted for 31,308 MW, photovoltaics for 32,389 MW, hydropower (excluding pumped-storage) for 5,650 MW, biomass for 6,000 MW and geothermal energy for 12 MW.

The German Renewable Energy Act (Erneuerbare Energien Gesetz – EEG) gives precedence to renewable energy resources, and has been decisive in the increase of renewable energy's contribution. According to the Act, network operators have to pay the providers of electricity fed into the network from EEG plants an EEG-stipulated minimum revenue. In addition, electricity produced from renewable sources is also given priority, irrespective of demand.

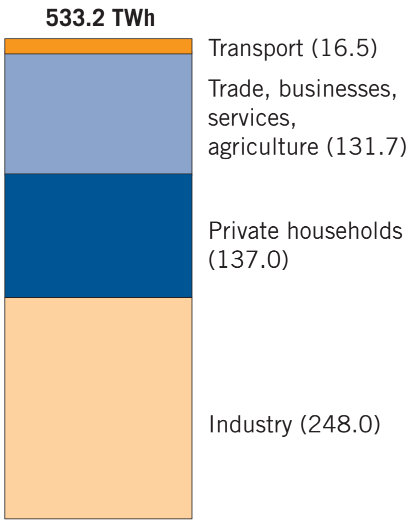
The total feed-in volume based on renewable energy (EEG volume, market premium volume, and green electricity volume) totalled around 114,544 GWh in 2012.

Compensation and premium payments to plant operators totalled €19.282 billion in 2012. Revenues from sales in 2012 (less direct costs) amounted to €2.763 billion. On balance, net support payments totalled €16.519 billion in 2012. This works out as an average net support rate of

Figure 4.16: Net electricity production 2012, in TWh



Net electricity consumption 2012, in TWh



Source: BDEW

Table 4.2: Net bottleneck capacity of electricity producing power plants, by energy source, in MW

Energy source	2012*	
	total energy industry**	**thereof: public supply**
Lignite	21,507	20,839
Nuclear energy	12,068	12,068
Hard coal	26,667	24,061
Natural gas	25,640	21,200
Oil	5,300	5,100
Renewables, including:	75,359	75,309
Onshore wind power	31,028	31,028
Offshore wind power	280	280
Hydropower	5,650	5,600
Biomass	6,000	6,000
Photovoltaics	32,389	32,389
Geothermal energy	12	12
Remaining, including:	11,900	8,900
Pumped-storage	5,710	5,710
Total	**178,441**	**167,477**

* preliminary figures (as at: 31 December 2012),

** including electricity production plants in the mining and manufacturing industries,

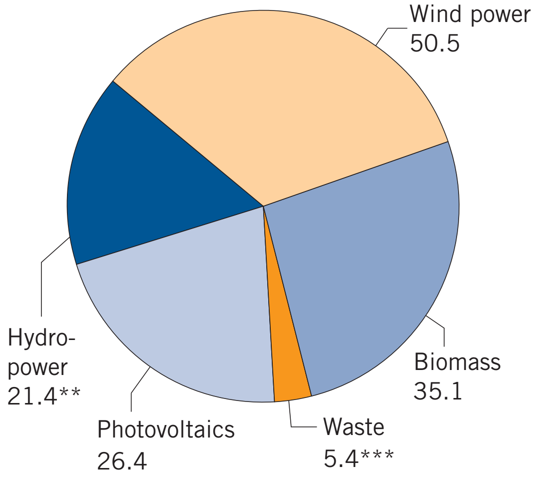
Sources: BDEW, VGB, Bundesnetzagentur, AGEE-Stat around 14.4 cents/kWh. The EEG reallocation charge amounted to 3.592 cents/kWh in 2012.

The total EEG feed-in is lower than the total contribution of renewable energy to electricity production. This is as, according to the EEG, feed-in from hydropower is only supported with installations up to 5 MW. In addition, electricity generated from waste classified as renewable is not covered by the EEG.

Renewable energy contributed 144.3 TWh to heating requirements in 2012, giving it a market share in the heating sector of around 10.4 %. This amount was generated by biomass (131.2 TWh), solar thermal energy (6.1 TWh) and geothermal energy (7.0 TWh).

Figure 4.17: Net electricity production from renewable energy in Germany 2012, in billion kWh

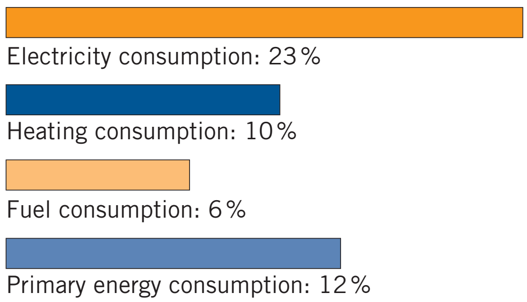
138.8 billion kWh ≙ 22.9 % of gross domestic electricity consumption*



* 59.5 TWh
** Pumped-storage without natural inflows is not included
*** Including other renewable energy sources

Source: BDEW, September 2013

Figure 4.18: Renewable energy market share 2012, in %



Source: BDEW

4.2 Amendments to the German Renewable Energy Act

EEG amendments in 2012

As in previous years, the German Renewable Energy Act (Erneuerbare-Energien-Gesetz, or EEG) was again amended in 2012. The main changes were amendments to incentives for photovoltaics, and the comprehensive exemption of electricity storage facilities from the EEG reallocation charge. Electricity storage facilities, which currently total around 7 GW of pumped-storage, were already subject to economic pressure resulting from reduced market price differences in the German electricity market (averaging only 1 cent/kWh), and were also burdened by increasing network charges.

The amendments to incentives for photovoltaics are a reaction by legislators to major additions to capacity totalling more than 7 GW in both 2010 and 2011. This expansion to capacity was also continued in 2012, driven by strong margins in the production of PV installations. Tariff rates were considerably reduced, limited to installations up to 10 MW and subject to monthly digression to avoid future peaks in capacity expansion. These measures are expected to result in a decrease of PV capacity to be installed in future, particularly with respect to large solar parks. Although tariff rates for smaller installations were also greatly reduced, the operators of such installations can switch to onsite consumption and refinance their installations principally by saving the increased end customer price, now 27 cents/kWh. In contrast, the tariff rate for feed-ins from smaller PV installations amounted to only 17 cents/kWh in January 2013. The expected reduction in PV capacity expansion and financing mainly through onsite consumption (in place of EEG-tariffs) mean that PV will not play a significant future role in further increases to the EEG reallocation charge. In any case, the amended EEG provides for a threshold of 52 GW of PV capacity eligible for incentives. At the end of 2012, the value was slightly over 32 GW.

In exchange for their consent to reduce and limit photovoltaic incentives, the German Federal States requested incentives for solar power storage units. These incentives can increase the share of onsite consumption and make use of the high difference between end customer price and the EEG tariff rates. The support, totalling €50 million, will be included in the market incentive programme of the Reconstruction Credit Institute (KfW) in the spring of 2013, and is intended to incentivise 25,000 storage units.

In addition, management premiums from the sale of electricity from wind and PV installations were considerably reduced in autumn by means of the Management Premium Ordinance. These reductions are only lower in cases where the installations that sell their electricity into the market can be steered by remote control. The background to these changes was the additional financial burden as significantly more onshore wind installations than expected switched from the fixed feed-in system to selling their electricity into the market in order to claim the EEG market premium.

EEG Proposal

The EEG is one of the most heavily debated issues in German energy policy. The main reason for this is the 2013 increase of the EEG reallocation charge by 1.685 cents/kWh to a current total of 5.277 cents/kWh. Criticism was directed at a number of elements of the EEG, including the exemptions of the industry from the full EEG. Capping industry's EEG burden has resulted in the EEG reallocation charge being 1 cent/kWh higher than would be the case if all electricity procured from public networks were subject to the full EEG reallocation fee. This difference must be borne by non-privileged customers – primarily households and medium-sized industrial companies. According to transmission system operators, the extension of the industry exemptions to procured electricity from 1 GWh/year, as stipulated in the 2011 EEG amendment, resulted in an increase to the EEG reallocation charge of only 0.14 cents/kWh. The greatest rise in the EEG burden by far results from the €6.3 billion increase of the additional EEG costs to a total of €20.4 billion. A driver for this is also the lower than expected wholesale electricity price.

On 12 October 2012, shortly before the announcement of the 2013 EEG reallocation charge, the Federal Minister for the Environment, Peter Altmaier, presented a proposal for a fundamental reform of the EEG to the press. Discussions between the Federal Government and the State Governments at the Renewable Energy Platform also provided a background to this. This platform was established as the Federal States plan a cumulative expansion of renewable energy's electricity supply from today's level of 25 % to 50 % in 2020 compared to the government's target of 35 %.

The proposal by the Federal Ministry for the Environment only suggests amendments to the EEG and leaves the discussion of the changes to an open consultation (including multiple conferences from November 2012 to May 2013), as well as an advisory body consisting of 20 individuals from state government, parliament, the private sector and community groups. Once consensus is achieved, the corresponding legislation should be drafted. Given the upcoming parliamentary elections, drafts passed by the Federal Cabinet later than February 2013 are subject to the discontinuity of the Bundestag, making a fundamental amendment to the EEG in 2013 unlikely.

