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# Energy Consumption

in Germany in 2015

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# Slight Increase in Energy Consumption in 2015 Due to Cooler Weather Conditions and Good Economic Situation

## Content



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Edited by Dr. Hans-Joachim Ziesing (hziesing@ag-energiebilanzen.de)

**Arbeitsgemeinschaft Energiebilanzen e.V.**

Mohrenstraße 58, 10117 Berlin
hziesing@ag-energiebilanzen.de

Max-Planck-Straße 37, 50858 Köln
uwe.maassen@braunkohle.de

www.ag-energiebilanzen.de

# Slight Increase in Energy Consumption in 2015 Due to Cooler Weather Conditions and Good Economic Situation

According to preliminary calculations made by the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group), energy consumption in Germany peaked at 13,306 petajoules (PJ), which translates into 454.0 million tons of coal equivalent (Mtce), in 2015. This equals an increase of 1.1 % compared to the previous year.

The increase is primarily due to the weather, which was slightly cooler than the much milder previous year, and the associated higher demand for heating energy. According to estimates of the AG Energiebilanzen, the increase in consumption resulting from the positive economic trend (+1.7 %) and the growth in population (+1 million people) was compensated by gains in energy efficiency. If adjusted to the weather conditions, last year's energy consumption would have actually decreased by an estimated 0.4 %.

As measured by the original values and when compared to the previous year, the macroeconomic energy productivity weakened considerably again in 2015: While the energy productivity in 2014 was almost 7 % higher than in 2013, it improved by only 0.5 % in 2015. Adjusted to the temperature effect, though, it amounted to more than 2 % which was, once again, on par with the longterm trend (1990 to 2014: Almost 2 %).

With the exception of renewable energy and (primarily subject to temperatures) natural gas, the consumption of all other energy carriers decreased more or less considerably. In line with nuclear power generation, the use of nuclear energy exhibited the greatest decrease with 5.5 %; its proportion of the total primary energy consumption, thus, dropped to 7.5 %.

Hard coal consumption decreased in 2015. After a significant decline in the previous year (-6.3 %), the reduction in 2015 was noticeably smaller with 0.7 %. The same is true for lignite; its use went down by 0.3 % in 2015 compared to -3.4 % in the previous year. The development for mineral oil was not much different; after a 2.4 % decrease in the previous year, its consumption remained virtually unchanged in 2015.

At the same time, consumption of the most important mineral oil products developed quite differently: While the consumption of diesel fuel increased considerably once again (+3.7 %), which was primarily due to the higher demand from the transportation and construction sectors, less gasoline (-1.5 %) was used because of the declining numbers of vehicles with gasoline engines; the consumption of aviation fuels remained virtually unchanged. Naphtha, which is primarily used in chemistry, experienced the greatest decline (-6.3 %). Despite the weather in 2015, which was cooler than the previous year, and despite falling oil prices, sales of light fuel oil dropped compared to the previous year (-0.5 %). The anticipated increase in sales obviously failed to occur because consumers met their increased demand primarily from existing oil stocks.

Even though mineral oil's total contribution to primary energy consumption decreased slightly, oil continued to be the most important primary energy carrier with 4,511 PJ or almost 34 %. It was followed by natural gas, whose consumption increased by 5 % due to the temperatures in 2015, with a share of more than 21 %; hard coal with 12.7 %; and renewables closely behind in fourth place with 12.5 %. Lignite had a share of 11.8 % in the total primary energy consumption and nuclear energy 7.5 %.

Renewables increased their contribution in 2015 by about 10 % to almost 1,670 PJ. While the use of biomass increased by around 3 %, the proportion of hydropower (excluding pumped storage) stayed at the previous year's level. With a plus of 53 %, wind energy (onshore and offshore) experienced by far the strongest growth compared to the previous year. When it comes to solar energy (photovoltaics and solar thermal energy), the increase of 6 % was much lower than in the preceding years due to the moderate expansion of photovoltaics. Biofuels even experienced a decrease of 6 %.

The increase in gross electricity consumption was slightly higher than the primary energy consumption: With about 600 billion kWh in 2015, it exceeded the previous year's value by 1.3 %. This was even 3.5 % below the highest level to date, which amounted to

almost 622 billion kWh in 2007. Yet the macroeconomic electricity productivity, which had improved by an annual average of more than 1 % between 1990 and 2014, increased only by a mere 0.4 % in 2015, which was actually far below the long term trend.

Compared to gross electricity consumption, gross electricity production exhibited a substantially higher increase of almost 4 % (plus 24 billion kWh) in 2015. This was the sole result of power generation from renewables, which went up by more than 33 billion kWh or 20 % respectively. If one summarizes the very different renewables, then they continued to expand their top position in power generation with a production share of approximately 196 billion kWh or about 30 %. All other energy carriers produced less electricity in 2015 than in 2014. The sharpest declines were recorded for nuclear energy (-5.5 %), mineral oil (-4.6 %) as well as natural gas (-2.5 %). With 0.5 % each, power generation from hard coal and lignite decreased just slightly. Right behind renewables, lignite (its share in 2015: 23.8 %) and hard coal (18.1 %) continue to be the most important energy carriers. With a proportion of 14.1 %, nuclear energy follows only in fourth place, but remains still ahead of natural gas whose position continued to deteriorate in 2015 as well.

Since gross electricity production has increased much more than gross electricity consumption, the high surpluses obtained from the exchange of electricity with foreign countries[1] once again reached a record high of almost 52 billion kWh in 2015. Particularly high export surpluses were repeatedly recorded for the exchange with the Netherlands (23.8 billion kWh), Austria (13.8 billion kWh), Switzerland (11.7 billion kWh), and Poland (10.6 billion kWh). Surpluses in the flow of electric power from abroad traditionally come from France, whereby the import surplus from France decreased from 14.0 billion kWh in 2014 to 9.9 billion kWh in 2015. The import surplus from the Czech Republic also went down from 3.2 billion kWh to now only 0.3 billion kWh. In contrast, there were slight increases in the import surpluses from Denmark (2.4 billion kWh) and Sweden (1.8 billion kWh).

At the moment, it is not yet possible to ascertain the overall development of greenhouse gas emissions in 2015 in a more comprehensive manner. However, a rough estimate of energy-related $CO_2$ emissions can be made on the basis of the changes in primary energy consumption for the respective emission-bearing and emission-free energy sources. Since the structure of energy consumption has shifted further towards emission-free and/or low-emission energy sources, $CO_2$ emissions are likely to have increased slightly less (0.6 %) than consumption when compared to the original values, and/or, vice versa, are likely to have declined slightly more (-0.8 %) when taking the impact of temperature changes into account. Insofar as neither any process-related $CO_2$ emissions nor any other greenhouse gas emissions underwent any fundamentally different developments and insofar as the total greenhouse gas emissions decreased to the aforementioned extent in 2015, then Germany has most likely failed once again to attain the aspired target of declining emissions as measured by the values adjusted to the temperature effect. In order to meet the national objective of reducing greenhouse gas emissions by 40 % below the 1990 levels by 2020, a reduction well above 3 % would have actually been necessary for 2015 when taking the emission values between 2014 and 2020 into consideration.

*1 The data on international electricity trading which are used in this report generally relate to the physical exchange of electricity with foreign countries.*

# Total Primary Energy Consumption

In 2015, primary energy consumption in Germany amounted to a total of 13,306 PJ or 454 Mtce; compared to the previous year, this equaled a reduction of 1.1 % which translates into 149 PJ/5.1 Mtce (please see Table 1).

Table 1

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**Primary Energy Consumption in Germany in 2014 and 2015** [1)]

| Energy Carrier | 2014 | 2015 | 2014 | 2015 | Changes in 2015 compared to 2014 | | | Proportions in % | |
|---|---|---|---|---|---|---|---|---|---|
| | Petajoules (PJ) | | Million Tons of Coal Equivalent (Mtce) | | PJ | Mtce | % | 2014 | 2015 |
| Mineral Oil | 4,516 | 4,511 | 154.1 | 153.9 | -5 | -0.2 | -0.1 | 34.3 | 33.9 |
| Natural Gas | 2,679 | 2,812 | 91.4 | 95.9 | 133 | 4.5 | 5.0 | 20.4 | 21.1 |
| Hard Coal | 1,703 | 1,691 | 58.1 | 57.7 | -12 | -0.4 | -0.7 | 12.9 | 12.7 |
| Lignite | 1,572 | 1,567 | 53.6 | 53.5 | -5 | -0.1 | -0.3 | 11.9 | 11.8 |
| Nuclear Energy | 1,060 | 1,001 | 36.2 | 34.2 | -58 | -2.0 | -5.5 | 8.1 | 7.5 |
| Renewable Energy | 1,519 | 1,669 | 51.8 | 56.9 | 150 | 5.1 | 9.9 | 11.5 | 12.5 |
| Electricity Exchange Balance | -128 | -186 | -4.4 | -6.4 | -58 | -2.0 | - | -1.0 | -1.4 |
| Other | 237 | 242 | 8.1 | 8.3 | 5 | 0.2 | 2.1 | 1.8 | 1.8 |
| **Total** | **13,157** | **13,306** | **448.9** | **454.0** | **149** | **5.1** | **1.1** | **100.0** | **100.0** |

*1) All data are preliminary; discrepancies in the totals are due to rounding off*

*Source: Working Group on Energy Balances (AGEB)*

Except for the comparably positive economic trend in 2015, the increase in primary energy consumption is mainly due to the weather which was cooler than the previous year:

- Calculated over a year, the degree day figures in 2015 were almost 9 % higher (which means "colder") than in 2014. In particular, the months of February, March, and April as well as September and October were substantially cooler than the respective months of the previous year (please see Figure 1).
- Compared to the long-term average, though, 2015 was actually "warmer" with almost 8 % fewer degree day values. In Germany, 2015 proved to be one of the warmest years since the measurements had commenced in 1881.

In light of the fact that the temperature-dependent demand for heating accounts for a large proportion of the energy consumption, it was the cooler weather, compared to the previous year, which directly influenced consumption to increase primarily in private households as well as the trade, commerce, and service sectors.

Figure 1

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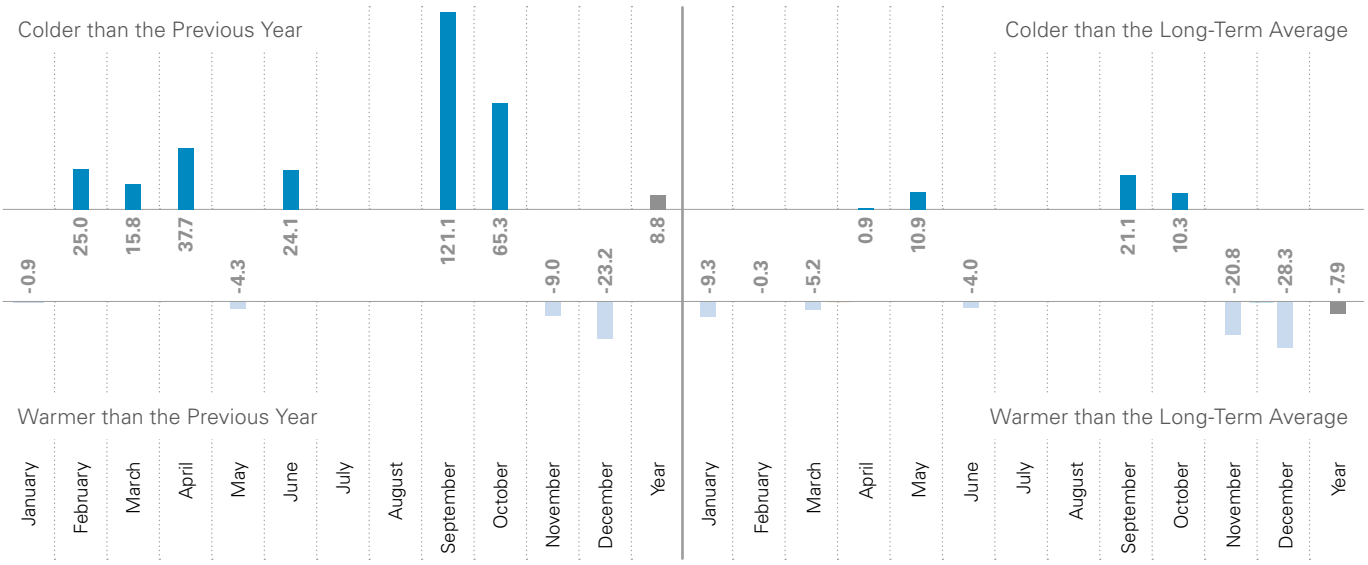
**Monthly Degree Day Figures in Germany in 2015 (16 Measurement Stations)***

Changes in 2015 Compared to the Previous Year and to the Long-Term Average (1980-2015) in %




*Source: Germany's National Meteorological Service (DWD)*

**) Due to their limited informative value, the months of July and August are not included*

In addition, the economic trend tended to have a beneficial effect on increasing consumption; however, with different outcomes for the individual sectors:

- The price-adjusted gross domestic product, for example, increased by no less than 1.7 % in 2015 when compared to the previous year.

- With 1.1 % each, however, production in the processing and manufacturing industries exhibited noticeably weaker growth. This also applies to such energy-intensive sectors as the manufacture of chemical products with a production minus of 0.4 % or the manufacture of glass, ceramics, and mineral processing with a plus of 0.1 %.
  With 0.2 %, metal manufacture and processing also exhibited only minimal growth.
  Machine construction, albeit less energy-intensive, even recorded a production decline of about 1 %.
  In contrast, vehicle construction as well as the manufacture of data processing systems, electronic and optical products experienced strong growth.
  Figure 2 shows the annual rates of change in the production indices for 14 important branches of the manufacturing industry between 2012 and 2015.

- Against this backdrop, it can be assumed that a major portion of the increase in energy consumption accrued primarily outside the manufacturing industry. In addition to the tertiary sector, this is likely to be attributable above all to the (cross-sectoral) heating of buildings as well as, when taking the overall increase in fuel consumption into account, partially also to the transportation sector.