The proposal lists such problems as misallocation and overfunding, as well as the primary focus being placed only on quantitative expansion. Suggested amendments include:

- The EEG target for 2050 should remain at 80 %, but the target for 2020 should be raised from at least 35 % to 40 %.
- Expansion of renewable energy should be consolidated in order to avoid market overheating. Establishing targets for other renewable energy sources than PV could also result in the technologies becoming competitive more rapidly.
- Incentives should be open to all technologies. That is, according to the proposal, no individual renewable energy source should be excluded or unfairly disadvantaged by the choice of the model.
- The development of renewable energy should be coordinated with a strategic reserve for Southern Germany, which will be required from 2018. Greater security of supply could also be achieved by an incentivised or required combination of different energy sources.
- The required expansion to the network should be specified in the Federal Grid Development Plan in 2013.

This initiated discussion on the future design of the EEG. While some participants advocated a fundamental reform of the EEG, others wanted only gradual changes to be undertaken. All proposals shared the sentiment that incentives for present EEG installations should not be touched, whereby the existing EEG regulations for current installations (and thus the EEG reallocation charge) should be preserved until at least 2032.

The FDP, the RWI and professors from TU Cottbus have suggested quota models as a market alternative to further develop renewables in a cost-effective manner. Saxony has already had a similar proposal but was rejected in the Bundesrat. However, the BMU, a number of companies, industry associations and NGOs take a critical position regarding quota models as they believe the models won’t incentivise the more expensive technologies. They are also concerned about the overcompensation of cheap locations and technologies if more expensive locations or technologies are necessary to meet quotas. Finally, there are concerns regarding lower public participation if renewable projects are no longer exempted from price and sales risks.

Tendering models comprise a further part of the discussion, such as those suggested by the arrhenius institute, in which public authorities conduct competitive local tenders for yet to be determined renewable energy technologies. These should ensure that network bottlenecks are avoided and costs kept down by the competitive tender.

The industry association BDEW advocates further development of selling RES electricity in order to claim the market premium. This should become obligatory and could be paid as a fixed market premium instead of being adjusted ex post based on the EEG tariff rates. The objective is to better integrate renewable energy through scheduled deliveries, allowing renewable energy installations to take part in the spot market as well as the balancing market. Reduction of bonuses could also intensify competition between some renewable energy installations. The Economic Council of the CDU supports similar amendments. The TU Berlin points out that sufficient backup capacity could already be ensured with the existing instruments, given selling obligations for EEG installations and the associated balancing group responsibilities. The discussions are far from being over, and will be bundled into the Renewable Energy Platform by the BMU. A major amendment to the EEG can realistically be expected only at the end of 2014.

Electricity Price Brake 2013

Given the threat of an increasing EEG reallocation charge in 2014, on 13 February 2013, the Federal Minister for the Environment and the Federal Minister for the Economy proposed additional short-term measures to “safeguard the electricity price”. With the approval of the Bundesrat, these could still be implemented within this legislative period. Despite the cancellation of further development of liquidity reserves, and PV growth being limited and directed towards onsite consumption, the strong fall in wholesale electricity prices threatens a further increase to the EEG reallocation charge by the end of 2014. The 2014 EEG reallocation charge should therefore be frozen at the 2013 level, and subsequently be permitted to increase only by an annual rate of 2.5 %. This would result in only €500 million per year for new installations.

In order to accomplish this, the following permanent measures need to be established. On one hand, the privileged industrial companies which, according to their exemption scheme, currently only pay an EEG reallocation charge of 0.05 cents/kWh should pay between 0.5 and 0.7 cents/kWh instead. In addition, operators of installations where the electricity is consumed onsite (who have up to now been exempt from the EEG reallocation charge), should also pay a similar amount. The expansion of the base on which the EEG is levied should achieve savings of €700 million for non-privileged customers.

At the same time, a 4 % reduction in tariff rates is proposed for renewable energy installations built after 1 August 2013. In addition, operators of EEG installations are to only receive the market value of their electricity for the initial 5 months following installation start-up. Only PV installations are exempt from these regulations. In contrast, operators of new onshore wind installations have to accept additional reductions of remuneration rates and cancellation of bonuses. These could total up to -20 %. Altmaier indicated overfunding as grounds for these changes, which can also be observed in the very high rental yields for wind generation locations. Operators of new installations of over 150 kW should also be obliged to conduct the selling of their RES electricity into the market, while the recently reduced management premium should be fully eliminated in the mandatory market premium model. In addition, existing renewable energy installations should forgo 1.5 % of support payments in 2014. In total, these measures should achieve savings of €1.16 billion for non-privileged customers.

The short-term implementation of the proposed measures prior to the parliamentary elections of 22 September 2013 could be politically difficult, due to both the higher financial burdens borne by German industry in comparison to international competitors as well as the deteriorated investment conditions for EEG installations.

4.3 Monitoring the Energy Transition

The monitoring of changes in the energy sector has taken increasing shape in "year two" of the energy transition in Germany. The announcement of this took place early on: The German Federal Government had already provided for "scientifically based monitoring" as early as September 2010 in its Energy Concept to determine if its ambitious energy transformation plans could be achieved within the planned frames of reference. On 19 October 2011 the Federal Government established the "Energy of the Future" monitoring process. Under the terms of this process, a Monitoring Report is to be provided on an annual basis, and a Progress Report every three years. The process is additionally supported by a panel of four energy experts.

The first Monitoring Report under the terms of the monitoring process has been available since 19 December 2012. It was prepared together by the German Federal Ministry for Economics and the German Federal Ministry for the Environment, and passed by the Federal Cabinet. The accompanying commentaries of the panel of four experts have also been available since December 2012.

The first Monitoring Report relates to the energy landscape in 2011, and primarily presents a comprehensive stock-take on the current situation (an "opening balance"). This provides a basis for interpreting the development of the energy sector in the following annual reports. The approximately 120-page report begins with an assessment of the three aspects of the energy policy triangle: It still regards Germany as having a high level of energy security (albeit with reduced reserves in the electricity sector); it recognises the significantly increased prices with respect to economic competitiveness; and it paints a detailed picture with regard to environmental sustainability. To establish a foundation for further assessments, 49 indicators are subsequently listed. These are followed by a comprehensive presentation of different factors relevant to energy, which, in addition to the subjects of energy efficiency, renewable energy, power plants, networks and greenhouse gas emissions, includes such factors as prices and costs, buildings and transport as well as macroeconomic effects.

The approximately 150-page commentary by the expert panel conducts a comprehensive evaluation of the first Monitoring Report. Of particular note is the suggestion, given the vast number of policy objectives, that a hierarchy of objectives be established. The panel considers that the primary objectives should be the reduction of greenhouse gas emissions and the phase-out of nuclear energy. Sub-objectives and measures need to be differentiated from these primary objectives. The distinction can help answer questions of where corrections are possible and where they are not. The experts also give some important guidance regarding the indicators used in the Monitoring Report for its assessments. They view the current list of indicators as over-complex and suggest for the future a compact list of easily comprehensible key indicators. Finally, they indicate the increased data collection requirements expected in future and encourage an amendment to the Energy Statistics Act.

In addition to – and even prior to – the governmental monitoring, a number of other institutions revealed their monitoring instruments to the public in 2012. These are also intended to be updated on an annual basis. Representative examples of these include: the BDI publication "Energiewende-Navigator"(Energy Transition Navigator) which uses a traffic light system to review the previously mentioned energy policy triangle, as well as the factors of acceptance and innovation; the "Deutsche Energie-Kompass" (German Energy Compass) issued by the IG BCE trade union, which, as a result of representative surveys, pays special attention to issues of acceptance; the "Deutscher Energiewende-Index (DEX)" (German Energy Transition Index) issued by Ernst&Young and dena, which examines the sentiments of various energy-relevant groups (such as energy supply companies, network operators, investors, consumers, government, etc.) with respect to the energy transition; and finally the "Energiewende-Index Deutschland 2020" (Energy transition index Germany 2020) issued by McKinsey, which provides an overview of the status of the energy transition every three months.

These all recognise that monitoring the energy transition is a learning process which needs to be refined in the coming years. Monitoring also cannot be an end in itself: It should provide society with recognised, meaningful information, allowing a sophisticated debate on the energy transition; and it should enable government to adjust its position accordingly in the face of potential problematic developments.

4.4 Shale gas potential in Germany

Shale gas is now globally recognised as a significant natural gas resource. The catalyst for this was the development of numerous shale gas deposits in North America. The USA should prospectively be able to cover its natural gas requirements from its own sources in the medium term. In contrast, Germany has to import more than 85 % of its natural gas needs. Against this background, the Federal Institute for Geosciences and Natural Resources (BGR) has initiated a project to estimate these resources. This project, titled "Oil and gas from shales – potential for Germany" and abbreviated as NIKO (for NIcht-KOnventionell – German for unconventional), has a planned project duration of four years (from 2011 to 2015). The objective of the project is to first determine domestic shale gas potential, and then to also ascertain the shale oil resources. All relevant shale formations where oil and gas could be formed and stored are being investigated. The study also addresses the aspects of environmental impact, technological developments and issues of sustainability. These however are not the object of consideration in this article. The BGR published a first preliminary estimate of shale gas potential in mid-2012, and the results of this are briefly described in the following section.

Shale gas deposits in Germany

Shale gas belongs to the group of so-called unconventional natural gas resources. The formation and composition of unconventional natural gas is basically the same as with conventional deposits, as equivalent preconditions have to be fulfilled. In contrast to conventional natu-

Figure 4.19: Distribution of bituminous shale meeting the basic prerequisites for the formation of shale gas (grey area)

The areas primarily trace the known hydrocarbon provinces in the large sedimentary basins. The hatched areas indicate the regional distribution of potential shale gas formations, depending on the selection criteria applied.

Source: BGR

Table 4.3: Gas-in-place and technically recoverable quantities of shale gas in Germany (assuming a recovery factor of 10 %), in trillion (10^{12}) m^3

Formation	gas-in-place			technically recoverable		
	Minimum	Median	Maximum	Minimum	Median	Maximum
Lower Cretaceous – Wealden	1.1	2.4	4.4	0.1	0.2	0.4
Lower Jurassic – Posidonia shale	0.9	2.0	3.8	0.1	0.2	0.4
Mississippian	2.5	8.3	17.7	0.3	0.8	1.8
Total*	**6.8**	**13.0**	**22.6**	**0.7**	**1.3**	**2.3**

* The total quantities are derived from the simulation and therefore do not exactly correspond to the sum of the values of the individual formations.

ral gas deposits, where the natural gas is concentrated in spatially restricted structures, unconventional deposits are extensively distributed underground. They have only very limited natural pathways and very small pore spaces in which the natural gas in stored (for further information, see also the WEC report: Energy for Germany 2012). These "continuous" hydrocarbon deposits require more involved extraction methods to achieve economic development of underground shale. This is where techniques such as hydraulic fracking and horizontal drilling come into play, creating artificial pathways to increase the contact area between drilling and the deposit. Without the application of these techniques, shale gas production would only be economical in exceptional cases.

There are a number of organically rich shale formations in Germany in which shale gas could be found. A series of selection criteria was first defined to obtain a selection of formations to be investigated. The most important criterion is the quantity of hydrocarbon that could form. This is dependent on the quantity and type of organic material, as well as the thermal maturity. For natural gas to form at all, the rock has to sink to great depths in the course of geological time, so that the organic material can be converted to hydrocarbons through heat and pressure. For the BGR study, the density and depth of the formation constitute further important selection criteria.

The preliminary assessment of shale gas potential in Germany investigated shale from the Mississippian subperiod, Wealden (lower Cretaceous period) and Jurassic Posidonia shale. The regional distribution of prospective areas (Figure 4.19) was determined based on the application of the previously described parameters. According to this, potential for shale gas can be found in the southern edge and eastern part of the Northwest German Basin, in northeast Germany as well as in the middle of the Upper Rhine Plain region.

Estimation of potential

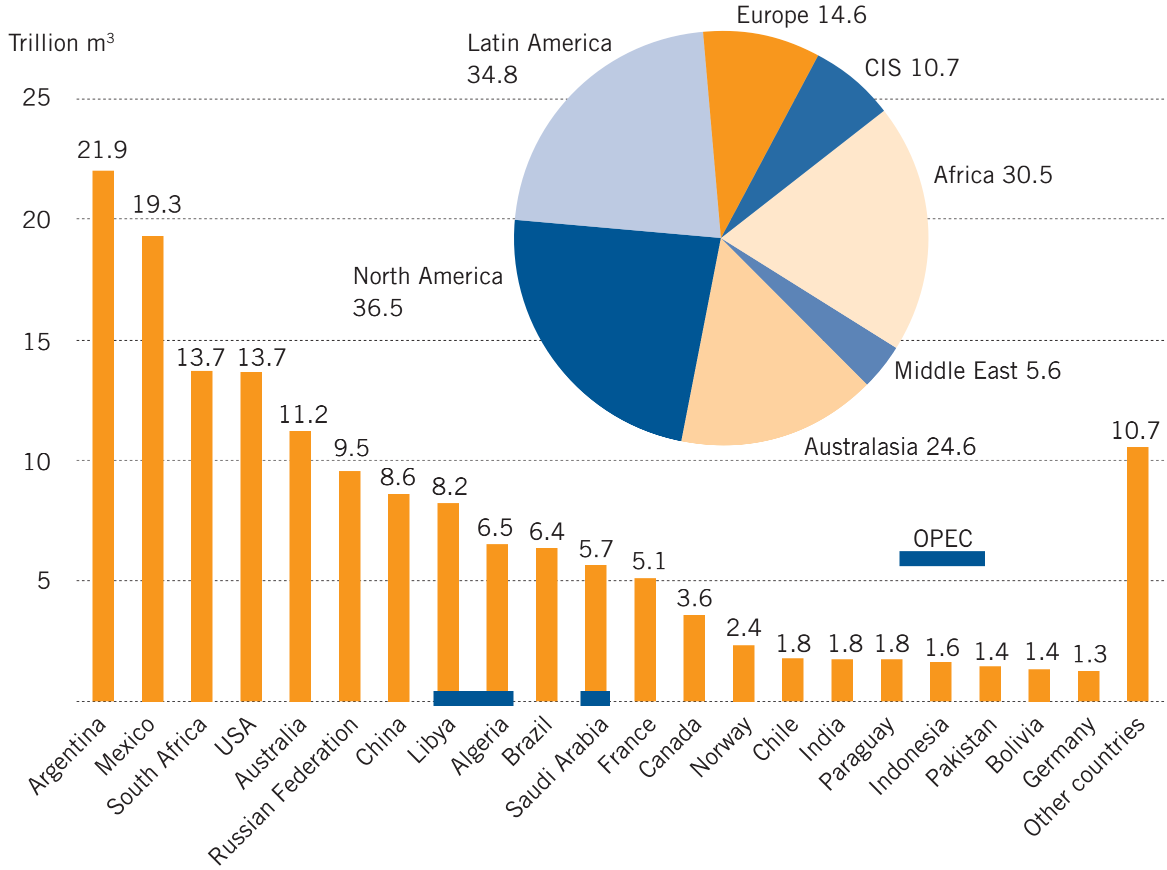
Natural gas can be found in two forms in shale: it can be adsorbed onto organic material and shale surfaces or be present as free gas in pore spaces and fissures. Both gas phases are separately evaluated for the assessment and subsequently presented together as the total quantity (gas-in-place, or GIP).

The volume for each formation is subsequently calculated, as determined by the distribution and density of the formation. The quantity of adsorbed gas is calculated by multiplying the volume of rock by the density of the rock and a factor indicating the concentration of gas per cubic metre. The share of cavity volume filled with gas (porosity) is decisive in determining the share of free gas. The volume of free natural gas is calculated by multiplying the gas-filled porosity with the volume of rock and the gas expansion factor. The gas expansion factor is necessary for the conversion of the natural gas volume stored in deposit conditions to the volume at room temperature and atmospheric pressure. The total quantity of natural gas results from adding the quantities of both gas phases together.

Uncertainties in calculating quantities of gas, for example due to limited availability of data, are quantified by means of the statistical procedure known as the Monte Carlo method. Using this method the probability is calculated in a quantitative analysis over a number of random experiments. The results of the calculation indicate the probability of a quantity of gas being in a specific interval.

The total amount of shale gas present in the formations investigated is between 6.7 trillion m^3 (p05) and 22.7 trillion m^3 (p95) (see Table 4.3). The median totals around 13 trillion m^3 GIP (p50). The results of the probabilistic assessment (stated in p05, p50 and p95 percentiles) give

Figure 4.20: Total shale gas resources and regional distribution



Source: BGR database, as at 2010, the figures for Poland are from EIA 2011, the figures for Germany from BGR 2012b

the probability that the actual values will not be below or above the derived value (minimum p05 – a 95 % probability that actual value won't be below the derived value; median p50 – average value; maximum p95 – a 95 % probability that the actual value won't be above the derived value). Mississippian shale demonstrates the greatest potential. The calculated median GIP quantity of around 8 trillion m³ is far above that of Posidonia shale (lower Jurassic) and Wealden (lower Cretaceous), which both total around 2 trillion m³ GIP. There is however currently little reliable data relating to Mississippian shale. Little information is available for basic factors such as the regional distribution of facies and variations in density. This greatly limits the accuracy of the estimations. Posidonia shale is in a better initial position with respect to such estimations. With this type of shale the potential for shale gas in North Germany is estimated as relatively high, due to the geochemical parameters and relatively homogenous composition of the sediments. Shale gas potential in Posidonia shale can be found in the southern edge of the Northwest German Basin, as well as in the middle of the Upper Rhine Plain. Wealden shale also possesses a relatively high shale gas potential, and is located in the south of the Northwest German Basin.

Once the GIP quantities have been determined, the technically recoverable potential share has to be ascertained, i.e. the resources of real interest. As there is no current production of shale gas in Germany, there are also no figures based on experience regarding the resource share of GIP quantities. Production data from the USA indicate that the recovery factor generally fluctuates from 10 % to 35 % of GIP quantities, and higher than this in some cases. Taking a conservative approach, this study assumes a technical recovery factor of 10 % of GIP quantities. The technically recoverable natural gas quantities correspondingly total between 0.7 trillion to 2.3 trillion m^3 (Table 4.3). This quantity of shale gas resources is far above Germany's conventional natural gas resources, which amount to 0.15 trillion m^3 and its natural gas reserves, which total 0.146 trillion m^3.