Figure 2

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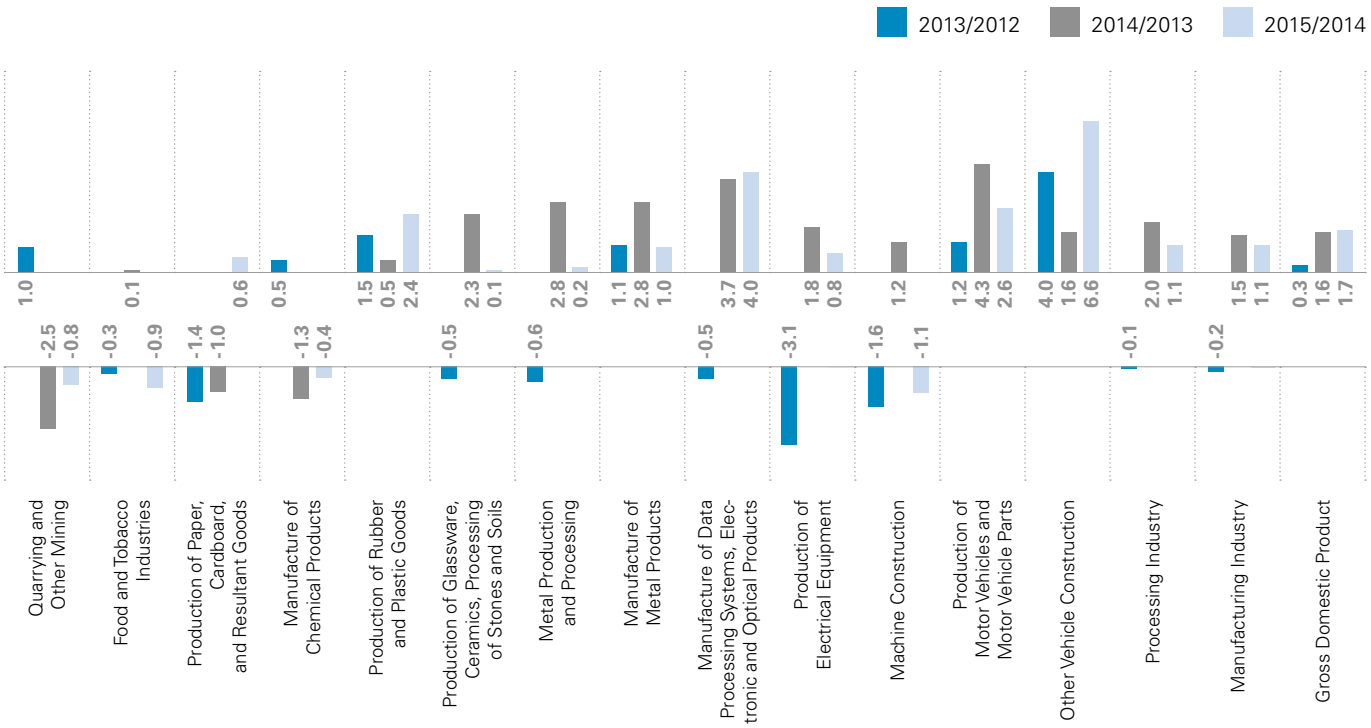
**Production Index in Germany's Manufacturing Industry between 2012 and 2015**

Changes Compared to the Previous Year in %




*Source: Federal Statistical Office (Destatis)*

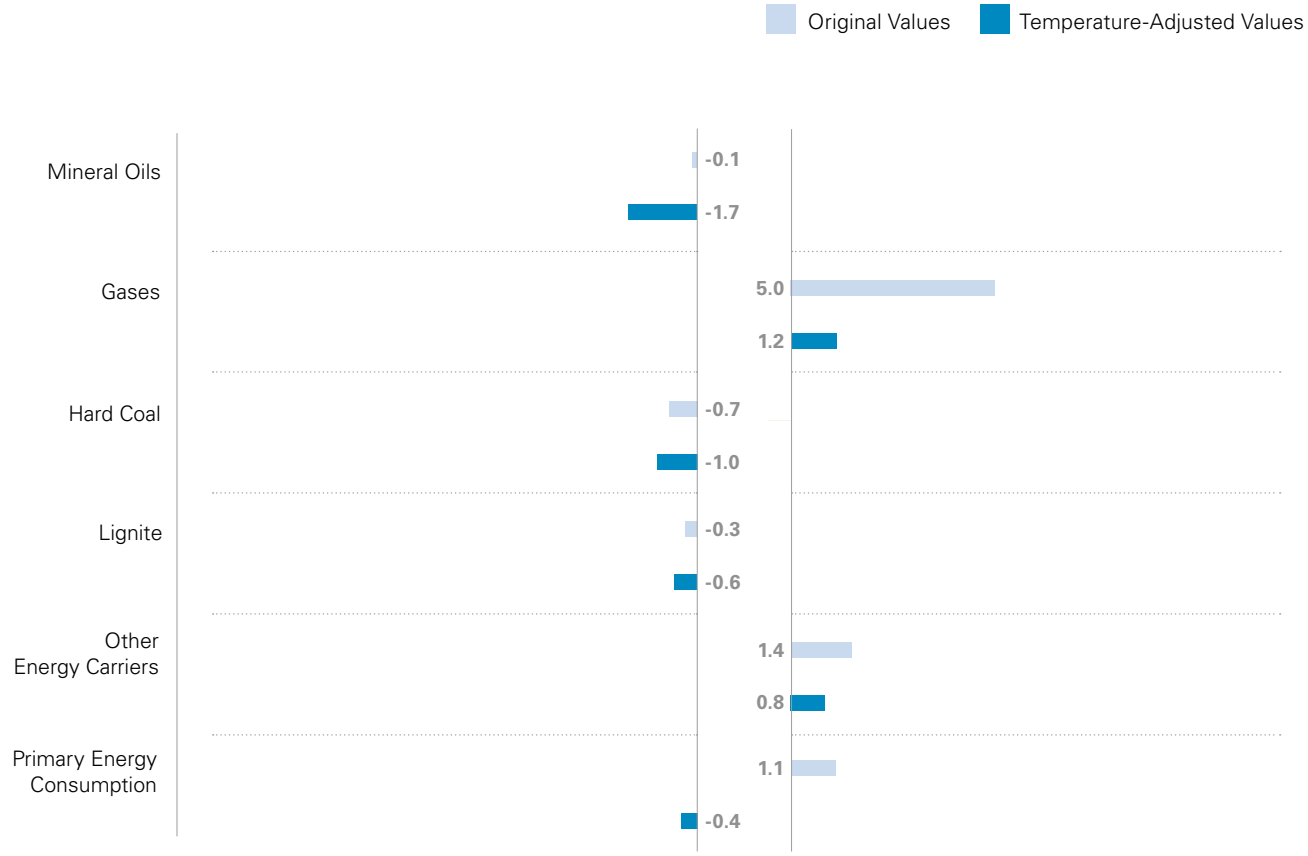
If one considers the impact of the low temperatures on the changes in primary energy consumption and if one were to assume temperatures similar to the long-term average, then the primary energy consumption, with all other parameters remaining unchanged, would not have increased by 1.1 %, but rather decreased by about 0.4 %.[2] Thus, the temperature effect had a different impact on the individual energy sources. It mainly influences the consumption of the energy carriers natural gas and mineral oil which account for a large proportion of the heating market (which depends on the outside temperatures). While natural gas consumption in 2015, based on the original values, was 5 % higher than in the previous year, the values adjusted to the temperature effect indicated an increase of only about 1 %. When it comes to mineral oil consumption, the temperature influence is reflected in a decline of almost 2 % instead of the virtually unchanged original values. The other energy carriers whose consumption is much less dependent on the weather conditions exhibited only minor differences between the actual and the (estimated) values adjusted to the temperature effect (please see Figure 3).

2 *To adjust energy consumption to the temperature effect, please see the German Institute for Economic Research (DIW): Energienachfrage in Deutschland in Abhängigkeit von Temperaturschwankungen und saisonalen Sondereffekten. Expert's report on behalf of the Federal Minister for Economic Affairs. By Hans-Joachim Ziesing in cooperation with Jochen Diekmann. Berlin, September 1995.*

Figure 3

**Primary Energy Consumption in Germany According to Energy Carriers**

Changes in 2015 Compared to 2014 in %




*Sources: Working Group on Energy Balances (AGEB); Germany's National Meteorological Service (DWD)*

When assessing the changes in primary energy consumption, particularly with regard to mineral oil consumption, it needs to be kept in mind, though, that the original values for storable fuels (coals and mineral oil products) only include sales figures. Hence, the actual consumption may deviate from these sales figures by the respective changes in stockholding. Yet these inventory changes are statistically recorded only for the energy sector and the manufacturing industry where they can be incorporated in the requisite consumption calculation. This is not the case for private households as well as the trade, commerce, and service sector. Hence, the actual energy consumption in these two sectors can only be estimated in this report – albeit in a general manner – on the basis of surveys conducted on the individual fueling behavior and the resultant changes in the refueling rate. This applies, above all, to light fuel oil. According to rough estimates, the tanks of private households and in the trade, commerce, and service sector were most likely filled so well in 2015 that consumers, in part, reverted to these reserves instead of making additional purchases. Correspondingly higher would have been the actual fuel oil consumption in 2015 when compared to the fuel oil sales. The reduction in stocks is probably the reason why the primary energy consumption, adjusted to the temperature effect, did not decrease (minus 0.4 %), but instead actually increased slightly by 0.4 % (please see Table 2). [3]

3 *Because of the comparably great uncertainties when considering the inventory effect, the following analyses will be restricted to temperate-adjusted values.*

Table 2

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**Macroeconomic Energy Productivity in Germany between 1990 and 2015**

| | Unit | 1990 [1] | 1995 | 2000 | 2005 | 2010 | 2013 | 2014 [2] | 2015 [2] | Average Annual Change in % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 2014 to 2015 | 1990 to 2000 | 2000 to 2015 | 1990 to 2015 |
| Gross Domestic Product (price-adjusted, 2010 = 100) | Concatenated Volume Figures in Billion Euros | 1,959.1 | 2,145.1 | 2,358.7 | 2,426.5 | 2,580.1 | 2,693.3 | 2,736.4 | 2,782.6 | 1.7 | 1.9 | 1.1 | 1.4 |
| Population [3] | 1,000 | 79.5 | 81.3 | 81.5 | 81.3 | 80.3 | 80.6 | 81.0 | 81.6 | 0.7 | 0.2 | 0.0 | 0.1 |
| Primary Energy Consumption (unadjusted) | Petajoules | 14,905 | 14,269 | 14,401 | 14,558 | 14,217 | 13,822 | 13,157 | 13,306 | 1.1 | -0.3 | -0.5 | -0.5 |
| Primary Energy Consumption (temperature-adjusted) | Petajoules | 15,125 | 14,218 | 14,702 | 14,582 | 13,909 | 13,776 | 13,576 | 13,524 | -0.4 | -0.3 | -0.6 | -0.4 |
| Primary Energy Consumption (temperature and inventory adjusted) | Petajoules | 15,152 | 14,218 | 14,771 | 14,723 | 13,966 | 13,797 | 13,487 | 13,542 | 0.4 | -0.3 | -0.6 | -0.5 |
| Gross Electricity Consumption | Billion kWh | 550.7 | 541.6 | 579.6 | 614.1 | 615.4 | 604.9 | 592.2 | 600.0 | 1.3 | 0.5 | 0.2 | 0.3 |
| Energy Productivity (unadjusted) | Euros/GJ | 131.4 | 150.3 | 163.8 | 166.7 | 181.5 | 194.9 | 208.0 | 209.1 | 0.6 | 2.2 | 1.6 | 1.9 |
| Energy Productivity (temperature-adjusted) | Euros/GJ | 129.5 | 150.9 | 160.4 | 166.4 | 185.5 | 195.5 | 201.6 | 205.7 | 2.1 | 2.2 | 1.7 | 1.9 |
| Energy Productivity (temperature and inventory adjusted) | Euros/GJ | 129.3 | 150.9 | 159.7 | 164.8 | 184.7 | 195.2 | 202.9 | 205.5 | 1.3 | 2.1 | 1.7 | 1.9 |
| Electricity Productivity | Euros/kWh | 3.56 | 3.96 | 4.07 | 3.95 | 4.19 | 4.45 | 4.62 | 4.64 | 0.4 | 1.4 | 0.9 | 1.1 |

*1) Some figures are estimates*
*2) Preliminary data*
*3) Average population based on the 2011 census (result as per the closing date May 9, 2011: 80,219,695 inhabitants)*

*Sources: Federal Statistical Office (Destatis); German Association of Energy and Water Industries (BDEW)*

The Federal Government's energy policy decisions on the continued support of renewable energy and the exit from nuclear power are also reflected in the changing structure of primary energy consumption. In 2015 as well, the most important energy carrier continued to be mineral oil with a proporation of about a third. This was followed by natural gas with a share that marginally increased to 21.1 % (2014: 20.4 %). Slightly decreased proportions were recorded for hard coal (from 12.9 % to 12.7 %) and lignite (from 11.9 % to 11.8 %). A more significant decline was reported for nuclear energy; to be precise, it dropped from 8.1 % to 7.5 %. This is also attributable to the decommissioning of the Grafenrheinfeld nuclear power plant in late June 2015. In contrast, renewable energy advanced once again in 2015 and positioned itself with a share of 12.5 % even in front of lignite and just slightly behind hard coal. Just like in the previous year, the other energy carriers contributed less than 2 % to meeting the energy demand. The large surplus obtained from physical flows of electric current to foreign countries caused primary energy consumption to decrease (by 1.4 percentage points).

While the macroeconomic performance increased by 1.7 %, the energy productivity of the German economy, as measured by the original values and compared to last year's sharp increase (by nearly 7 %), only improved by 0.5 % in 2015. Adjusted to the temperature effect, however, it amounted to more than 2 % which was, once again, on par with the long-term trend (1990 to 2014: Almost 2 %). All told, though, it can be affirmed that energy consumption continues to develop independent of the macroeconomic trend (please see Table 2 and Figure 4).

When assessing this development, however, it is essential to not only consider the temperature influence, but also a statistical effect which results from the fact that international conventions require the application of the so-called efficiency method for balancing the energy sources without considering the requisite calorific value. Since nuclear energy does not have any natural calorific value, the facilities' degree of efficiency is set at 33 % with the help of this method. Following the same logic, the degree of efficiency for renewable energy (water, wind, photovoltaics) and for the electricity trade balance with foreign countries is estimated to be at 100 %.