Data is now available for a number of countries with respect to their shale gas deposits. Despite the different methods of calculation applied, and even more significant uncertainties, a rough overview of global shale gas resources can be arrived at (Figure 4.20). Given the progressive increase in knowledge in this field, corrections in rankings resulting from reassessments also in other countries are to be expected. Subject to the still incomplete state of the data, the BGR currently reports around 157 trillion m^3 of global shale gas resources.[1]

Outlook

The use of natural gas as an energy source constitutes an important pillar of the energy transition. Production of conventional natural gas is however on the decline in Germany, while dependence on imports is increasing. Annual consumption of natural gas in Germany totals around 90 billion m^3, and currently only around 12 % is covered by domestic production. Determined quantities of shale gas in Germany are between 6.8 trillion m^3 and 22.6 trillion m^3. Assuming a recovery factor of 10 %, between 0.7 trillion and 2.3 trillion m^3 of technically recoverable natural gas is present. This places shale gas quantities clearly above Germany's conventional natural gas resources (0.15 trillion m^3) and natural gas reserves (0.146 trillion m^3). The development and production of shale gas using the necessary technology should take place according to the legal requirements, and in a controlled and environmentally sound manner. If these criteria are met, fracking also can be applied following the evaluation of extensive preliminary local investigations. In principle, this is possible to accomplish in an environmentally sound fashion from a geoscientific perspective. To what extent shale gas production will take place, if at all, is currently not foreseeable. Broad public acceptance is a prerequisite for accessing this resource. To achieve this, the geosciences have to address the public concerns. In this context they can contribute to opinion forming with the aid of scientifically based information and transparency.

1 The BGR study on shale gas potential in Germany is available at: http://www.bgr.bund.de/DE/Themen/Energie/Downloads/BGR_Schiefergaspotenzial_in_Deutschland_2012.pdf

4.5 The role of the financial industry in energy investment

Germany's complete phase-out of nuclear energy by 2022 will again increase the need for investment in renewable energy, electricity networks and energy efficiency measures. At the same time, the earning power of energy supply companies is falling, who have traditionally played the role of investors. This has led to a debate on new financing solutions to implement the energy policy objectives.

The German Federal Government-initiated energy transition has resulted in a devaluation of assets for some industry market participants of a scope not anticipated by either company owners or managers. The political decisions taken have led to energy supply companies suffering from a simultaneous combination of falling earning power and increasing investment requirements. The erosion of earnings in the energy production industry is ultimately the result of a changed production mix brought about by the legislators.

The falling earning power of German energy suppliers is reflected in reduced market valuations as well as the downward-adjusted forecasts by analysts for individual companies. The growing indebtedness of many energy supply companies in combination with the collapse of established value chains has resulted in increased attention being given to the industry by ratings agencies. Classic market participants are quite obviously unable to provide the billions required to finance the energy transition by themselves. The negative development in share prices has effectively ruled out further increases in equity, and additional borrowing by the established energy suppliers also eventually reaches its natural limits.

To free up additional resources, energy suppliers in Germany have thus begun to sell, entirely or in part, activities that no longer belong to the core business. In this context, former affiliates alone have announced the sale of over €20 billion of assets and have progressed with the implementation of this objective to various degrees. Measures to realign business models and increase efficiency have also been conducted parallel to this.

A reduction of shareholding of this scale was not possible within the utilities industry itself, which has resulted in public sector or financial intermediaries being strongly represented among the buyers (see Figure 4.21).

Figure 4.21: Transactions in the German energy industry (examples)

Object of sale	Buyer	Seller	Enterprise value (approx.)	Date
e·on Thüringer Energie	Kommunaler Energie-Zweckverband Thüringen	e·on	EUR 0.9 billion	Jan 2013
E.ON Energy from Waste	EQT	e·on	EUR 1.0 billion	Dec 2012
Berliner Wasserbetriebe	Berlin	RWE	EUR 650 million	Jul 2012
Open Grid Europe The Gas Wheel	Macquarie	e·on	EUR 3.2 billion	May 2012
amprion	Pension funds/ insurance companies	RWE	EUR 1.1 billion	Jul 2011
enso	EVD	VATTENFALL	EUR 150 million	Jun 2011
steag	Rhein-Ruhr Konsortium von kommunalen Energieversorgern	EVONIK INDUSTRIES	EUR 3.2 billion	Dec 2010
Thyssengas Erdgaslogistik	Macquarie	RWE	EUR 500 million	Dec 2010
50hertz	elia Powering a world in progress	VATTENFALL	EUR 800 million	Mar 2010
GESO Beteiligungs und Beratungs AG	TWD	EnBW	EUR 850 million	Feb 2010
transpower stromübertragungs gmbh	TenneT Taking power further	e·on	EUR 1.1 billion	Nov 2009
thüga Aktiengesellschaft	KOM9 Integra Konsortialpartner	e·on	EUR 2.9 billion	Oct 2009

The buy-side is dominated by institutional and municipal investors rather than strategic investors

Source: mergermarket

Figure 4.22: Involvement of institutional investors – key features

1. Financially sound financing partner with high credit ratings and broad acceptance
2. No strategic ambitions of institutional investors, but a long-term investment horizon
3. Passive co-investor alongside an experienced operative partner
4. Interested in secure investments with stable cash flows and reasonable returns
5. High investment requirements and interest in follow-up investments – securing optimal capitalisation

→ **Implementation of a long-term partnership between energy suppliers and institutional investors**

Source: G. F. Sommer, Commerzbank

The public sector and its associated companies are well-known for their unsurpassed capacity to obtain cheap borrowed capital. Nevertheless, for a variety of reasons, they are unable to shoulder the costs of the energy transition alone. The risk weighting, the regionality or the sheer size of the investments make only select parts of the energy transition attractive to these market participants. A focus of public energy supply companies' investments was the takeover of existing energy distribution and supply activities, which are classified as both relatively low-risk and connected to municipalities.

The takeover of existing infrastructure by states or municipalities does not however make an active contribution to the energy transition; rather it only represents the expansion of public sector influence in the German energy industry. In this context, it is of particular note that foreign energy supply companies have gradually retreated from the German market and have made no attempt to position themselves in the market.

All-in-all, this has made it clear that neither the private sector nor public energy supply companies will raise the necessary capital for the energy transition. The current

Figure 4.23: Insurance companies as potential investors

Insurance companies in search of new investments

- Current low level of interest rates
- Stability and attractiveness of cash flows
- No correlation with capital market development
- Protection from inflation
- Lack of alternative investments

Largest German insurance companies

Rank 2011	Company	Income from premiums (2011, in € mil)	Change in %
1	Allianz Group	103,560	–2.7
2	Münchener-Rück-Gruppe	49,572	+8.9
3	Talanx AG	23,682	+3.6
4	Generali Deutschland Holding AG	16,168	–0.7
5	V+R Konzern	11,332	+2.0
6	Axa Konzern AG	10,634	+2.1
7	Debeka Versicherungen	8,849	+3.2
8	Versicherungskammer Bayern	6,644	–7.1
9	Zurich Gruppe Deutschland	6,323	–9.4
10	Signal Iduna Gruppe	5,467	–3.1

→ **Major interest in long-term capital investment in regulated energy infrastructure**

Source: Frankfurter Allgemeine Zeitung, 4 July 2012

Figure 4.24: Advantages of institutional investor involvement for energy supply companies – key features

1. Cost/time efficient process conducted with the utmost confidentiality
2. Long-term relationship with partners that have good credit ratings
3. Reduction of financial burden through follow-up investments
4. Avoidance of the strategic influence of direct competitors
5. Compatibility of shareholder interests

→ **Creating a "win-win situation" for both energy suppliers and institutional investors**

Source: G. F. Sommer, Commerzbank

low interest rates have however made a part of the energy industry interesting for institutional investors, who previously concentrated on buying bonds. Key features of these investors are briefly outlined in Figure 4.22.

German insurance companies and pension funds are well-known as long-term investors, largely as a result of the nature of insurance regulations. In total, they manage investments of over €1,000 billion. A substantial component of these investments used to be government bonds, but these have recently suffered considerable downgrades to their risk/return profile. For risk-averse conservative institutional investors the regulated part of the energy industry is a welcome alternative to investments in fixed interest bonds. An overview of the annual income from premiums for the major insurance companies is presented in Figure 4.23.

When considering investments, German institutional investors are guided by factors of return, predictability and security, whereby long-term commitments play a major role due to the large investment volume involved. The investment preferences of these financial intermediaries intersect well with the investment requirements of the German network-based energy industry, which also needs to think in a long-term manner. In addition to the matching timeframes, the complementarity of the partner is also highly relevant. Whereas institutional investors can provide both long-term capital and follow-up investments, energy industry representatives can ensure the necessary expertise for the operation of these companies. At the same time it is in the interest of both energy supply companies and investors to ensure that there are no competing interests, and that a friction-free environment is established for shareholders and the operational business. The key advantages for involving institution investors from the perspective of energy suppliers are summarised in Figure 4.24.

In Germany, the investment of pension funds and insurances companies in the high-voltage network of the Dortmund-based Amprion received broad attention and demonstrated the public acceptance of this manner of infrastructure financing. It allows the funds of private individuals to finance even major investments in a professional manner, and sets a precedent that others will justifiably emulate.

WEC Inside

5

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

World Energy Council (WEC)

The World Energy Council (WEC) was founded in 1923 with headquarters in London. Today, the organisation comprises around 90 national committees, representing over 90 % of global energy production. The WEC is the platform for the discussion of global and long-term issues relating to the energy industry, energy policy and energy technology. As a non-governmental, not-for-profit organisation, the WEC forms a global network of expertise which is represented in the industrialised countries, newly industrialised countries and developing countries from all regions of the world.

The activities of the WEC cover the entire spectrum of energy sources – coal, oil, natural gas, nuclear energy and renewable energy – as well as the associated environmental and climate issues. It is the only global network of its kind covering all energy sources. Since its foundation, its objective has been to promote the sustainable utilisation of all forms of energy – for the benefit of everyone.

The WEC conducts studies as well as technical and regional programmes in pursuit of this objective. Every three years, the organisation hosts the most prestigious international energy conference, the *World Energy Congress.* This event, lasting several days, aims to promote a better understanding of current and future energy issues and solutions 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 (WEC) for Germany. It is comprised of companies from the energy industry, associations, academic institutions and individuals. As a non-governmental, not-for-profit organisation, the Weltenergierat – Deutschland is independent in forming its opinions. The Executive Board of the organisation comprises representatives from all energy sources.

The objective of the Weltenergierat – Deutschland is the implementation and dissemination of the achievements of the WEC in Germany, in particular to create awareness of the global and long-term aspects of energy and environmental policy, also in national debate.

To this end, the Weltenergierat – Deutschland is actively involved with the opinions and studies of the WEC. In addition, it also organises its own events, conducts its own studies and, with this publication "Energy for Germany", provides an annual overview of the most important energy industry data and prospects for the world, Europe and Germany.

www.weltenergierat.de

5.1 Highlights 2012 / 2013

Events 2012 / 2013

Energy and Mobility Technologies

25 June 2012, Berlin

In June 2012, around 100 representatives from business and politics accepted the invitation from the Weltenergierat – Deutschland and its partners to the “Energy and Mobility Technologies of Tomorrow” conference.

Dr Markus Wrake, Senior Energy Analyst at the International Energy Agency (IEA), presented the publication “Energy and Technology Perspectives” (ETP). The report evaluates current progress in relation to climate protection in the 2 °C, 4 °C and 6 °C scenarios and outlines the challenges. According to the IEA, global warming can be limited to 2 °C only if an additional USD 36 trillion is invested globally before 2050. Potential for energy savings can be found particularly with regard to the areas of cooling and heating. CCS could provide significant leverage for the global reduction of CO_2.

CCS was also evaluated as a priority research project for Germany by Dr Christian Urbanke, Chair of the BDI Energy Research Committee and Vice President of Corporate Technology at Siemens, in his presentation. A total of 10 technological developments were classified as priorities in “Technologies of the Future”, an evaluation by the industry umbrella organisation. These were mostly in connection with the development and integration of renewable energy, as well as with increasing efficiencies in industry and power plants.

In the second part of the event, the outlook for the transport sector was presented. Prof. Karl Rose, Director of Policies and Scenarios at the World Energy Council, presented the latest “Global Transport Scenarios 2050”. The special feature of this scenario project is the involvement of experts through local workshops around the world. The scenarios clearly demonstrate a doubling of the number of motor vehicles 2050, and that the rise in CO_2 will increase the sense of urgency for regulators. Karl Rose thereby presented a first chapter from the World Energy Council scenario work, which will be published in autumn 2013.

Dr Markus Wrake, Senior Energy Analyst, IEA

Prof. Karl Rose, Director Policies & Scenarios, World Energy Council

A keynote speech from a business perspective was then delivered by Dr Matthias Klauda, the Technical Director of Automotive Systems Integration at Robert Bosch GmbH. He presented the challenges and the promising technical developments in the transport sector, such as interesting advances with regard to electric engines for motor vehicles. In the medium-term however, combustion engines will remain the dominant motor technology, albeit with significant potential for increases in efficiency.

Following this, Dr Ruprecht Brandis, BP Europa SE, Alexander Koerner, IEA, Dr Knut Kübler, BMWi and Friedrich Schulte, RWE AG, discussed the findings of the scenarios together with Prof. Karl Rose.

Energy Day 2012: "Tomorrow's Energy Policy – Opportunities, Risks and Side Effects"

11 September 2012, Berlin

Under the heading "Tomorrow's Energy Policy – Opportunities, Risks and Side Effects", leading German and international experts from politics and business discussed current topics for the energy industry and energy policy at the Weltenergierat – Deutschland's Energy Day 2012.

The morning was entirely dedicated to the subject of Market and Regulation. Dr Leonhard Birnbaum, Vice Chair of the Weltenergierat – Deutschland and Vice Chair Europe of the World Energy Council, and Jochen Homann, President of the Bundesnetzagentur were among those who represented the sometimes differing approaches.

In the context of the energy transition, Dr Birnbaum sees Germany confronted with a fundamental decision to be taken between, on the one hand, a market economy and more Europe, and on the other hand, a deterministic state controlled economy. In his opinion, the sovereignty of the market and consumer must not be sacrificed for the sake of the energy transition. According to Birnbaum, Germany needs the efficiency of a market economy instead of duties and charges.

Addressing the possibility of a new market design, the President of the Bundesnetzagentur, Jochen Homann, warned of spiralling regulation. The EEG has disrupted fundamental connections in the electricity market. Although a natural monopoly indisputably requires regulation, the efficiency of the regulation must remain in the foreground.

The afternoon focussed on current developments in the field of unconventional energy sources. In his keynote speech, Joachim Pünnel, Vice President Business Unit Germany, Wintershall Holding GmbH, described the global potential of unconventional energy sources as significant and noted the USA as a pioneer in production. Outside of North America, development in the field of shale gas has been promising, but can hardly be considered advanced.

Public acceptance and trust in the industry are the key to the production of unconventional energy sources. According to Deborah Gordon from the Carnegie Endowment for International Peace, important questions regarding environmental impact, emissions and water consumption would have to be answered to achieve this. Fact-based information from industry and science has to provide the foundation for political decision making.

It became clear during the podium discussion that the focus of national debates regarding the production of unconventional energy sources differs depending on the country. According to Marek Karabuła, 75 percent of Poles accepted the production of shale gas in their own country, with the independent and cheap supply of energy being the focus of Polish energy policy. Oliver Krischer, MdB, Bündnis90/Die Grünen, made it clear that, in Germany, fracking is most commonly associated with environmental risks.

Deborah Gordon, Senior Associate, Carnegie Endowment for International Peace

(from left to right) Dr Leonhard Birnbaum, Vice Chair Europe, World Energy Council; Jochen Homann, President, BNetzA

Jürgen Stotz, Chair, Weltenergierat – Deutschland

(from left to right) Christian Spanik; Ulrich Kelber, MdB, SPD; Dr Holger Krawinkel, Head of Housing, Energy and Environment Department, Verbraucherzentrale Bundesverband e. V. (VZBV); Dr Joachim Pfeiffer, MdB, CDU; Dr Klaus von Sengbusch, Head of Energy Management, 50Hertz Transmission GmbH

Joachim Pünnel, Vice President Business Unit Germany, Wintershall Holding GmbH

Dr Carsten Rolle, Executive Director, Weltenergierat – Deutschland

(from left to right) Dr Steffen Bukold, Energy Comment; Dr Heinrich Herm Stapelberg, Public & Government Affairs Manager, ExxonMobil; Dr Andreas Hübner, Researcher, GFZ German Research Centre for Geosciences; Deborah Gordon, Senior Associate, Carnegie's Energy and Climate Program; Marek Karabuła, President of the Board, Polish Oil and Gas Company; Oliver Krischer, MdB, Bündnis 90/Die Grünen

Matthew Hulbert, Lead Analyst, European Energy Review

Presentation of the report on international hydropower storage

9 October 2012, Berlin

The Weltenergierat – Deutschland report "The significance of international hydropower storage for the energy transition" was produced in cooperation with experts from Switzerland, Austria, Norway and Sweden from Prognos AG, and has attracted a great deal of interest both nationally and internationally. Among other topics, the report investigates the potential of hydropower storage in the Alpine region and Scandinavia, as well as the economic efficiency of interconnectors between Germany and the electricity supply systems of the countries in the report. According to the report, pumped-storage installations and hydropower storage installations in the Alpine region and Scandinavia provide an opportunity to integrate electricity from renewable energy sources in Germany. Norway in particular stands out as an interesting partner: the potential for construction of new interconnectors is between 7 GW and 12 GW, which could utilise between 26 and 52 % of German surplus electricity.

Jens Hobohm, Head of the Energy Industry Department, Prognos AG

The results of the report were presented and discussed in Berlin at the Haus der Deutschen Wirtschaft (House of German Business). Ingard Moen, Vice President for International Business Development at Statnett, provided comment on the results from a Norwegian perspective. In doing so, he made it clear that the technical and economic challenges in planning a connection between two electricity systems – such as between Germany and Norway – are very complex indeed. Dialogue with foreign market participants is important for investment decisions, especially with regard to changes in the political conditions that have an impact on the energy market.

Ingard Moen, Vice President, International Business Development, Statnett

Following the presentation, the results of the report, and future cooperation between Germany and its partners in Scandinavia and the Alpine region were discussed by Dr Alexander Gratzer, Chair of the WEC Austria, Dr Stephan Kolb, Head of Public Affairs, Statkraft AS, and Boris Schucht, Chief Executive Officer, 50Hertz Transmission, together with Jens Hobohm, Head of the Energy Industry Department, Prognos AG. It was stressed that an energy transition at the European level and with multilateral cooperation can create numerous synergies.