Compared to the previously used so-called substitution method, this results in higher primary energy consumption for nuclear energy whereas the calculated primary energy consumption for the aforementioned renewables and for international electricity trading is lower. The greatest savings effect, thus, occurs if and when the electricity produced by nuclear power plants is completely replaced by renewable energy and/or electricity imports. This effect, which had a particularly strong impact in 2011/2012 due to the substantial decline in nuclear energy, on the one hand, and the significant increase in using power generated from renewable energy, on the other hand, was also recorded for 2015: While the electricity produced in nuclear power plants in 2015 was 5.3 billion kWh lower than in 2014, power generation from wind, water, and solar radiation (PV) grew by 32.7 billion kWh.
If nuclear energy were to be assessed according to the substitution method as is done for the relevant renewables, and if 40 % were to be assumed as the average degree of efficiency for nuclear energy, then the primary energy consumption would have increased by 2.6 % instead of 1.1 %. Given the gross domestic product, this would mean that the energy productivity would not have improved by 0.6 %, but rather

Figure 4

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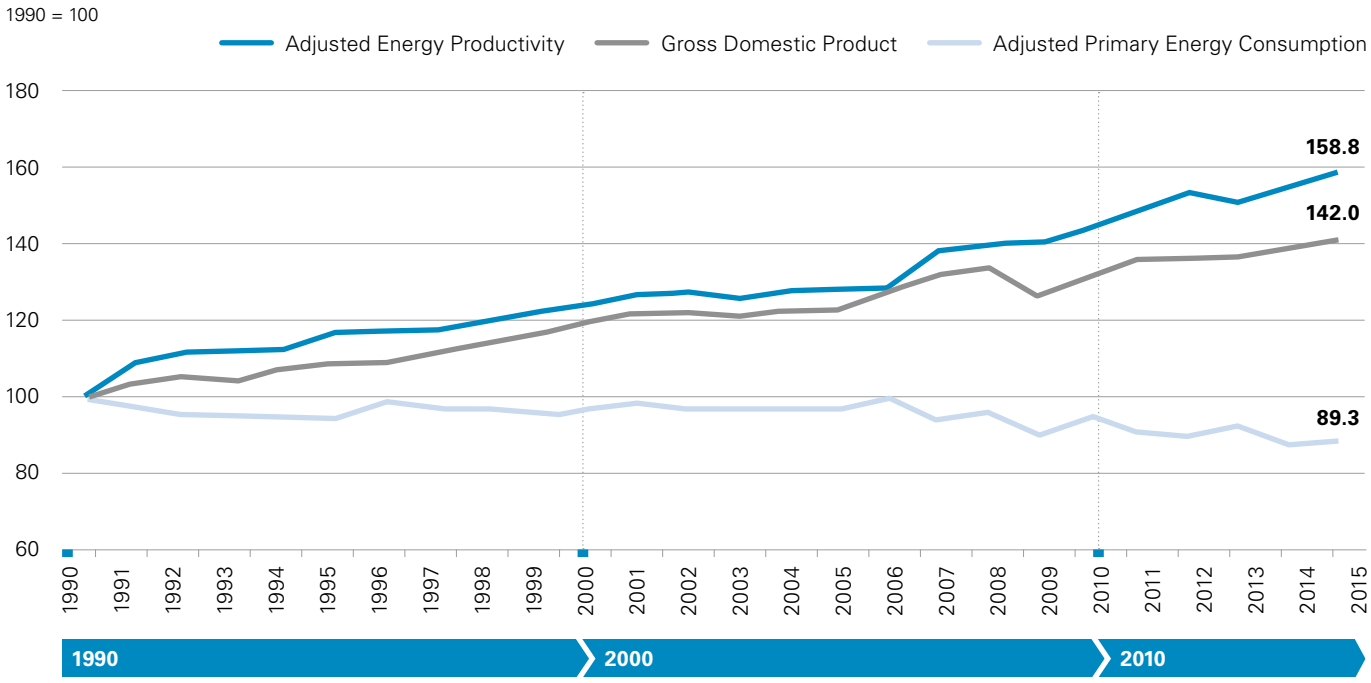
**Gross Domestic Product, Primary Energy Consumption, and Energy Productivity in Germany between 1990 and 2015**




*Sources: Federal Statistical Office (Destatis); Working Group on Energy Balances (AGEB)*

deteriorated by 0.9 %. The statistical productivity effect would, thus, amount to approximately 1.5 percentage points in 2015.

With component decomposition, it is possible to identify the key factors which influence the changes in the (adjusted) primary energy consumption (please see Figure 5).

The changes between 2014 and 2015 aptly demonstrate the enormous influence of the decreased energy intensity (that is, the improvement in energy efficiency) on the reduction of the (temperature-adjusted) primary energy consumption. This way, it was possible to significantly overcompensate the consumption-enhancing effect of the macroeconomic growth and the increase in population. As a matter of fact, similar relations regarding the effectiveness of the individual components also apply when considering the entire period from 1990 to 2015. Here as well, the consumption-reducing effects of an overall increase in energy productivity clearly outbalance the consumption-enhancing effects of economic growth. Compared to these two opposing effects, the demographic component for changes in energy consumption in Germany does not play any major role at all. This applies at least to such a highly aggregated representation. This does not mean, though, that, for example, the population's age structure, family and household sizes, and similar factors have no influence on the level and structure of primary energy consumption.

A glance at Germany's foreign trade balance for energy carriers is also of interest (please see Table 3). When it comes to all the fossil fuels (which include coals, mineral oil, and natural gas), Germany is a considerable net importer. In 2015 as well, this did not fundamentally change. Significant changes, however, were recorded for import prices of fossil fuels in 2015. As a result, the import calculation for coal, oil, and gas (with regard to the import balance) decreased from nearly 85 billion euros by almost 23 billion euros, which equals a reduction of about a quarter, to approximately 62 billion euros. By far the largest decline was recorded for oil with a minus of almost 20 billion euros, i.e. more than a third. That this is solely a price effect is also demonstrated by the fact that the weight of the import balance actually increased slightly. This also applies to gas imports even though their import value on balance decreased by more than one tenth. The situation is different for coal imports which exhibited not only a reduction in volume, but even more so in costs.

Figure 5

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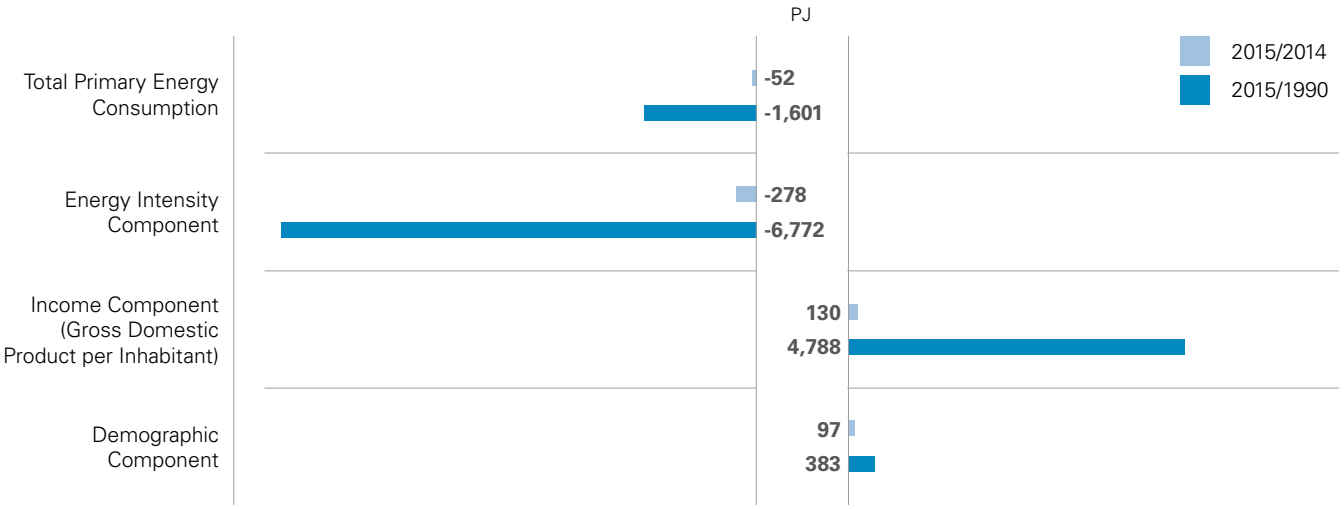
**Contributions of Diverse Influencing Factors to the Changes in the Adjusted Primary Energy Consumption in Germany**

Changes in 2015 Compared to 2014 and 1990 in Petajoules




*Sources: Federal Statistical Office (Destatis); Working Group on Energy Balances (AGEB)*

Table 3

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**Balance of Foreign Trade with Energy Carriers in Germany between 2010 and 2015**

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Changes in 2015 Compared to 2014 | |
|---|---|---|---|---|---|---|---|---|
| | Foreign Trade Balance (Imports ./. Exports) in Billion Euros | | | | | | | % |
| Coal, Coke, and Briquettes | 4.4 | 5.9 | 5.1 | 4.4 | 4.3 | 3.9 | -0.4 | -9.2 |
| Petroleum, Petroleum Products, and Related Goods | 49.4 | 64.5 | 68.0 | 67.0 | 57.6 | 37.8 | -19.8 | -34.3 |
| Gas [1] | 20.7 | 26.7 | 27.1 | 26.4 | 22.8 | 20.2 | -2.6 | -11.2 |
| **Total Fossil Fuels** | **74.6** | **97.1** | **100.2** | **97.8** | **84.6** | **61.9** | **-22.7** | **-26.8** |
| Electric Power | -1.0 | -0.4 | -1.4 | -1.9 | -1.7 | -2.1 | -0.3 | -18.5 |
| **Total** | **73.5** | **96.7** | **98.8** | **95.9** | **82.9** | **59.9** | **-23.0** | **-27.8** |

*1) Including transit volumes*

*Source: Federal Statistical Office (Destatis) (values according to sections of the Standard International Trade Classification (SITC, 2-digit level))*

Unlike fossil energy, Germany actually exhibits an increasing surplus for electric power which is generated by physical flows of electricity to foreign countries and amounted to 2.1 billion euros in 2015; compared to the previous year, this was an increase by 0.3 billion euros which translates into 18.5 %. As measured by the foreign trade balance for fossil fuels, this value continues to be relatively small for electric power. Foreign trade of mineral oil still dominates the field and is far ahead with an approximate share of 60 % in the foreign trade balance for fossils.

# Primary Energy Production in Germany

In 2015, domestic energy production increased for the first time again which was primarily due to the significant expansion of renewable energy; namely, by 1.6 % to 4,131 PJ or 139.3 Mtce (please see Table 4).

In contrast to renewable energy, though, domestic production from fossil fuels decreased consistently. The strongest decline was exhibited by hard coal with a drop of almost 18 % and by natural gas with a drop of nearly 14 % while domestic oil production decreased just slightly (-1 %). Today, the most important indigenous energy are renewable energy sources with a share of about 41 %, closely followed by lignite with almost 40 %. Both of them rank far ahead of natural gas, hard coals, and petroleum.

When taking into account the primary energy consumption in 2015, the proportion of indigenous energy remained virtually unchanged; it increased from 30.9 % to 31.0 % (please see Table 4).

Table 4

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**Primary Energy Production in Germany in 2014 and 2015**

| | Production | | | | Changes in 2015 compared to 2014 | | Proportions | |
|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2014 | 2015 | | | 2014 | 2015 |
| | Petajoules (PJ) | | Million Tons of Coal Equivalent (Mtce) | | PJ | % | % | |
| Mineral Oil | 121 | 120 | 3.5 | 3.5 | -1 | -1.0 | 2.6 | 2.5 |
| Natural Gas, Petroleum Gas | 318 | 272 | 10.9 | 9.3 | -47 | -14.7 | 7.9 | 6.6 |
| Hard Coal | 229 | 188 | 7.8 | 6.4 | -41 | -17.9 | 5.7 | 4.6 |
| Lignite | 1,617 | 1,608 | 55.2 | 54.9 | -9 | -0.5 | 40.2 | 39.4 |
| Renewable Energy | 1,544 | 1,702 | 51.8 | 56.9 | 158 | 9.9 | 37.7 | 40.9 |
| Other Energy Carriers | 237 | 242 | 8.1 | 8.3 | 5 | 2.1 | 5.9 | 6.0 |
| **Total** | **4,066** | **4,131** | **137.3** | **139.3** | **64** | **1.6** | **100.0** | **100.0** |
| For information purposes: Proportion of Primary Energy Consumption | - | - | - | - | - | - | 30.9 | 31.0 |

*Some figures are estimates; discrepancies in the totals are due to rounding off*

*Sources: German Association of Energy and Water Industries (BDEW); The German Coal Industry's Statistical Office; German Industrial Association of Oil and Gas Producers (WEG); Association of the German Petroleum Industry (MWV)*

# Mineral Oil

Compared to the previous year, Germany's oil consumption in 2015 remained virtually unchanged with a preliminary figure of 153.9 Mtce. This figure, though, represented the lowest oil consumption for Germany since 1990. At the same time, consumption of the most important mineral oil products developed very

Table 5

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**Consumption and Volume of Mineral Oil in Germany in 2014 and 2015**

| | | 2014 [1] | 2015 [1] | Change |
|---|---|---|---|---|
| | | in Million Tons | in Million Tons | in % |
| **Total Consumption** | | **105.6** | **105.4** | **-0.1** |
| Self-Consumption and Losses [2] | | 5.7 | 5.9 | 5.0 |
| Domestic Consumption | | 99.9 | 99.5 | -0.1 |
| Proportion of: | Gasoline | 18.5 | 18.2 | -1.5 |
| | Diesel Fuel | 35.6 | 36.9 | 3.7 |
| | Aviation Fuels | 8.5 | 8.5 | -0.3 |
| | Fuel Oil, Light | 16.8 | 16.7 | -0.5 |
| | Fuel Oil, Heavy [3] | 4.3 | 5.2 | 21.1 |
| | Naphtha | 17.1 | 16.0 | -6.3 |
| | Liquid Gas | 2.8 | 3.1 | 8.9 |
| | Lubricants | 1.1 | 1.1 | -1.5 |
| | Other Products | 5.2 | 4.4 | -11.5 |
| | Recycling (to be deducted) | -6.5 | -7.2 | 11.1 |
| | Biofuels [4] (to be deducted) | -3.5 | -3.4 | -2.0 |
| **Total Volume** | | **105.6** | **105.5** | **-0.1** |
| Refinery Production | | 100.3 | 103.7 | 3.4 |
| Generated from: | Input of Crude Oil | 91.3 | 93.5 | 2.4 |
| | Input of Products | 9.0 | 10.2 | 13.1 |
| Foreign Trade Products (Balance) | | 15.8 | 14.1 | - |
| | Imports | 37.0 | 36.7 | -1.0 |
| | Exports | 21.2 | 22.6 | 6.4 |
| Compensation [Balance (Bunker, Differences)] | | -10.5 | -12.3 | - |
| Refining Capacity | | 102.6 | 103.3 | - |
| Utilization of Refining Capacity in % | | 88.9 | 90.5 | - |
| Primary Energy Consumption of Mineral Oil (Mtce) | | 154.1 | 153.9 | -0.1 |

*1) Preliminary data; some figures are estimates*
*2) Including changes in stocks*
*3) Including other heavy residues*
*4) Only added biofuels*

*Discrepancies in the totals are due to rounding off*

*Source: Association of the German Petroleum Industry (MWV)*

differently (please see Table 5): While the consumption of diesel fuels increased significantly once again (+3.7 %), which was primarily due to the higher demand coming from the transportation and construction sectors, and climbed to a record high with sales amounting to almost 37 million tons, less gasoline was used because of the declining number of vehicles with gasoline engines (-1.5 %); whereas the consumption of aviation fuels remained virtually unchanged. All told, the demand for fuels, which make up approximately 60 % of Germany's total oil consumption, increased by about 2 %.

The demand for light and heavy fuel oil developed inconsistently as well. Although the prices decreased once again by about 10 % and despite the cooler weather when compared to the previous year, less light fuel oil was sold than in the previous year (-0.5 %). The anticipated rise in sales obviously failed to occur since consumers met their increased demand primarily from existing oil stocks and did not have their tanks refilled even though the prices were lower. In contrast, deliveries of heavy fuel oil increased significantly by about one fifth which was above all due to the recommissioning of petrochemical plants.

The other mineral oil products predominantly saw a decrease while naphtha, which is primarily used in chemistry, experienced the greatest decrease (-6.3 %).

Due to significantly lower international procurement costs for crude oil and semi finished products, Germany's oil supply was once again restructured in 2015. Production from crude oil and/or products was increased by more than 2 % and 13 % respectively to a total of almost 104 million tons. In 2015, the additionally available refining capacity of 103.3 million tons amounted to 90.5 % which was higher than in 2014.