The results of the report were subsequently presented in further events, such as the German Norwegian Energy Forum. The report was also presented in Brussels to various multipliers from business and politics, including the European Commission and European Council.

Ghorfa – 3rd German – Arab Energy Forum

11 – 12 October 2012, Berlin

The Weltenergierat – Deutschland supported the German – Arab Energy forum in Berlin again in 2012. Among others, Dr Carsten Rolle, Executive Director of the Weltenergierat – Deutschland, moderated the panel on current developments in oil and gas.

Under the auspices of the Federal Minister for the Economy, Dr Philipp Rösler, and invited by the Arab-German Chamber of Commerce and Industry e.V. (Ghorfa), management boards and experts from the energy industry met for the 3rd time. Current developments in wind energy were discussed, as well as conventional energy, supply of drinking water and its security, oil and gas supply, solar energy and, finally, energy transport.

As in previous years, the German – Arab Energy Forum provided the around 300 participants from politics, business and academia an ideal platform for discussions regarding possible future cooperation, and arrangement of concrete joint projects involving the German and Arab energy industries.

Audience at the German – Arab Energy Forum

Executive Assembly

4 – 8 November 2012, Monaco

As part of the 2012 Executive Assembly of the World Energy Council in Monaco a successor to the previous Chair, Pierre Gadonneix, was nominated. The candidate selected in Monaco, Marie-José Nadeau, will assume her office as the new Chair of the World Energy Council at the World Energy Congress 2013 in Daegu. In doing so, she will become the first woman in this position in the 90-year history of the WEC. Marie-José Nadeau has chaired the Communications and Outreach Committee since 2007 and is also a member of the WEC Finance Committee. In addition, she is responsible for a great deal of the success of the 2010 World Energy Congress in Montreal.

The Executive Assembly also selected the South Korean Younghoon David Kim as Co-Chair-elect, who will also assume office in Daegu. Younghoon David Kim was the WEC Vice Chair for Asia Pacific and South Asia from 2005 to 2011.

Both will serve in their respective functions until 2016. After this, Younghoon David Kim will serve as Chair of the WEC for a further three years.

This is the first time in the history of the WEC that both a Chair and Co-Chair have been elected. The goal of this approach was to achieve greater organisational continuity, to better represent the WEC globally and to provide more continuity in the leadership of the organisation.

Dr Leonhard Birnbaum was also unanimously elected as the new Vice Chair for Europe of the WEC in Monaco. With this he succeeds Dr Johannes Teyssen, CEO of E. ON SE, who had remained in office for the maximum possible two terms. As a newly elected Vice Chair, Leonard Birnbaum strengthens his involvement, already exercised in his capacity as Vice Chair of the Weltenergierat – Deutschland. After the election, Leonhard Birnbaum spoke in favour of approaching the future of energy supply from a European mindset and to shape it accordingly. His new function gives him the opportunity to do this and discuss the important energy topics with representatives from neighbouring states in a European context.

Presentation of the World Energy Outlook 2012

13 November 2012, Berlin

On 13 November 2012, the International Energy Agency presented the current World Energy Outlook in the Bundeswirtschaftsministerium (Federal Ministry for Economics). This event was conducted in cooperation with the Weltenergierat – Deutschland.

Some of the significant results of the IEA presented by its Chief Economist, Dr Fatih Birol, were:

The main scenario of the WEO indicates that by 2035 global primary energy consumption will be 35 % higher than in 2010. Within the same period of time, total demand for electricity will increase by over 70 %. Developing and newly industrialised countries will account for 93 % of global growth in primary energy consumption and 84 % of growth in electricity demand. Fossil fuels will continue to play a dominant role in covering global energy consumption, contributing 75 % of the total in 2035 (as compared with 81 % in 2010).

Presentation by Dr Fatih Birol, IEA

Until 2035, all conventional energy sources will contribute to supply in increasing absolute amounts – with natural gas demonstrating a particularly strong increase. By 2035, global consumption of natural gas will increase by 50 %. Global electricity generation from renewable energy sources will triple by 2035. At this point in time renewable energy sources will represent around 30 % of global electricity generation, almost as much as coal, which will represent 33 %. By 2035, the share of electricity generated by natural gas will increase by one percent to 23 %. In contrast, nuclear energy will generate 12 % of global electricity in 2035, representing a fall of one percent. The main scenario indicates CO_2 emissions increasing by 23 % from 2010 to 2035, however the EU-27's contribution to global CO_2 emissions will fall from 12 % to 7 %.

Expert Panel "European Gas Market: A Winter Outlook – and beyond"

22 November 2012, Berlin

Together with the Stiftung Wissenschaft und Politik (SWP), the Weltenergierat – Deutschland organised the "European Gas Market: A Winter Outlook – and beyond" expert panel in Berlin. Under the direction of Dr Kirsten Westphal (SWP) and Dr Carsten Rolle (Weltenergierat – Deutschland), around 35 experts from Germany and the rest of Europe discussed the current situation in the gas market as well as foreseeable developments.

The received opinion was that the future prospects for natural gas in Germany are no longer as promising as was recently expected. Despite the growing importance of gas globally, gas as an energy source is increasingly losing importance in Germany. Against the background of the developments in unconventional energy sources in the USA and Canada and the falling prices for CO_2 certificates, the use of coal in electricity generation is undergoing a renaissance in Germany. Gas power plants are scarcely worthwhile given current conditions. State-supported renewable energy has fundamentally changed the conditions for power plant operation.

In addition to the heating market, future prospects for gas are to be found primarily in the transport sector, which is already accustomed to fossil fuels. This could significantly reduce CO_2 emissions from ships, trucks and locomotives.

International Expert Panel on European Gas Markets

World Energy Leaders' Summit

5 – 6 February 2013, New Delhi

At the beginning of February, more than 80 high profile representatives from the energy industry, as well as ministers from 30 countries assembled at the World Energy Leaders' Summit (WELS) in the Indian capital New Delhi. These high-level meetings take place twice a year in countries with rapidly growing economies.

World Energy Leaders' Summit in Neu-Delhi

The objective of these events is to facilitate dialogue between leading representatives of the energy industry and politics, and in particular to discuss and address critical and decisive energy-related topics. The focus of the New Delhi discussions was the question of how the development of renewable energy can be accelerated around the world. The share of energy generated through renewable sources is still small but steadily increasing, if slowly. What is important here is further technological development, targeted financial support and the construction of plants as close as possible to where the energy is consumed.

German-Swiss Event "Shared path to a secure energy supply. What kind of infrastructure does the energy transition require?"

20 February 2013, Berlin

In February 2013, in cooperation with the Swiss Embassy and the BDI, the Weltenergierat – Deutschland organised a high-profile forum in Berlin on the topic "Germany – Switzerland: Shared path to a secure supply of energy. What kind of infrastructure does the energy transition require?" Around 80 participants accepted the invitation to the residence of the Swiss ambassador. The keynote speeches for the following discussion were delivered by Director General Detlef Dauke, BMWi, and Dr Walter Steinmann, Director of the Swiss Federal Office of Energy and initiator of the Swiss Energy Strategy 2050. Both emphasised the good cooperation between the countries. Switzerland is traditionally an important transit country for electricity in the heart of Europe.

Speech by Dr Walter Steinmann, Director of the Swiss Federal Office of Energy (SFOE), in the Swiss embassy

Furthermore, they discussed the future of cooperation in the electricity sector with Pierre-Alain Graf, CEO of Swissgrid, and Dr Hans-Josef Zimmer, Chief Technical Officer at EnBW. Bureaucratic obstacles regarding network expansion in Switzerland and uncertainty with respect to future market design were cited as challenges. Despite these difficulties, the common interest of all participants in a continuation or intensification of the transnational cooperation in the electricity sector was expressed (quote from the panel discussion "Electricity is Friendship"). A strengthened regional network is particularly sensible with regard to the development of volatile renewable energies. In future, this will also increase the importance of pumped-storage hydroelectric installations in Switzerland.

Executive Board meeting with EU Commissioner Günther Oettinger

29 April 2013, Berlin

The spring meeting with EU Commissioner Oettinger has become a fixed appointment in the calendar of the Executive Board of the Weltenergierat – Deutschland. This year the participants met on 29 April in Berlin for a joint luncheon.

This year, the focus of Commissioner Oettinger's speech and the following discussion with the Members of the Executive Board was the further development towards a unified European internal energy market, and the developments in Europe resulting from shale gas and shale oil production in North America. According to Günther Oettinger, all consumers in America now have to pay only around a quarter of the European price for gas, which is especially relevant for energy intensive industries. Europe thus risks falling behind when it comes to planning the location of new plants in the raw materials industry, and energy intensive industry in general. In his view, if Europe doesn't act accordingly, up to three million jobs could be lost throughout the continent in the coming years. This is one more reason for him to advocate an approach to fracking that is careful but also goal-oriented, and coordinated across Europe.

The next appointment with Commissioner Oettinger is planned for spring 2014 in Brussels.

Commissioner Günther Oettinger in discussion with representatives from the Weltenergierat – Deutschland

Young Energy Professionals – Activities 2012/2013

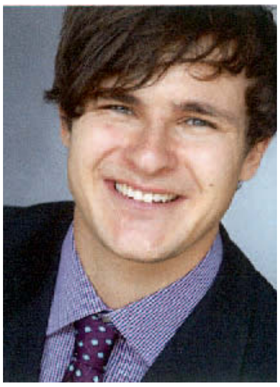
YEP meeting with Dr Andreas Wiese, Executive Director Energy Division, Lahmeyer International, Bad Vilbel, February 2012

Since the Youth Programme of the World Energy Congress held in Rome 2007, the Young Energy Professionals (YEP) have been meeting twice a year in Germany to share experience and views, and plan projects. The goal of the YEP is to impart fact-based knowledge on energy-related topics, especially to the younger generations.

Most recently, the YEP met in September at Siemens in Erlangen, where, in addition to participating in excursions, they had the opportunity to talk with high-ranking representatives from the company. In the past the group has taken part in the preparations for the Energy Day and also contributed to "Energy for Germany". In December 2012, the YEP Chris Schmelter from Vattenfall Stromnetz Hamburg, and Matthias Müller from Siemens visited civil engineering students at the Beuth University of Applied Sciences in Berlin. There they gave the students some insight into the subject of the integration of renewable energy into the electricity network, and its associated costs and investments. Additional YEP meetings are planned in 2013 at Marquard & Bahls in Hamburg, as well as at 50Hertz in Berlin.

YEP meeting at RePower in Rendsburg, August 2011

Three Young Professionals from Germany were selected by the World Energy Council to take part in the Future Energy Leaders' Programme (FELP) of the World Energy Congress in Daegu/South Korea in October 2013. The German delegation participating in the Future Energy Leaders' Congress will consist of Hannes Bieler from Hitachi Power Europe, Samuel Alt from Siemens and Chris Schmelter from Vattenfall Stromnetz Hamburg. In total, 100 young energy industry professionals from 90 countries shall attend the FELP. The programme has been designed in cooperation with FELP "alumni" and offers excellent opportunities for international networking amongst the younger generations. As an alumnus from Germany, Martin Pinkpank from Lahmeyer International has been involved in the organisation of this year's FELP.



Hannes Bieler, R & D Projects, Hitachi Power Europe

Samuel Alt, Energy Communication, Siemens

Chris Schmelter, Controlling Distribution, Stromnetz Hamburg GmbH

Martin Pinkpank, Business Development Thermal Power Plants, Lahmeyer International

Publications 2012 / 2013

World Energy Issues Monitor 2013
February 2013

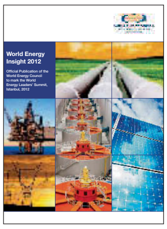
The "Issues Monitor" presents the results of the annual survey issued among the WEC's global network of experts. The central question is "What keeps energy leaders awake at night?" The subject of investigation is the growing uncertainty in the energy sector, which has resulted in an increasingly urgent positioning of energy supply issues on the global political agenda. Observations of the "Global Energy Leaders Community" at the regional, national and international levels are summarised and evaluated as part of the study. For the first time, the study this year includes specific assessments of selected countries: Colombia, Germany, India, Indonesia, South Africa and Switzerland.

World Energy Trilemma 2012: Time to get real – the case for sustainable energy policy
December 2012

The "World Energy Trilemma 2012" report was published in collaboration with the global management consulting firm Oliver Wyman. It is intended to inform decision makers from business and politics worldwide about sustainable energy systems. The publication is the first in a two-part series of reports based on interviews with more than 40 CEOs and senior executives from across the global energy sector. The report also includes the 2012 Energy Sustainability Index; a global ranking of the 93 WEC member countries based on their performance on the three aspects of the energy trilemma (energy security, environmental impact mitigation and social equity).

World Energy Perspective: Smart grids – best practice fundamentals for a modern energy system
October 2012

This edition of "World Energy Perspective" is dedicated to smart grids, and examines the principles of best practise for a modern energy system. Smart grids are an essential element of the transformation to a low-carbon economy which is also concerned with energy security. This report sheds light on the current status of smart grids and brings together the financing mechanisms for their development based on the best practise examples from various countries (India, Japan, China, South Korea, Brazil, Europe and North America).



World Energy Insight 2012
April 2012

"World Energy Insight 2012" is the official publication of the WEC. It includes articles, case studies and interviews with high-ranking experts and decision makers, dealing with a variety of current issues concerning the global energy industry.

2. Survey on the German energy transition: German Energy Policy – a blueprint for the world?

March 2013

The second global survey of energy experts conducted by the Weltenergierat – Deutschland confirms: The German energy transition is still no blueprint for the world, but is however an important source of ideas and inspiration. As in 2011, international energy industry experts from the network of the World Energy Council were surveyed regarding the success of the energy transition, its impacts and its function as an example to be emulated. 23 national committees, mainly from Europe, took part in the current survey.

Analysis of the responses shows that more than two years after the publication of the Energy Concept, the world continues to watch German energy policy very closely. Germany can serve as an example for the rest of the world only with an energy supply that continues to be secure and, and above all, economic. In particular, the concerns of Germany's European neighbours need to be taken very seriously. 80 % of all respondents believe that the German energy transition will result in an increase in electricity prices in their own country. Furthermore, up to 90 % of European countries assume a price increase in their own country, and almost 60 % fear a negative impact on their own energy security.

None of the respondents believes that Germany will achieve all the goals mentioned in the timetable. The share of those who consider that goals can be partially fulfilled, albeit delayed, has considerably increased from 37 % (2011) to just over 70 % (2013). The foreign energy experts are undecided as to whether Germany will be able to reach its CO_2 targets. The share of sceptics has however increased from 39 % in 2011 to 50 %, while the share of optimists has fallen from 61 % to 50 %.

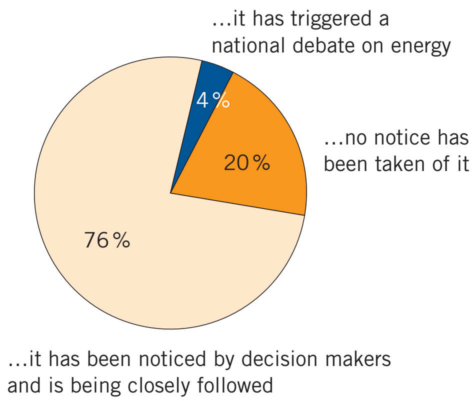
Around 56 % of respondents can still imagine adopting elements of the energy concept, particularly the CO_2 targets and turning more towards renewable energies. In comparison to 2011 however, the share of those who cannot imagine adopting any of the German targets has increased from 20 % to 44 %. This is not surprising, as 76 % of all respondents describe that their country fulfils neither the technical nor the economic preconditions for such an approach. In Europe, more than two-thirds of respondents feel that their country does not fulfil the necessary preconditions for an energy transition as implemented in Germany.

The foreign energy experts are quite sceptical that Germany's economic power can be maintained. A clear majority of 60 % have concerns about a short to medium term weakening of German economic power as a result of current energy policy. 52 % of respondents feel that this weakening will also be long term. Only around a third believes that the energy transition will result in a strengthening of Germany's economic power. In connection with this, around two-thirds of respondents agree with the exemptions granted to German energy-intensive and export-oriented industries, and would also advocate this approach in their own land when faced with increasing electricity prices.

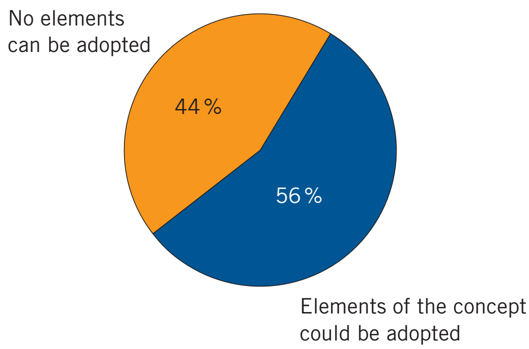
According to Jürgen Stotz, Chair of the Weltenergierat – Deutschland, these results indicate that the German Federal Government still has a lot of work ahead of it. For the energy transition to be a successful export and, in consequence, lead to important changes throughout the world, Germany must not only achieve success, but also work hard to persuade other countries, keep close track of possible impacts on its neighbours and coordinate more closely at the European level. From a global environmental perspective, Germany has not really succeeded if its very ambitious goals and their implementation have no emulators. After all, 76 % of all respondents indicate that German energy policy is no blueprint for their own country.

Figure 5.1: German Energy Policy – a Blueprint for the World?

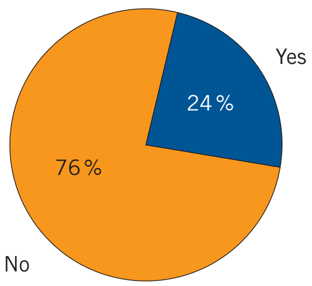
How is Germany's current energy policy perceived in your country?



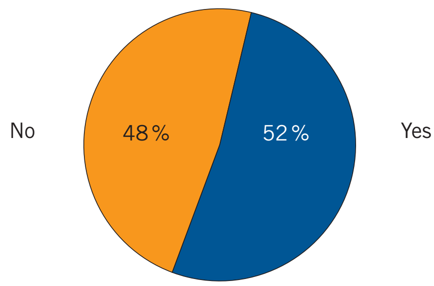
Do you expect that your country will adopt elements of Germany's current energy policy?