While exports of mineral oil products increased by more than 6 %, product imports were slightly reduced. Thus, the import surplus for mineral oil products decreased significantly from almost 16 million tons in 2014 to approximately 14 million tons in 2015.

Due to its very limited domestic petroleum resources, Germany is primarily dependent on crude oil imports which, with 91.3 million tons in 2015, exceeded the previous year's level by about 2 %.

In 2015, the three most important countries supplying crude oil to German refineries continued to be Russia (with a share of almost 36 %), Norway (nearly 14 %), and the United Kingdom (11 %); these countries contributed well above 60 % to German crude oil imports also in 2015 (please see Table 6). Important supplier countries also include Nigeria, Kazakhstan, Azerbaijan, Algeria, and Libya.

Divided into individual development areas, the countries of the former Soviet Union (CIS states) were able to further expand their share of German crude oil imports, which had already been very high before; namely, from almost 46 % in 2014 to nearly 49 % in 2015. In contrast, losses were recorded by the OPEC states (in 2015: About 16 %) and the countries bordering on the North Sea (in 2015: Around 25 %). Smaller supplier countries such as Egypt, Mexico, Tunesia, and others, however, were able to increase their deliveries significantly; albeit in absolute terms at a low level. All told, the contribution made by this group of small suppliers increased from 9 % to more than 10 % in 2015.

In 2015 as well, international oil prices and the Euro/US Dollar exchange rate developed quite unsteadily; in other words, they experienced considerable short-term fluctuations (please see Figure 6). While crude oil grade Brent UK, which is important for Europe, had peaked at an annual average of about 112 US dollars per barrel (= 159 liters) in 2012 (the monthly peak in July 2008 had been about 133 US dollars per barrel), the average price in 2013 and 2014 dropped to 109 US dollars and 99 US dollars respectively per barrel. The development in 2015 showed a clear downward trend: Particularly since May, when the crude oil price reached its annual peak of about 64 US dollars per barrel, prices dropped and only reached about 38 US dollars per barrel in December 2015.

The exchange rate of the Euro (to the US Dollar) is also relevant for the price trend for German crude oil imports. Since mid 2014, the Euro exchange rate has deteriorated substantially. Compared to December 2014, the exchange rate dropped by 12 % from 1.2331 US dollars to 1.0877 US dollars by December 2015. But German crude oil import prices actually declined much slower than the changes in the global market prices for crude oil.

Table 6

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**Germany's Crude Oil Imports in 2014 and 2015 According to Countries of Origin**

| Important Supplier Countries/ Production Regions | 2014 | 2015 [1] | 2014 | 2015 [1] |
|---|---|---|---|---|
| | in Million Tons | | Proportions in % | |
| Russia | 30.0 | 32.6 | 33.6 | 35.7 |
| Norway | 15.2 | 12.5 | 17.0 | 13.7 |
| United Kingdom | 9.7 | 10.0 | 10.9 | 11.0 |
| Nigeria | 7.1 | 6.7 | 7.9 | 7.3 |
| Kazakhstan | 6.8 | 6.4 | 7.6 | 7.0 |
| Azerbaijan | 4.1 | 5.3 | 4.6 | 5.8 |
| Algeria | 3.6 | 3.5 | 4.0 | 3.8 |
| Libya | 3.2 | 2.9 | 3.6 | 3.2 |
| Saudi Arabia | 1.4 | 1.2 | 1.6 | 1.3 |
| Denmark | 0.3 | 0.7 | 0.3 | 0.8 |
| Other Countries | 8.0 | 9.5 | 8.9 | 10.4 |
| Total | 89.4 | 91.3 | 100.0 | 100.0 |
| OPEC | 16.5 | 14.3 | 18.5 | 15.7 |
| North Sea [2] (excld. FRG) | 25.2 | 23.2 | 28.2 | 25.4 |
| Former CIS | 40.9 | 44.3 | 45.7 | 48.5 |
| Other | 6.8 | 9.5 | 7.6 | 10.4 |
| **Total** | **89.4** | **91.3** | **100.0** | **100.0** |

*1) Preliminary data*
*2) Including other EU countries*
*Discrepancies in the totals are due to rounding off*

*Source: Federal Office of Economics and Export Control (BAFA)*

This resulted in a 36 % reduction of the German crude oil import prices from an annual average of 555 €/t in 2014 to 356 €/t in 2015. During the course of 2015, the import prices even decreased to rates of 276 €/t. That is why German refineries were able to reduce their expenses for crude oil imports from 49.6 billion euros (2014) to 32.5 billion euros (2015).

Prices for oil products in Germany primarily followed the reduced costs for crude oil and the decline in international product quotations; albeit at different rates (please see Figure 7). While the prices for premium gasoline, diesel fuel, and light fuel oil had exhibited a downward trend already since 2012, a drastic decline began in mid 2015: On average, the annual prices for premium gasoline decreased by 8.8 %, for diesel fuel by 13.3 %, and for light fuel oil due to the lower tax proportion even by 23 %. In light of these developments, just German car drivers alone probably experienced a reduction of an estimated 10 billion euros. As measured by the producer price index, mineral oil products in Germany were on average and in total about 15 % more favorable in 2015 than in 2014.

Figure 6

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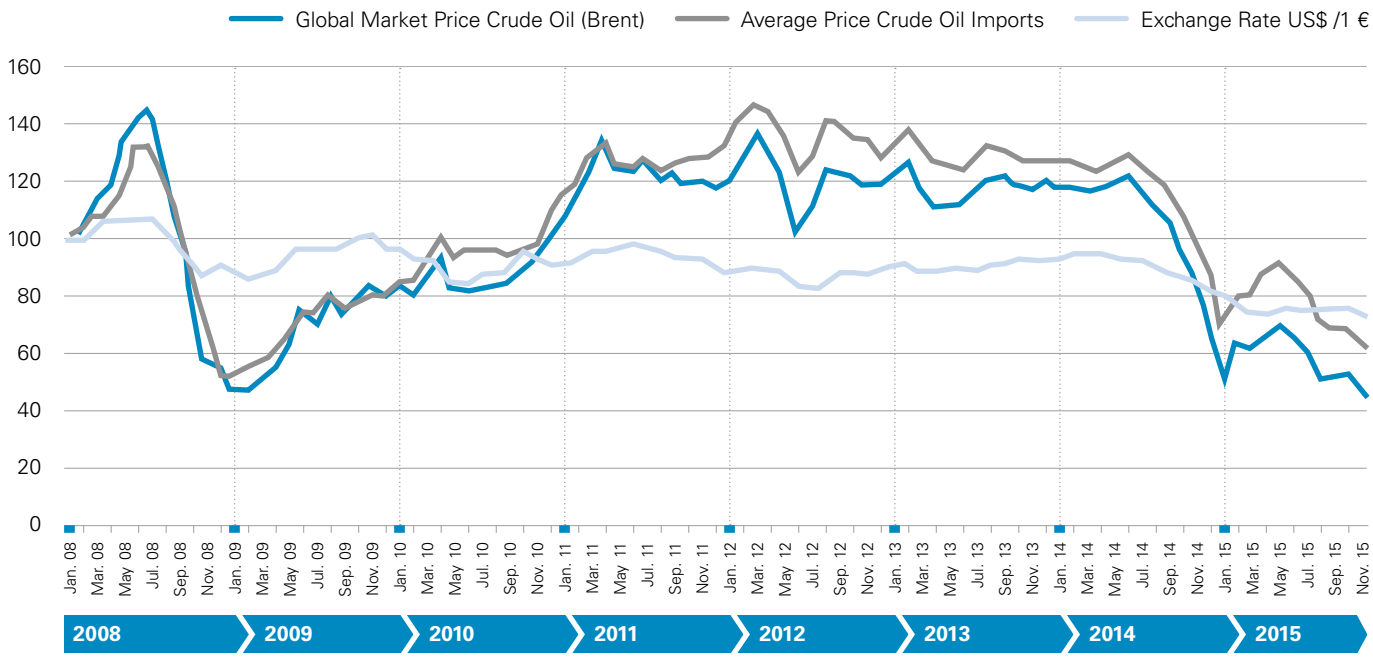
**Global Market Prices for Crude Oil (Brent) [1], Border-Crossing Prices for German Crude Oil Imports [2], and Exchange Rates between January 2008 and December 2015**




*1) Original values in US Dollars per barrel*
*2) Original values in Euros per ton*

*Sources: Federal Ministry for Economic Affairs and Energy (BMWi); Deutsche Bundesbank (German Central Bank); Association of the German Petroleum Industry (MWV)*

Figure 7

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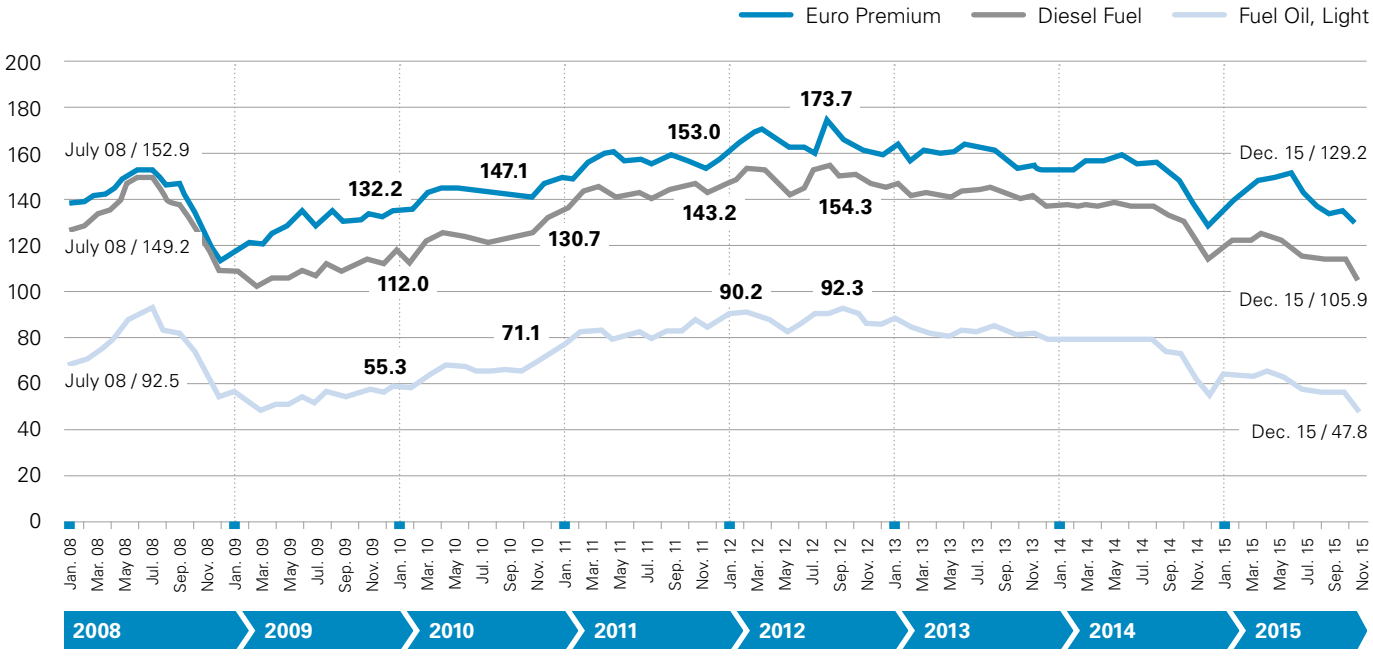
**Prices for Fuels and Light Fuel Oil in Germany between 2008 and 2015**

Eurocents per Liter




*Sources: Association of the German Petroleum Industry (MWV); Federal Statistical Office (Destatis)*

## Natural Gas

In 2015, natural gas consumption in Germany increased by 5 % to 866 billion kWh. This was primarily due to the temperatures during the heating season, which were actually lower than in 2014 and, thus, resulted in an increased use of natural gas for generating heat. The use of natural gas in power plants and heating stations supplying the general public was reduced slightly by 1 %.

With an average temperature of 9.9°C, 2015 together with the years 2000 and 2007 has been the second warmest year on record in Germany – so far, only 2014 had been warmer. The energy demand for heating purposes, however, increased slightly because even though the beginning of the year was mild compared to the longterm average, it was actually cooler than in the previous year.

When it comes to the use of natural gas in the individual consumption sectors, the following trends have become apparent for 2015 so far (please see Table 7):

- The heating market recorded a significant increase in sales after the sharp decline in 2014. The natural gas consumed by private households as well as by commercial and service enterprises increased by almost 7 %. The number of natural gas heating systems continued to grow. By the end of 2015, a total of 20.3 million homes or almost half of the existing homes were equipped with a gas heating system. In the new housing market, natural gas heating systems accounted for a market share of almost 50 % – while construction activities (residential units approved for new construction) increased by 7 % compared to 2014.
- According to initial figures, the industry's demand for natural gas as a raw material and as a fuel in industrial power plants increased slightly by 2 %.
- The use of natural gas in power plants and heating stations supplying the general public developed in a different direction: Increased power generation from renewable energy caused electricity production from natural gas to decrease. Almost 2 % less natural gas was used as a fuel in the power plants and thermal power stations of the electricity suppliers. While combined heat and power plants used almost as much natural gas in 2015, the uncoupled generation of electricity in gas power plants supplying the general public decreased once again by 11 %. However, the above mentioned cooler temperatures resulted in an increased use in heating stations. All told, the use of natural gas in electricity and heat supply declined only slightly by 1 %. Due to the weather conditions and additional capacities, the use of natural gas in smaller, decentralized plants (CHP) and industrial plants recorded a slight plus. All told, natural gas accounted for a share of 9.1 % in Germany's gross electricity production in 2015.

Table 7

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## Volume and Use of Natural Gas in Germany in 2014 and 2015

| | Unit | 2014 [1] | 2015 [1] | Change in % |
|---|---|---|---|---|
| Domestic Production | Billion kWh | 98.0 | 84 | -14.7 |
| Imports | Billion kWh | 973.6 | 1,101 | 13.1 |
| Total Volume of Natural Gas | Billion kWh | 1,071.6 | 1,184 | 10.5 |
| Storage Balance [2] | Billion kWh | -5.8 | 7 | - |
| Exports | Billion kWh | 241.2 | 326 | 35.2 |
| Primary Energy Consumption of Natural Gas | Billion kWh | 824.6 | 866 | 5.0 |
| | Petajoules ($H_u$) | 2,679 | 2,812 | - |
| | Mtce ($H_u$) | 91.4 | 95.9 | - |
| **Structure of Natural Gas Volume According to Countries of Origin** | | | | |
| Domestic Production | % | 9 | 7 | |
| Russia | % | 38 | 40 | |
| Norway | % | 22 | 21 | |
| Netherlands | % | 27 | 29 | |
| United Kingdom/Denmark, Others | % | 4 | 3 | |
| **Structure of Natural Gas Consumption According to Consumer Groups** | | | | |
| Private Households and Small Trade | Billion kWh | 359.3 | 384 | 7 |
| Industry (Including Industrial Power Plants) | Billion kWh | 352.6 | 360 | 2 |
| Power Plants, Thermal Power and Heating Stations Supplying the General Public | Billion kWh | 111.2 | 110 | -1 |
| Self-Consumption and Statistical Differences | Billion kWh | 1.2 | 1.2 | - |

*1) Preliminary data; some figures are estimates*
*2) Minus = storage*
*Discrepancies in the totals are due to rounding off*

*Source: German Association of Energy and Water Industries (BDEW)*

Compared to 2014, the proportion of natural gas in the entire primary energy consumption increased by 0.7 percentage points and amounted to approximately 21 % in 2015.

Compared to the previous year, Germany's natural gas volume increased by 11 % to 1,184 billion kWh in 2015. 7 % of which were produced in Germany, 93 % were imported. Domestic production decreased by 15 % to 84 billion kWh. Germany's natural gas imports increased by 13 %. The most important supplier country was Russia: The share of Russian natural gas in the German volume increased from 38 % (2014) to 40 %. Norway's contribution decreased slightly from 22 % in 2014 to 21 % during the year under review even though a plus could be ascertained in absolute terms due to the increased import volume. The Dutch proportion increased by two percentage points and amounted to 29 %. The remaining 3 % were allocated to such other supplier countries as, for example, Denmark (2014: 4 %). All told, nearly 60 % of Germany's natural gas volume originated from Western Europe. With a plus of almost 35 %, Germany's natural gas exports experienced a significant increase.

On balance, about 7 billion kWh of natural gas were taken from storage facilities in 2015. In the previous year, on balance 6 billion kWh were stored.

According to initial figures, 8.4 billion kWh of biogas upgraded to natural gas quality were fed into the German natural gas grid during the year under review. In 2014, the feeding volume amounted to 7.5 billion kWh. In accordance with the AG Energiebilanzen's balancing scheme, these quantities are recorded both on the volume side and the consumption side under renewable energy and not under natural gas.

Since the liberalization of the energy markets, spot and futures markets for natural gas have developed rapidly. All told, gas trading at the European hubs exhibits significant growth. At the virtual trading points, essential supply and demand based price signals are created for the European and, thus, also the German market today. With short-term action gaining increased relevance on spot markets and in other trading centers, a price spread has been in place between the border-crossing prices for crude oil and natural gas since 2010 which can be clearly seen in Figure 8. Due to the massive decline of the oil price since late 2014, however, the prices converged once again. But the price trend for oil no longer plays any role in the development of procurement costs for gas today.

After having reached their highest level to date at the end of 2008, the import prices for natural gas first dropped considerably until August 2009, with an all time low in July 2009, and then increased once again almost continuously until the end of 2012. Compared to 2012, the year 2013 entailed a reduction in prices which continued in 2014: On an annual average and compared to the previous year, the import prices for natural gas fell by almost 15 % in 2014. This trend was continued in 2015; the import prices for natural gas decreased by 14.1 % in 2015. In December, the border price amounted to 4,892 €/TJ which translates into 1.7611 c/kWh.

Figure 8

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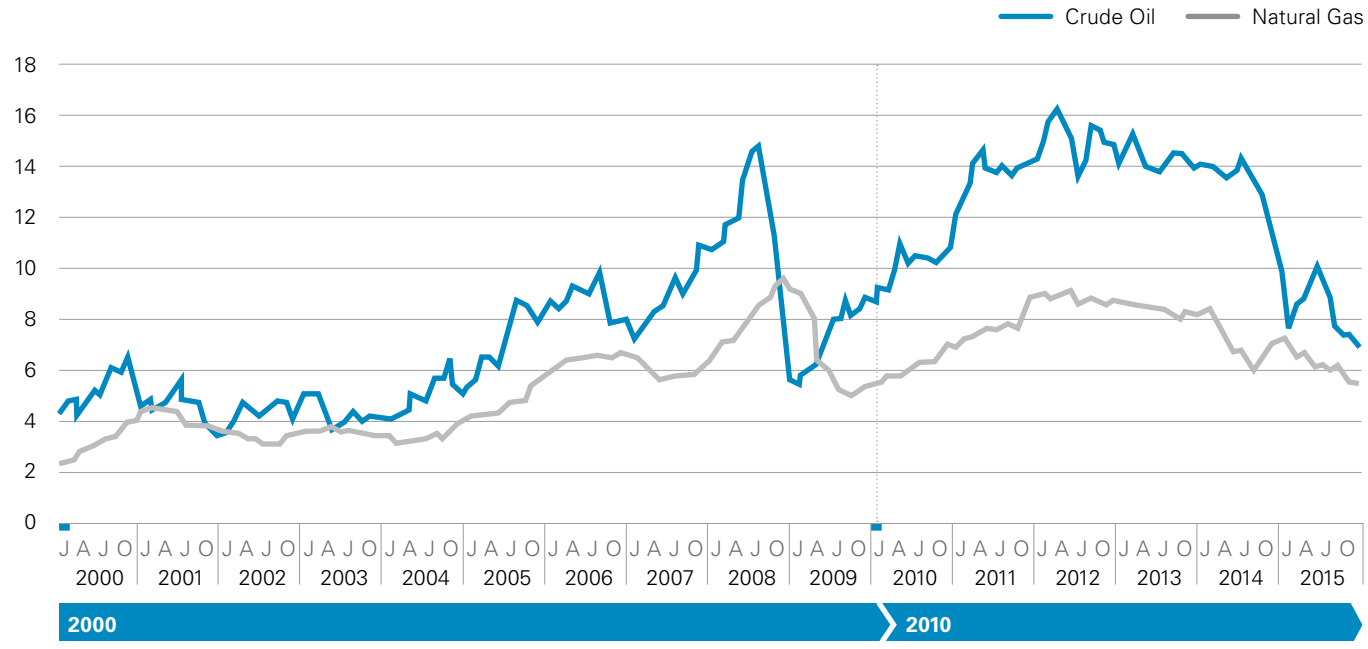
**Monthly Border-Crossing Values for Crude Oil and Natural Gas between 2000 and 2015**




*Source: Federal Office of Economics and Export Control (BAFA)*

The development of import prices has different effects on domestic sales prices (please see Figure 9). Different procurement periods for various customer groups result in diverging price trends. In addition, the relative price changes for bulk consumers are higher because of the lower overall price level. Parallel to the import prices for natural gas, the price for natural gas at the stock exchange decreased by 10.0 %. Sales prices to power plants decreased by 4.0 %. For large industrial clients (annual supply: More than 500 GWh), the prices decreased by 5.7 % compared to the previous year while small industrial gas consumers (supply: 11.63 GWh/a) paid 9.3 % less than before. Gas prices for the trade, commerce, and service sector as well as private households decreased by 1.8 % and 1.0 % respectively.

However, the diverging price trends for various customer groups are mainly attributable to different contract periods. For longer contract periods, the requisite gas volumes are purchased in advance on futures markets already at the beginning of the contract period in order to meet the obligation to deliver over the duration of the contract period (the so called "back to back procurement"). As a general rule, procurement periods as well as contract periods tend to be shorter for large consumers while they are longer for household customers and small-sized enterprises. A longer contract period actually means that short-term fluctuations of purchase prices are smoothed out and thus, with falling market prices, have a delayed impact on retail prices for end customers. However, this also applies conversely to increasing purchase prices which influence the retail price for end customers as well; albeit to a lesser extent and delayed.

The diverging development of stock exchange and distribution prices for various customer groups is associated with the composition of end customer prices and different contract periods. Procurement costs on the wholesale market actually reflect only a part of the end customer price. It also includes network charges designed to finance the grid infrastructure as well as taxes and duties which are only subject to slight fluctuations; this means that the price trends at the stock exchange have a weaker impact on price changes for end customers.

Figure 9

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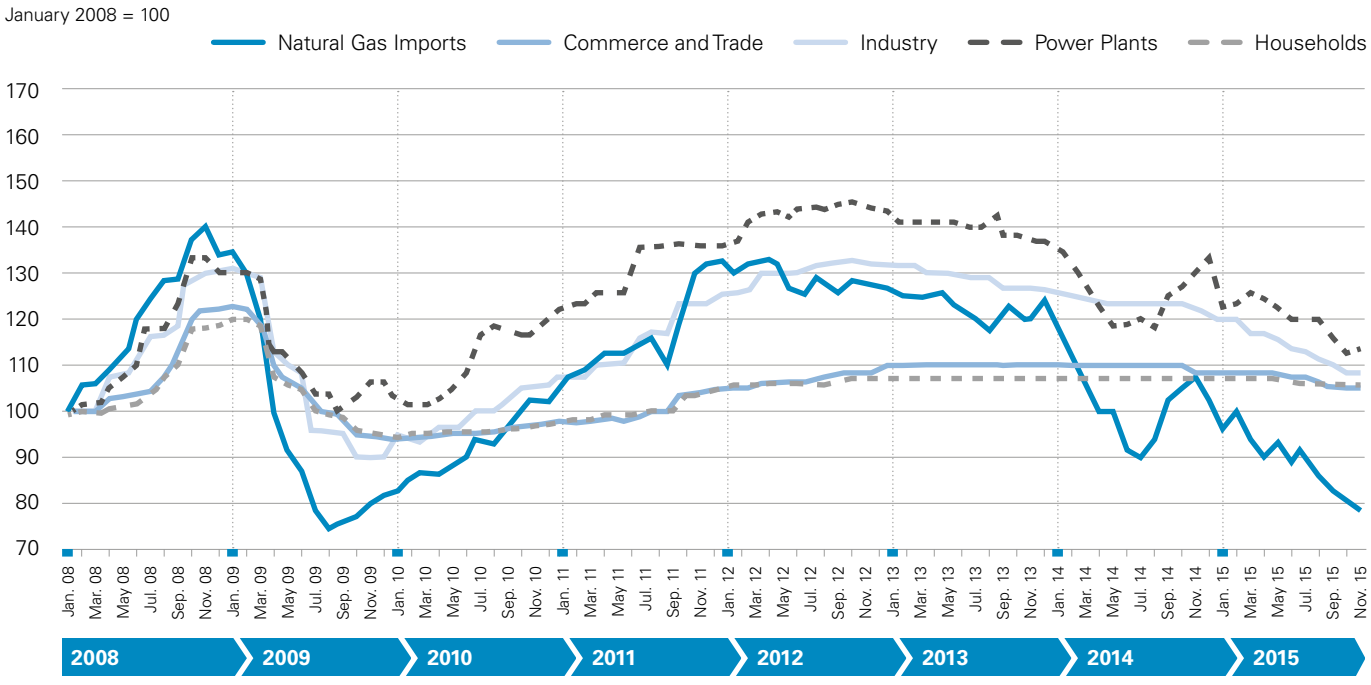
**Prices for Natural Gas Imports and Natural Gas Sales in Germany between 2008 and 2015**




*Sources: Federal Office of Economics and Export Control (BAFA); Federal Ministry for Economic Affairs and Energy (BMWi); Federal Statistical Office (Destatis)*

It is also interesting to consider the price expectations which evolved from futures at the stock exchange. A look at Figure 10 reveals quite a clear trend: For the delivery period of January 2017, significantly decreasing gas prices have been quoted since the beginning of 2015 which just recently (December 2015) were at a level of approximately 16 €/MWh.

Figure 10

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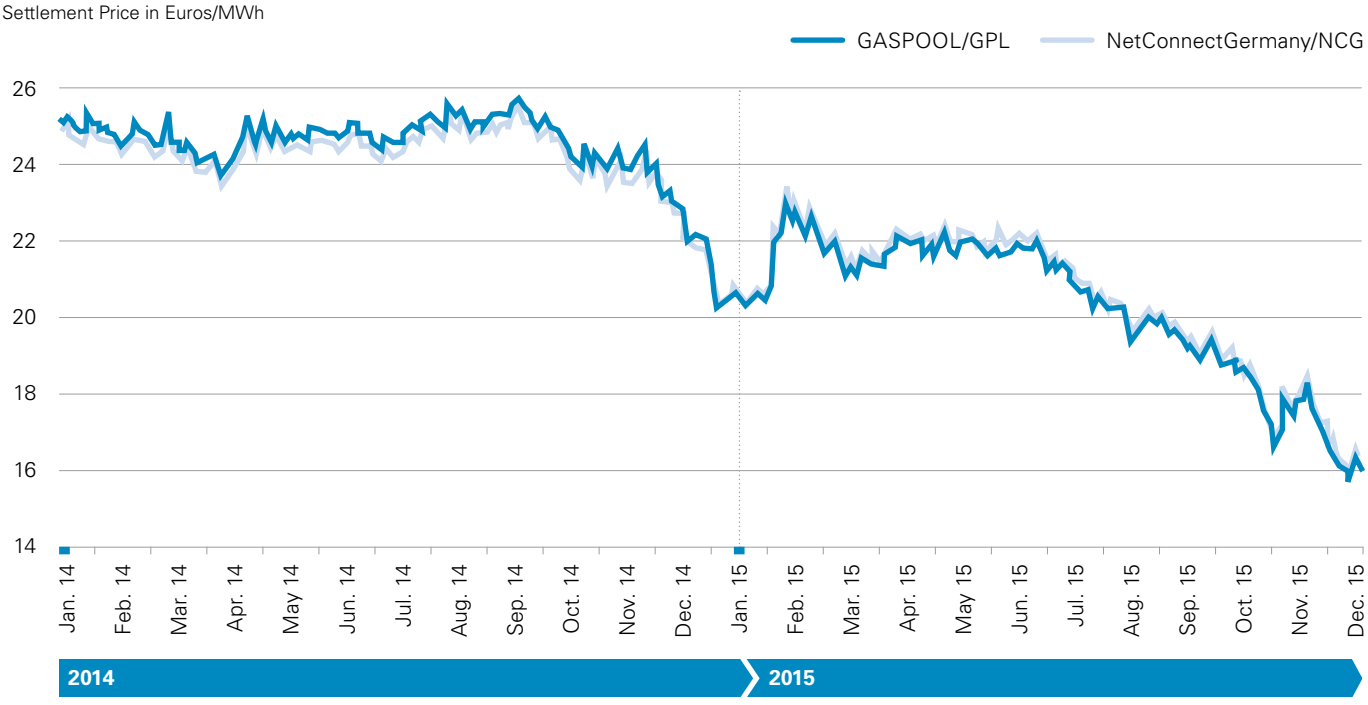
**Natural Gas Year Futures at the EEX in 2014 and 2015 for the Delivery Period January 2017**




*Source: EEX*

## Hard Coal

In 2015, the total hard coal consumption in Germany decreased only slightly compared to the previous year. According to preliminary estimates, it declined by 0.7 % to 57.7 Mtce (1,691 PJ). With a proportion of 12.7 %, hard coal, thus, continues to rank third behind mineral oil and natural gas in the domestic primary energy consumption mix. The downward trend in hard coal consumption, which has been observed in Germany for many years now and which will probably continue in the future as well, was actually supported by the persistently low global market prices for hard coal, an overall increase in domestic power generation, and an unaltered stable economic situation in the steel industry.