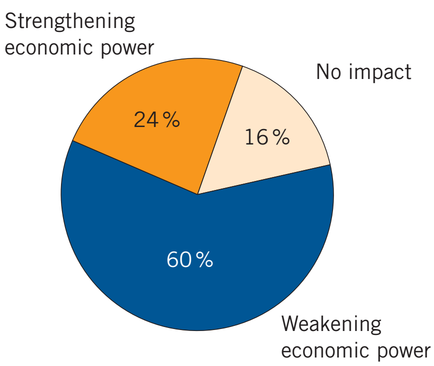
Does your country fulfil the technical and economic preconditions required to pursue Germany's current approach to energy policy?



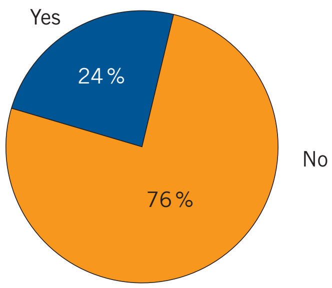
Do you think Germany's current energy policy jeopardises the security of energy supply for Europe?



What impact do you expect Germany's current energy policy will have on Germany's economic power? Short-/medium term (to 2020)



Could Germany's current energy policy serve as a blueprint for the world?



5.2 Outlook

Planned events

Expert Panel on "European gas market – changing landscapes and golden ages"
29 August 2013, Berlin

Expert Panel on "The global oil market and changing landscapes – implications for Germany and the EU"
24 September 2013, Berlin

World Energy Congress
13 – 17 October 2013, Daegu/South Korea

Presentation of the World Energy Outlook
27 November 2013, Berlin

Energy Day 2013
17 December 2013, Berlin

Planned publications

World Energy Perspectives: Unconventional Oil
June 2013

World Energy Perspectives: Energy Efficiency Policies & Technologies
September 2013

World Energy Trilemma & Energy Sustainability Index
September 2013

World Energy Scenarios
October 2013

World Energy Resources
October 2013

World Energy Perspectives: Global Electricity Initiative
October 2013

World Energy Perspectives: Cost of Technologies
October 2013

World Energy Issues Monitor
January 2014

5.3 Organisation of the Weltenergierat – Deutschland

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Babcock Borsig Service GmbH
Bayer Material Science AG
BDEW Bundesverband der Energie- und Wasserwirtschaft e.V.
BGR – Bundesanstalt für Geowissenschaften und Rohstoffe
BNL Clean Energy GmbH
BP Europa SE
CESI/IPH GmbH
DEBRIV – Deutscher Braunkohlen-Industrie-Verein e.V.
Deutsches ITER Industrie Forum e.V. (DIIF)
Deutscher Verband Flüssiggas e.V. (DVFG)
Deutscher Verein des Gas- und Wasserfachs e.V.
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Vattenfall GmbH
VDE – Verband der Elektrotechnik, Elektronik und Informationstechnik e.V.
VDI – Verein Deutscher Ingenieure e.V.
VGB PowerTech e.V.
VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V.
VNG – Verbundnetz Gas AG
Voith Hydro Holding GmbH & Co. KG
WIBERA Wirtschaftsberatung AG
Wintershall Holding AG
50Hertz Transmission GmbH

List of Acronyms and Abbreviations

Abbreviation/ Acronym	Meaning
ACER	Agency for the Cooperation of Energy Regulators
AECO	Alberta Energy Company
AGEE-Stat	Arbeitsgruppe Erneuerbare Energien-Statistik (Working Group on Renewable Energy – Statistics)
BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Office of Economics and Export Control)
bbl	barrel
BDEW	Bundesverband der Energie- und Wasserwirtschaft e. V. (German Association of Energy and Water Industries)
BDI	Bundesverband der Deutschen Industrie e.V. (Federation of German Industry)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources)
bil	billion
BMWi	Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BnetzA	Bundesnetzagentur (Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway)
BRICS	Brazil, Russia, India, China and South Africa
BTCE	billion tonnes coal equivalent
CCS	carbon capture and storage
CDM	Clean Development Mechanism
CDU	Christlich Demokratische Union Deutschlands (Christian Democratic Union)
CE	coal equivalent
CEO	Chief Executive Officer
CH_4	methane
CI	critical infrastructure
CIS	Commonwealth of Independent States
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
COP	Conference of the Parties
CSP	concentrated solar power

Abbreviation/ Acronym	Meaning
DEBRIV	Deutscher Braunkohlen-Industrie-Verein (federal German association for all lignite producing companies)
dena	Deutsche Energie-Agentur (Germany Energy Agency)
DEHSt	Deutsche Emissionshandelsstelle (German Emissions Trading Authority)
DOE	United States Department of Energy
EEFA	Energy Environment Forecast Analysis
EEG	Erneuerbare-Energien-Gesetz (German Renewable Energy Act)
EEX	European Energy Exchange
EIA	Energy Information Administration (agency responsible for energy statistics within the DOE)
ENTSO-E	European Network of Transmission System Operators for Electricity
EnWG	Energiewirtschaftsgesetz (German Energy Act)
ETP	Energy and Technology Perspectives
ETS	emissions trading system/emissions trading scheme
ETSAP	Energy Technology Systems Analysis Program
EU	European Union
EU ETS	European Union emissions trading system/European Union emissions trading scheme
EU-27	Members States of the European Union (as at 1 January 2013)
F-gases	fluorinated gases
FDP	Freie Demokratische Partei (Free Democratic Party)
FELP	Future Energy Leaders' Programme
FERC	Federal Energy Regulatory Commission
GCF	Green Climate Fund
GDP	gross domestic product
GENI	Global Energy Network Institute
GIP	gas-in-place
GIS	Geopolitical Information Service
GJ	gigajoule
GVSt	Gesamtverband Steinkohle e.V. (German Hard Coal Association)
GW	gigawatt
GWh	gigawatt hour

Abbreviation/ Acronym	Meaning
HFC	hydrofluorocarbon
ICE	IntercontinentalExchange, Inc.
IEE	Institute of Energy Economics
IEA	International Energy Agency
IG BCE	Industriegewerkschaft Bergbau, Chemie, Energie (mining, chemical and energy industrial union)
JEPIC	Japan Electrical Power Information Centre, Inc.
JETRO	Japan External Trade Organization
JI	Joint Implementation
kcal	kilocalorie
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
kg	kilogramme
KgCE	kilogramme of coal equivalent
km	kilometre
kW	kilowatt
kWh	kilowatt hour
KWK	Kraft-Wärme-Kopplung (combined heat and power)
KWK-G	Kraft-Wärme-Kopplungsgesetz (Combined Heat and Power Act)
LNG	liquefied natural gas
LULUCF	land use, land-use change and forestry
m^3/year	cubic metres per year
Mbbl/d	thousand barrels per day
MMbbl/d	million barrels per day
MbD	Mitglied des Deutschen Bundestages (Member of the German Federal Diet)
MBtu	million British thermal units
mil	million
MMBtu	million British thermal units
MTCE	million tonnes coal equivalent
$MtCO_2$-eq	million tonnes carbon dioxide equivalent
MW	megawatt
MWh	megawatt hour
NCG	NetConnect Germany GmbH & Co. KG
N_2O	nitrous oxide
NGO	non-governmental organisation
OE	oil equivalent
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries

Abbreviation/ Acronym	Meaning
p.a.	per annum
PFC	perfluorocarbon
PV	photovoltaic
RES	renewable energy source
RGGI	Regional Greenhouse Gas Initiative
RWI	Rheinish-Westfälisches Institut für Wirtschaftsforschung (Rhine-Westphalia Institute for Economic Research)
SCADA	supervisory control and data acquisition
SF6	sulphur hexafluoride
SFOE	Swiss Federal Office of Energy
SPD	Sozialdemokratische Partei Deutschlands (Social Democratic Party of Germany)
StromNEV	Stromnetzentgeltverordnung (Electricity Network Charges Ordinance)
SWP	Stiftung Wissenschaft und Politik (German Institute for International and Security Affairs)
TCE	tonne of coal equivalent
TOE	tonne of oil equivalent
TU Berlin	Technische Universität Berlin (Berlin Institute of Technology)
TWh	terawatt hour
UAE	United Arab Emirates
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
UBA	Umweltbundesamt (German Federal Environmental Agency)
USD	United States dollar
VAT	value added tax
VGB	VGB Powertech e.V. (European technical association for power and heat generation)
VZVB	Verbraucherzentrale Bundesverband e. V. (Federation of German Consumer Organisations)
WCI	Western Climate Initiative
WEC	World Energy Council
WELS	World Energy Leaders' Summit
WEO	World Energy Outlook
YEP	Young Energy Professionals

Units of Energy

Source unit \ Target unit	Million TCE	Million TOE	Billion kcal	TWh*
1 million tonnes of coal equivalent (TCE)	–	0.7	7,000	8.14
1 million tonnes of oil equivalent (TOE)	1.429	–	10,000	11.63
1 billion kilocalories (kcal)	0.000143	0.0001	–	0.001163
1 terawatt hour (TWh)	0.123	0.0861	859.8	–

* Conversion to TWh is not equivalent to a conversion to electricity, as conversion to electricity also has to take into account the efficiency of the conversion.

(1 barrel = 159 litres)

Kilo = k = 10^3 = thousand
Mega = M = 10^6 = million
Giga = G = 10^9 = billion
Tera = T = 10^{12} = trillion
Peta = P = 10^{15} = quadrillion

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