The volume of hard coal (domestic production and statistically recorded imports) decreased in 2015 by a total of 3.3 % when compared to the previous year; at the same time, however, stocks were reduced as well. The sum total of all recorded hard coal imports (including coke) decreased slightly by 1 % from 50.2 Mtce in 2014 to 49.7 Mtce in the reporting year. Domestic hard coal production dropped by almost 18 % to 6.4 Mtce. Decisive for the decline in domestic production was the phase out operation of the Auguste Victoria mine in Marl, one of the three remaining hard coal mines in Germany which had still been active until last year. Steeped in tradition, this mine was decommissioned as scheduled after a service life of 115 years at the turn of 2015/2016.

Due to the disproportionate decline in domestic production, the contribution of hard coal imports, which had already been dominating the supply of the German hard coal market for many years, continued to increase and reached a share of 89 % in 2015. Thus, no more than 11 % were actually covered by domestic production in 2015 which represents just over one tenth. This is the necessary consequence of the scheduled adjustment and phase out process in domestic hard coal mining in line with the coal policy guidelines for the socially acceptable phasing out of subsidized hard coal production in Germany by the end of 2018. In early 2016, only two hard coal mines were still operating in Germany: The Prosper Haniel mine in Bottrop as the last coal mine in the Ruhr District, and the Ibbenbüren mine. Both are part of the RAG Group, which meanwhile continues to systematically prepare itself for the post mining era that commences in 2019, for example, by utilizing mining infrastructure for renewable energy.

Just how big the German hard coal market, which will need to be served entirely by imports in the future, will actually be at that time is still uncertain today in light of the increasingly problematic general conditions primarily for electricity production from hard coal. Similar to the previous years, more than two thirds of the consumed hard coal accounted for power plant coals in 2015 as well. Despite the political wish to further expand the production of electricity from renewable energy sources, the use of hard coal in the power generation sector (including cogeneration) decreased only slightly this year – to be precise, by 0.3 % – with domestic electricity production exhibiting an overall increase. Due to the further reduction in fuel prices and fairly moderate prices for $CO_2$ certificates, the price advantage of hard coal, thus, was still considerable particularly when compared to the use of natural gas in the power plant sector. With a share of more than 18 % in 2015, hard coal continued to rank third also in the mix of energy carriers used in the production of electric power (here, behind renewable energy and lignite).

Compared to the previous year, the German steel industry's demand for coking coal and coke remained unchanged at 17.5 Mtce in 2015. Thus, more than 30 % of Germany's hard coal consumption once again accounted for this sector. In the heating market sector, which accounts for approximately 3 % of Germany's hard coal consumption and in which hard coal merely assumes certain niche functions today (as a domestic fuel and to meet the demand of small businesses, district heating plants, foundry coke), consumption decreased by about 7 % to 1.3 Mtce in 2015 (please see Table 8).

When it comes to the origin of imports delivered to the German hard coal market, Russia not only continued to maintain, but actually expanded its top position as the most important supplier country even further in 2015. That is why more than twice as much hard coal was delivered to the German market just from Russia alone as was delivered from domestic production in 2015. Following far behind in the ranking of the most important supplier countries in 2015 were the USA, albeit with declining quantities, as well as imports from

Table 8

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**Volume and Use of Hard Coal in Germany in 2014 and 2015**

| | Unit | 2014 [1] | 2015 [1] | Change |
|---|---|---|---|---|
| | | | | in % |
| Primary Energy Consumption | Mtce | 58.1 | 57.7 | -0.7 |
| Power Plants and Thermal Power Stations | Mtce | 39.2 | 38.9 | -0.3 |
| Steel Industry | Mtce | 17.5 | 17.5 | 0.0 |
| Heating Market | Mtce | 1.4 | 1.3 | -7.1 |
| Import of Hard Coal and Coke [2] | Mtce | 50.2 | 49.7 | -1.0 |
| Hard Coal Production | Mtce | 7.8 | 6.4 | -17.9 |

*1) Preliminary data; some figures are estimates*
*2) Coke converted into coal*
*Discrepancies in the totals are due to rounding off*

*Sources: German Coal Association (GVSt); The German Coal Importer Association; The German Coal Industry's Statistical Office*

Columbia which increased once again. Deliveries from Australia (primarily coking coals) also increased in 2015 while imports from Poland (more than one quarter accounted for coke) and, even more sharply, imports from South Africa declined.
It is presumed that global hard coal production (coking coal and steam coal), which had been growing continuously for more than one decade, not only came to a standstill in 2015, but actually declined for the first time ever. The production volume is likely to be around 7 billion tons. In particular, China reduced its production by approximately 110 million tons in 2015 while also announcing further cutbacks in its import volumes. In the USA, production declined by 70 million tons.

Table 9

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**German Hard Coal Imports According to Supplier Countries in 2014 and 2015**
(January to November; Including Coke; Excluding Non-Identifiable Countries)

| | 2014 | 2015 | 2014 | 2015 | Change |
|---|---|---|---|---|---|
| | in Million Tons | | Proportions in % | | in % |
| Russia | 12.3 | 13.8 | 27.6 | 32.2 | 12.2 |
| USA | 7.9 | 7.3 | 17.8 | 17.0 | -7.6 |
| Columbia | 5.4 | 6.6 | 12.1 | 15.4 | 22.2 |
| Australia | 5.3 | 5.7 | 11.9 | 13.3 | 7.5 |
| Poland | 5.1 | 4.2 | 11.5 | 9.7 | -17.6 |
| South Africa | 5.4 | 2.4 | 12.1 | 5.5 | -55.6 |
| Canada | 1.3 | 1.2 | 2.9 | 2.8 | -7.7 |
| Other Third Countries | 1.0 | 1.2 | 2.3 | 2.7 | 20.0 |
| Other EU Countries | 0.7 | 0.5 | 1.6 | 1.4 | -28.6 |
| **Total Imports** | **44.5** | **42.8** | **100.0** | **100.0** | **-3.8** |

*Discrepancies in the totals are due to rounding off*

*Sources: The German Coal Industry's Statistical Office; Federal Statistical Office (Destatis)*

Global market prices for hard coal continue to be in a downturn. In February 2015, the prices for steam coal reached their annual peak with slightly more than 63 US$/t CIF ARA while in December they fell to their lowest level in 2015 with a price slightly below 50 US$/t. In mid December 2014, one ton of steam coal still cost 72 US$/t. In December 2015, the price in US Dollars was, thus, approximately 30 % below the previous year's value (for a comparison of the global market prices for steam coal and crude oil, please see Figure 11).

A continuously weak Euro, compared to the US Dollar, compensated a substantial portion of the price decline for steam coal and, thus, resulted in currency-related price disadvantages for consumers in the Euro zone. During the 3rd quarter of 2015, for example, the average price for steam coal delivered free to the German border (BAFA price) amounted to 66.10 € per ton of coal equivalent (tce) which translates into 56.65 € per ton, which was actually below the lowest point of the third quarter of 2009. But compared to 71.21 €/tce and/or 61.04 €/t during the 3rd quarter of the previous year, this was "only" a decrease of about 4 to 5 euros which translates into 7 % (for border-crossing values of imported fossil fuels, please see Figure 12).

The price trend for coking coal is similar. While the prices were still quoted between 100 US$/t and 150 US$/t in 2014, they continued to decrease in 2015 as a result of the weaker demand and the continuous expansion of global production; precisely, by more than 20 % from 117 US$/t to less than 90 US$/t in late 2015. Even though a number of mines had already been shut down or decommissioned and other companies reduced their production, the supply seems to still exceed the demand significantly.

Freight rates in 2015 ranged between 3 US$/t and 8 US$/t for capesize vessels traveling on the benchmark route Richards Bay – Rotterdam. In August, freight rates appeared to be more stable for a short period of time, but they fell below 5 US$/t once again by the end of last year. Obviously, this market is fundamentally characterized by excess capacities. Here as well, China's reduced imports of Brazilian iron ore, steam coal, and coking coal have a price-cutting impact.

A look at the futures traded at the stock exchange (EEX) for the delivery period of January 2017 reveals a consistently downward trend from approximately 90 US$/t in early 2014 to values close to 40 US$/t at the end of 2015 (please see Figure 13).

Figure 11

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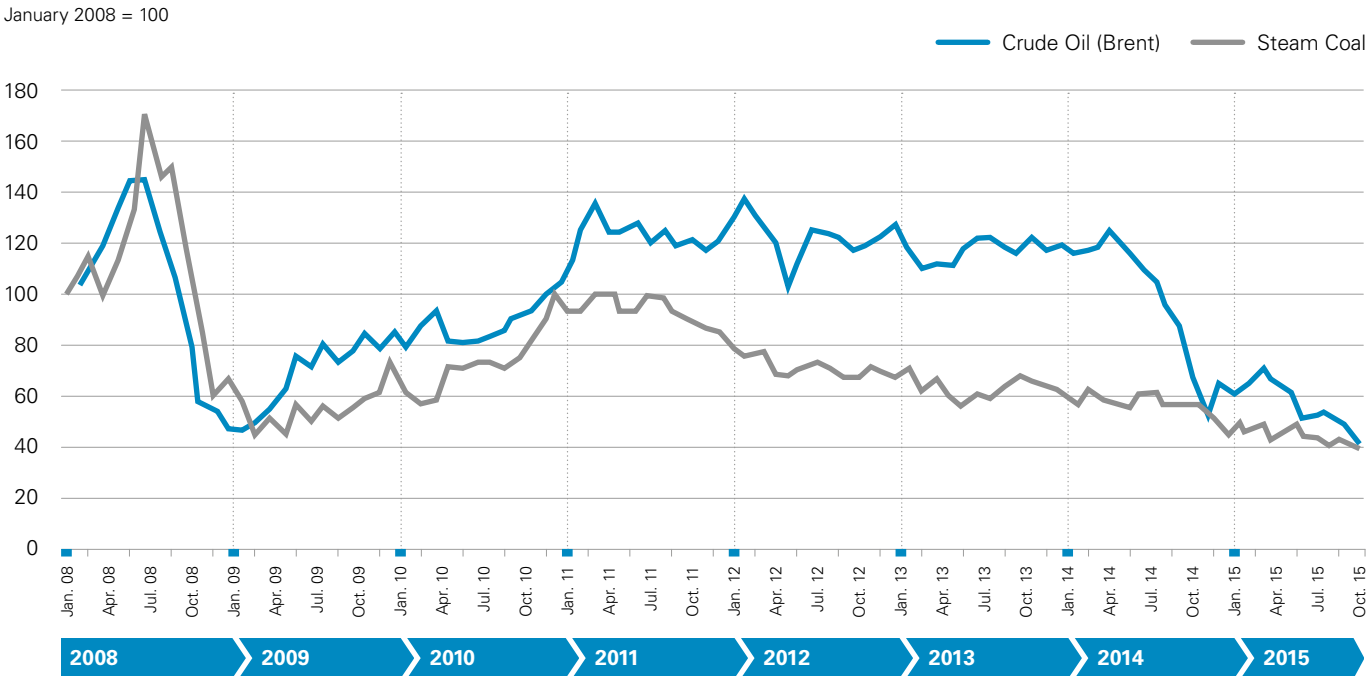
**Global Market Prices for Crude Oil (Brent) and Steam Coal between 2008 and 2015**




*Sources: The German Coal Importer Association (Mc Closkey's Coal Report); Association of the German Coal Industry (MWV)*

Figure 12

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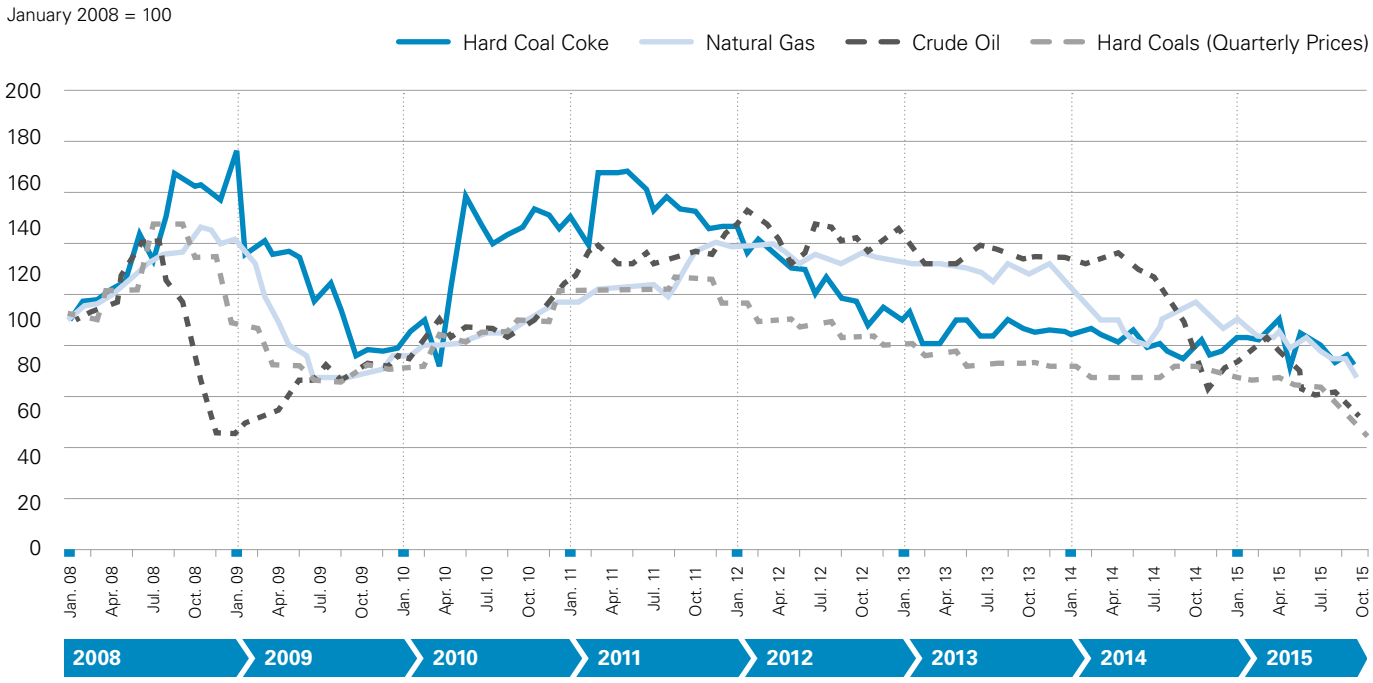
## Development of Energy Import Prices between 2008 and 2015




*Sources: The German Coal Importer Association; McCloskey's Coal Report; BAFA*

Figure 13

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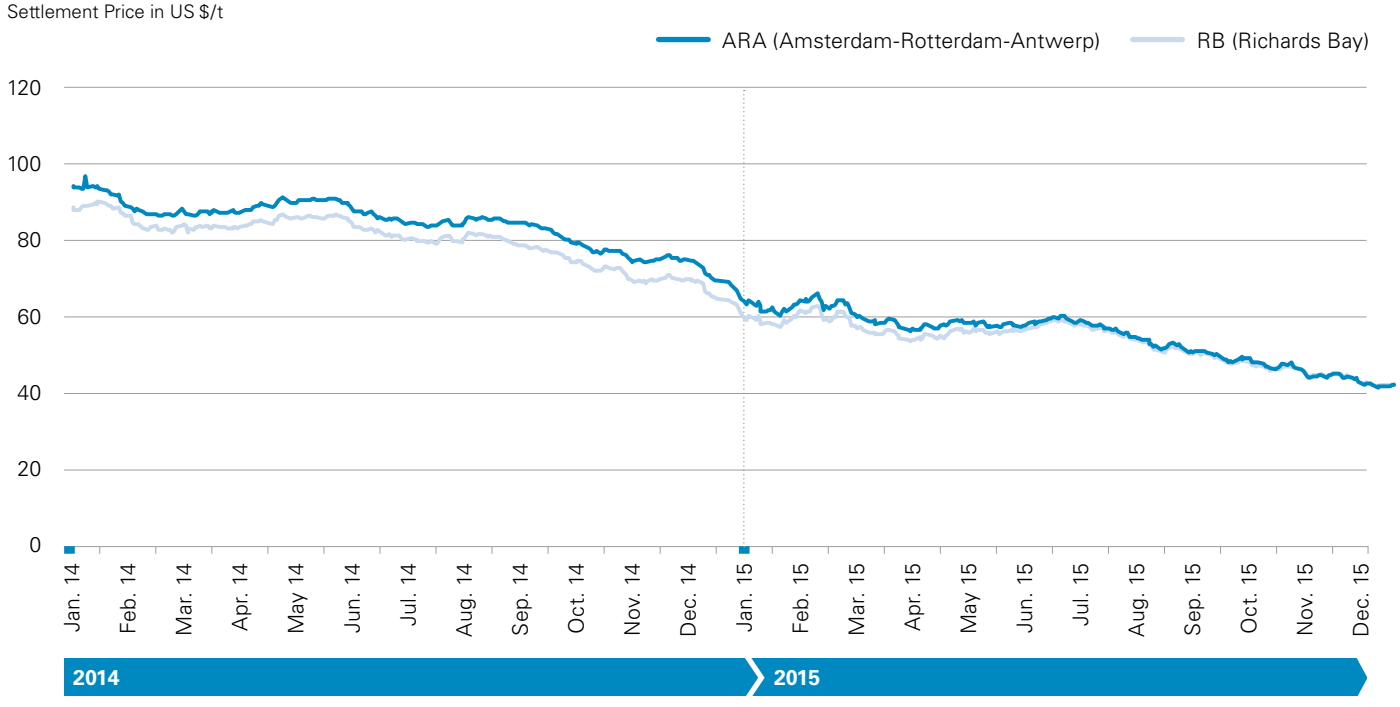
## Coal Futures at the EEX in 2014 and 2015 for the Delivery Period January 2017




*Source: EEX*

# Lignite

With 178.1 million tons in 2015, lignite production almost achieved the previous year's result even though the development was different in the individual districts: In Central Germany (-9.6 %) and the Helmstedt District (-18.7 %), coal extraction declined. In the Rhineland area (+1.7 %) and the Lusatian District (+1.0 %), however, it exceeded the previous year's result. These changes generally correspond to the

Table 10

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**Volume and Use of Lignite in Germany in 2014 and 2015**

| | Unit | 2014 | 2015 [1] | Change |
|---|---|---|---|---|
| | | | | in % |
| Domestic Raw Lignite Production According to Mining Districts | | | | |
| Rhineland | Million Tons | 93.6 | 95.2 | 1.7 |
| Lusatia | Million Tons | 61.8 | 62.5 | 1.0 |
| Central Germany | Million Tons | 20.9 | 18.9 | -9.6 |
| Helmstedt | Million Tons | 1.8 | 1.5 | -18.6 |
| **Total Lignite Production** | **Million Tons** | **178.2** | **178.1** | **-0.1** |
| | **Mtce** | **55.2** | **54.9** | **-0.6** |
| | **PJ** | **1,617** | **1,608** | **-0.6** |
| Use of Indigenous Lignite | | | | |
| **Total Sales** | **Million Tons** | **160.9** | **160.9** | **0.0** |
| to Power Plants Supplying the General Public | Million Tons | 159.0 | 159.3 | 0.2 |
| to Other Customers | Million Tons | 1.9 | 1.6 | -15.0 |
| Use for Refinement | Million Tons | 15.0 | 14.9 | -1.1 |
| Use in Lignite Mining Power Plants | Million Tons | 2.1 | 2.0 | -5.4 |
| **Total Volume of Refined Products from Domestic Production** | **1,000 tons** | **6,708** | **6,657** | **-0.8** |
| Foreign Trade | | | | |
| Total Imports | 1,000 tce | 72 | 46 | -36.1 |
| Total Exports | 1,000 tce | 1,543 | 1,395 | -9.6 |
| Foreign Trade Balance | 1,000 tce | -1,471 | -1,349 | - |
| Primary Energy Consumption of Lignite | Mtce | 53.6 | 53.5 | -0.3 |
| | PJ | 1,572 | 1,567 | -0.3 |
| Electricity Production from Lignite [1] | | | | |
| Power Plants Supplying the General Public | Billion kWh | 152.4 | 151.7 | -0.5 |
| Industrial Power Plants | Billion kWh | 3.4 | 3.3 | -2.2 |
| Total | Billion kWh | 155.8 | 155.0 | -0.5 |

*1) Preliminary data; some figures are estimates*
*Discrepancies in the totals are due to rounding off*

*Source: The German Coal Industry's Statistical Office*

respective development of deliveries to power plants supplying the general public (159.3 million tons; +0.2 %) which receive almost 90 % of the production (please see Table 10).

On average, the overall calorific value of the produced coals was slightly lower than in the previous year; with 54.9 Mtce (1,617 PJ), the energy content of the extracted lignite was, thus, 0.6 % below the previous year's result. Lignite's contribution to domestic energy production, once again, amounted to approximately 40 %. Hence, lignite continues to be an important domestic energy carrier.

With 155 billion kWh, power generation from lignite was almost on par with the previous year's production (-0.5 %). Lignite's share in power generation decreased to 23.8 % (previous year: 24.8 %). Thus, virtually every fourth kilowatt hour of the electricity used in Germany is sourced from lignite.

The manufacture of refined products based on lignite decreased in total by almost 1 % to about 6.7 million tons. Increases were reported for fluidized bed coal (+10 %). Briquette production (-4 %) and coke production (-3 %), however, remained below the previous year's result. The production of pulverized coal was almost at the same level as in the previous year (-0.4 %). With 53.5 Mtce (1,572 PJ), lignite-based primary energy consumption was almost on par with the previous year (-0.3 %); lignite, thus, met almost 12 % of the entire domestic demand for energy.

With a total consumption of 3.0 Mtce in 2015, the final energy sectors used approximately 1 % less lignite and lignite products than in the previous year. When it comes to industry and private households, the use of lignite fell marginally short of the previous year's level (please see Table 11).

Table 11

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**Lignite Balance for Germany in 2014 and 2015**

In 1,000 tce

| | | 2014 | 2015 [1] | Change |
|---|---|---|---|---|
| | | | | in % |
| Domestic Production | | 55,188 | 54,921 | -0.5 |
| + | Imports | 72 | 47 | -0.5 |
| = | Volume | 55,260 | 54,968 | -34.7 |
| +/– | Change in Stocks (Reduction: +, Replenishment: -) | -80 | -66 | - |
| – | Exports | 1,542 | 1,397 | -9.4 |
| = | Primary Energy Consumption | 53,638 | 53,505 | -0.2 |
| – | Use in Power Plants | 49,845 | 49,756 | -0.2 |
| – | Other Conversion Input | 4,870 | 4,841 | -0.6 |
| + | Conversion Output | 4,881 | 4,864 | -0.6 |
| – | Consumption during Production and Conversion as well as Non-Energetic Consumption | 766 | 771 | -0.3 |
| = | Final Energy Consumption | 3,038 | 3,001 | -1.2 |
| | Industry | 2,550 | 2,521 | -1.1 |
| | Households, Trade, Commerce, Services, Concessionary Coal | 488 | 480 | -1.6 |

*1) Preliminary data; some figures are estimates*

*Source: The German Coal Industry's Statistical Office*

## The Electric Power Industry

In 2015, the gross generation of electricity in Germany amounted to 651.8 billion kWh. Compared to the previous year, electricity production, thus, increased by 24.0 billion kWh, which equals 3.8 %. This increase was solely due to renewable energy (with the exception of hydropower); all conventional and nuclear energy carriers recorded declines. According to the available figures, electricity consumption increased only slightly; namely, by 1.3 % to 600.0 billion kWh (please see Table 12).

The electricity produced by lignite power plants amounted to 155.0 billion kWh in 2015. This equals a decline of 0.5 % when compared to the previous year's value. According to preliminary calculations, a net capacity of about 21,200 MW was installed at the end of the year. The contribution of lignite power plants to the gross electricity production amounted to 23.8 %. Last year, lignite was, thus, the most important energy carrier in the German electricity mix right after the renewables.

In 2015, hard coal fired power plants also delivered less electricity than in the previous year. They produced 118.0 billion kWh; this as well equals a decline of 0.5 % when compared to the previous year. During the reporting period, three new power plant units went online; at the same time, three units were decommissioned so that a capacity of 28,200 MW (net) was installed by the end of the year. Hard coal's share in the mix of energy sources supplying Germany with electric power amounted to 18.1 %.

During the reporting year, the nuclear power plants in Germany generated 91.8 billion kWh of electricity; this equals a share of 14.1 % in Germany's gross electricity production. After the Grafenrheinfeld nuclear power plant had been decommissioned in June 2015 within the scope of the agreed exit from nuclear power, the installed capacity (net) decreased from 12,068 MW to 10,799 MW.

The use of natural gas as a fuel in power plants designed to supply electricity was reduced by almost 2 %; since 2008, it has experienced a continuous decline. While the weather conditions accounted for a slight plus of 1.5 % for natural gas in cogeneration processes, the uncoupled generation of electric power from natural gas in those facilities which are exclusively used for electricity production continued to decline significantly in 2015 at a rate of 21 %. A major cause was the increased production of electricity by renewable energy plants. Due to the weather conditions and additional capacities, the use of natural gas in smaller, decentralized plants (CHP) and industrial plants recorded a slight plus. All told, natural gas accounted for a share of 9.1 % in Germany's gross electricity production in 2015.

In 2015, 20.5 % more electricity was generated from renewable energy than in the preceding year. Electricity production from wind energy exhibited the greatest increase. With 79.3 billion kWh, onshore wind turbines generated 23.4 billion kWh more electricity than in the previous year. This equals an increase of almost 42 %. Offshore wind turbines supplied 8.7 billion kWh, which was 7.3 billion kWh more than in 2014. All told and in a long-term comparison, 2015 was an above average, very strong wind year. Thus, not only the further expansion of wind turbines, but also the excellent wind conditions were decisive for the record high achieved in power generation from wind energy. Over a period of three months, more than 10 billion kWh were generated from wind each month (January, November, December); a benchmark which had not been exceeded so far. In eleven of the twelve months, more wind power was generated than in the respective months of the previous year; applied solely to onshore wind power, this was the case in ten months. In 2015, the installed capacity of onshore wind turbines increased by 3,536 MW while according to preliminary estimates, more than 2,000 MW were newly connected to the grid off shore. Thus, the total wind capacity installed in Germany now amounts to about 45,000 MW.

Photovoltaic systems supplied 38.4 billion kWh of electricity in 2015. This amount of electricity includes not only the electric power fed into the general supply network, but also the plants' in house consumption – irrespective of whether the latter is reimbursed pursuant to the German Renewable Energies Act (EEG) or not.

Table 12

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## Gross Electricity Production, Electricity Exchange, and Gross Electricity Consumption in Germany between 1990 and 2015 According to Energy Carriers

| | 1990 | 1995 | 2000 | 2005 | 2010 | 2014 [1] | 2015 [1] | 2014 to 2015 | 1990 to 2000 | 2000 to 2015 | 1990 to 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | in Billion kWh | | | | | | | Average Annual Change in % | | | |
| Lignite | 170.9 | 142.6 | 148.3 | 154.1 | 145.9 | 155.8 | 155.0 | -0.5 | -1.4 | 0.3 | -0.4 |
| Nuclear Energy | 152.5 | 154.1 | 169.6 | 163.0 | 140.6 | 97.1 | 91.8 | -5.5 | 1.1 | -4.0 | -2.0 |
| Hard Coal | 140.8 | 147.1 | 143.1 | 134.1 | 117.0 | 118.6 | 118.0 | -0.5 | 0.2 | -1.3 | -0.7 |
| Natural Gas | 35.9 | 41.1 | 49.2 | 72.7 | 89.3 | 61.1 | 59.6 | -2.5 | 3.2 | 1.3 | 2.0 |
| Mineral Oil | 10.8 | 9.1 | 5.9 | 12.0 | 8.7 | 5.7 | 5.4 | -4.6 | -5.9 | -0.6 | -2.7 |
| Renewables | 19.7 | 25.1 | 37.9 | 62.5 | 104.8 | 162.5 | 195.9 | 20.5 | 6.8 | 11.6 | 9.6 |
| Other | 19.3 | 17.7 | 22.6 | 24.1 | 26.8 | 27.0 | 26.1 | -3.2 | 1.6 | 1.0 | 1.2 |
| **Gross Electricity Production** | **549.9** | **536.8** | **576.6** | **622.6** | **633.1** | **627.8** | **651.8** | **3.8** | **0.5** | **0.8** | **0.7** |
| Electricity Flows from Foreign Countries | 31.9 | 39.7 | 45.1 | 53.4 | 42.2 | 38.9 | 33.5 | -13.9 | 3.5 | -2.0 | 0.2 |
| Electricity Flows into Foreign Countries | 31.1 | 34.9 | 42.1 | 61.9 | 59.9 | 74.5 | 85.2 | 14.5 | 3.1 | 4.8 | 4.1 |
| Foreign Electricity Exchange Balance | 0.8 | 4.8 | 3.1 | -8.5 | -17.7 | -35.6 | -51.8 | 45.5 | 14.3 | -220.8 | -218.2 |
| **Gross Electricity Consumption** | **550.7** | **541.6** | **579.6** | **614.1** | **615.4** | **592.2** | **600.0** | **1.3** | **0.5** | **0.2** | **0.3** |
| | Structure of Gross Electricity Production in % | | | | | | | | | | |
| Lignite | 31.1 | 26.6 | 25.7 | 24.7 | 23.0 | 24.8 | 23.8 | | | | |
| Nuclear Energy | 27.7 | 28.7 | 29.4 | 26.2 | 22.2 | 15.5 | 14.1 | | | | |
| Hard Coal | 25.6 | 27.4 | 24.8 | 21.5 | 18.5 | 18.9 | 18.1 | | | | |
| Natural Gas | 6.5 | 7.7 | 8.5 | 11.7 | 14.1 | 9.7 | 9.1 | | | | |
| Mineral Oil | 2.0 | 1.7 | 1.0 | 1.9 | 1.4 | 0.9 | 0.8 | | | | |
| Renewables | 3.6 | 4.7 | 6.6 | 10.0 | 16.6 | 25.9 | 30.1 | | | | |
| Other | 3.5 | 3.3 | 3.9 | 3.9 | 4.2 | 4.3 | 4.0 | | | | |
| **Gross Electricity Production** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | | | | |

*1) Preliminary data; some figures are estimates*
*Discrepancies in the totals are due to rounding off*

*Sources: German Association of Energy and Water Industries (BDEW); The German Coal Industry's Statistical Office; Working Group on Energy Balances (AGEB)*

Compared to 2014, this equaled an increase of 2.4 billion kWh. The contribution of solar energy to the German electricity mix amounted to 5.9 %. According to preliminary estimates, an additional photovoltaic capacity of about 1,500 MWp was installed in 2015; thus, a total of approximately 40,000 MWp were installed at the end of the year.

In the reporting year, 44.2 billion kWh of electricity were produced from solid, liquid, and gaseous biomass. This equaled an increase of more than 2 % compared to the previous year. Power plants generating electricity from biomass accounted for a share of 6.8 % in electricity production. In addition to the proportional power generation in waste-fueled power plants (from biogenic waste), 50.0 billion kWh of electricity were produced from biogenic energy sources in Germany in 2015. Their total contribution to the German electricity producers' mix of energy sources, thus, amounted to 7.7 %.

After the below average water year 2014, electricity production in hydroelectric power plants continued to diminish also in 2015 and, once again, decreased slightly by 1.4 % to 19.3 billion kWh.

The contribution of run of river and storage power plants to the electricity mix, thus, amounted to 3.0 %.

In total, 195.9 billion kWh of electricity were generated from renewable energy in the reporting year. According to initial figures, renewable energy's contribution to covering the gross domestic electricity consumption, thus, amounted to 32.6 % in 2015 (2014: 27.4 %). Their share in the gross electricity production was 30.1 %. That is why renewables were able to further expand their top position.

According to initial figures, cogeneration plants supplying the general public as well as cogeneration plants of industry and private facilities (for example, fossil or biogenic fuel fired mini or micro combined heat and power plants) produced approximately 105.2 billion kWh of electricity in 2015 (2014: 104.5 billion kWh). The contribution of electricity produced by cogeneration plants to Germany's net electricity production, including those amounts of cogeneratively produced electricity which are associated with the in house use of thermal energy for maintaining system operations in biogas plants (for example, fermenter heating), amounted to 17.1 % in 2015 (2014: 17.7 %).

Figure 14

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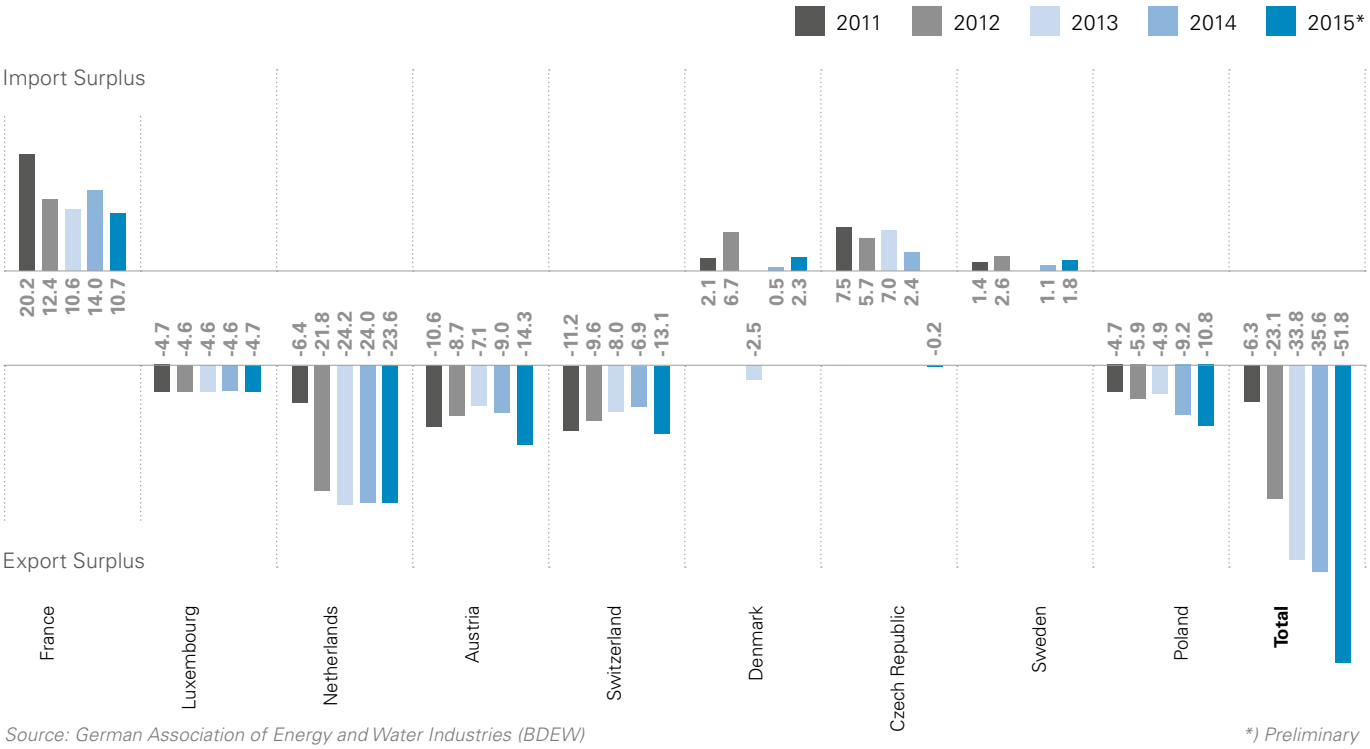
**Germany's Electricity Exchange Balance with Neighboring Countries between 2011 and 2015**

Electricity Flows in Billion kWh




*Source: German Association of Energy and Water Industries (BDEW)*

**) Preliminary*

Electricity production in large-scale thermal power stations supplying the general public increased once again; this was primarily due to the weather during the 2015 heating season, which was actually cooler than the previous year. Another increase in capacity was exhibited by the decentralized sector.

After Germany's negative balance in the electricity exchange with its neighboring countries had initially decreased in 2011, and then increased again considerably during the subsequent years, it reached its highest level so far in the reporting year 2015. Figure 14 shows the respective import and/or export surpluses.

Physical flows of electricity to the Netherlands are still by far the highest, followed by physical flows to Austria and Switzerland (Netherlands: 24.0 billion kWh, Austria: 17.8 billion kWh, Switzerland: 16.1 billion kWh). A major portion of such physical flows of electricity from Germany to the Netherlands, however, actually moves farther in the direction of Belgium and the United Kingdom. Once again, the largest amounts of electricity came from France to Germany, followed by the Czech Republic and Denmark (France: 12.1 billion kWh, Czech Republic: 6.1 billion kWh, Denmark: 5.1 billion kWh).

All told, 85.2 billion kWh of electricity flowed from German power grids to foreign countries (2014: 74.5 billion kWh) while Germany sourced 33.5 billion kWh from abroad (2014: 38.9 billion kWh). With an export surplus of 51.8 billion kWh, the balance for 2015 significantly exceeded the previous year's level (2014: 35.6 billion kWh). It should be noted in this context that such cross border electricity flows do not constitute any contractually agreed deliveries, but rather transit volumes and loop flows.

Industrial power consumption increased from 244.4 billion kWh in 2014 by 0.5 % to 245.5 billion kWh during the reporting period. Electricity-intensive industries, though, exhibited very diverse developments. In comparison, power consumption in the trade, commerce, and service sector grew faster. It increased from 138.3 billion kWh by 2.2 % to 141.4 billion kWh. The consumption of electric power in private households increased to a similar extent by 1.8 % from 129.7 billion kWh to 132.0 billion kWh. The primary reasons were the cooler weather during the heating season and the warmer weather during the summer months which, thus, also dampened the decline in electricity consumption as a result of savings measures on part of the consumers and improvements in efficiency. Consumption in the transportation sector slightly exceeded the previous year's figure. In total, net electricity consumption increased by 1.3 % to 530.6 billion kWh. Gross electricity consumption recorded the same growth. It is uncertain whether this development ended the downward trend in electricity consumption which had continued over the past couple of years, and whether the Federal Government's objective of reducing electricity consumption by 10 % between 2008 and 2020 is to be reached or not. Towards this end, power consumption ought to be reduced by no less than an annual average of 1.5 % during the period between 2015 and 2020. One may compare this to the average annual change rate of only -0.4 % between 2008 and 2015 (please see Table 13).

Due to the significant decline in power consumption which was accompanied by good economic growth, the macroeconomic electricity productivity, when expressed as the ratio of the price-adjusted gross domestic product to gross electricity consumption, increased by 0.4 % in 2015 compared to the previous year. During the period between 1990 and 2015, the average annual increase in productivity amounted to 1.1 % (please see Figures 15 and 16).

Table 13

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## Electricity Balance of Germany's Power Supply between 2000 and 2015

| | 2000 | 2008 | 2010 | 2013 | 2014 | 2015 [1] | 2014/ 2015 | 2000 to 2015 |
|---|---|---|---|---|---|---|---|---|
| | Billion kWh | | | | | | Change in % | |
| **Gross Electricity Production** | **576.5** | **640.7** | **633.1** | **638.7** | **627.8** | **651.8** | **3.8** | **1.7** |
| Self-Consumption in Power Plants | -38.1 | -39.7 | -38.1 | -36.9 | -36.1 | -35.6 | -1.4 | -10.4 |
| **Net Electricity Production** | **538.5** | **601.0** | **594.9** | **601.8** | **591.7** | **616.2** | **4.1** | **2.5** |
| Electricity Flows from Foreign Countries | 45.1 | 40.2 | 42.2 | 38.4 | 38.9 | 33.5 | -13.9 | -16.8 |
| Electricity Flows into Foreign Countries | 42.1 | 62.7 | 59.9 | 72.2 | 74.5 | 85.2 | 14.5 | 36.0 |
| **Net Domestic Electricity Volume** | **541.5** | **578.5** | **577.2** | **568.0** | **556.2** | **564.4** | **1.5** | **-2.4** |
| Pump Current Consumption | 6.0 | 7.9 | 8.6 | 7.8 | 8.0 | 8.0 | 0.0 | 0.7 |
| Grid Losses and Unrecorded Factors | 34.1 | 32.2 | 28.0 | 24.5 | 24.2 | 25.8 | 6.9 | -19.7 |
| **Net Electricity Consumption** | **501.4** | **538.4** | **540.6** | **535.7** | **524.0** | **530.6** | **1.3** | **-1.4** |
| Proportion of: | | | | | | | | |
| Mining and Manufacturing Industries | 239.1 | 252.4 | 249.7 | 245.1 | 244.4 | 245.5 | 0.5 | -2.7 |
| Households | 130.5 | 139.5 | 141.7 | 137.0 | 129.7 | 132.0 | 1.8 | -5.4 |
| Commerce and Trade | 68.3 | 75.3 | 76.5 | 78.8 | 77.0 | 78.2 | 1.6 | 3.9 |
| Public Institutions | 42.9 | 51.4 | 51.6 | 53.2 | 51.8 | 53.5 | 3.3 | 4.2 |
| Agriculture | 7.5 | 8.7 | 9.0 | 9.6 | 9.5 | 9.7 | 2.1 | 11.5 |
| Transportation | 13.1 | 11.1 | 12.1 | 12.0 | 11.6 | 11.7 | 1.0 | 5.1 |
| **Gross Domestic Electricity Consumption** | **579.6** | **618.2** | **615.4** | **604.9** | **592.2** | **600.0** | **1.3** | **-2.9** |

*1) Some figures are preliminary and estimates*

*Source: German Association of Energy and Water Industries (BDEW)*

Figure 15

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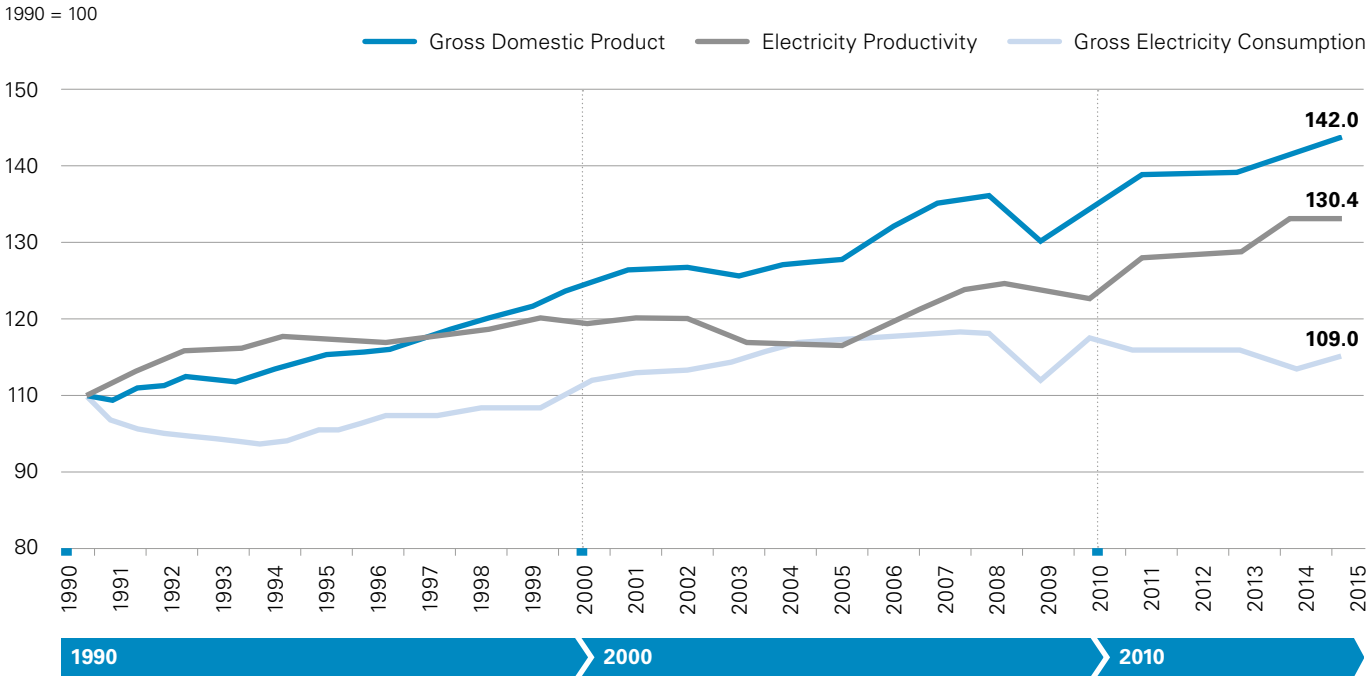
## Gross Domestic Product [1], Gross Electricity Consumption, and Macroeconomic Electricity Productivity [2] in Germany between 1990 and 2015




1) Price-adjusted
2) Gross domestic product per unit of gross electricity consumption

Sources: Federal Statistical Office (Destatis); The German Coal Industry's Statistical Office; German Association of Energy and Water Industries (BDEW)

Figure 16

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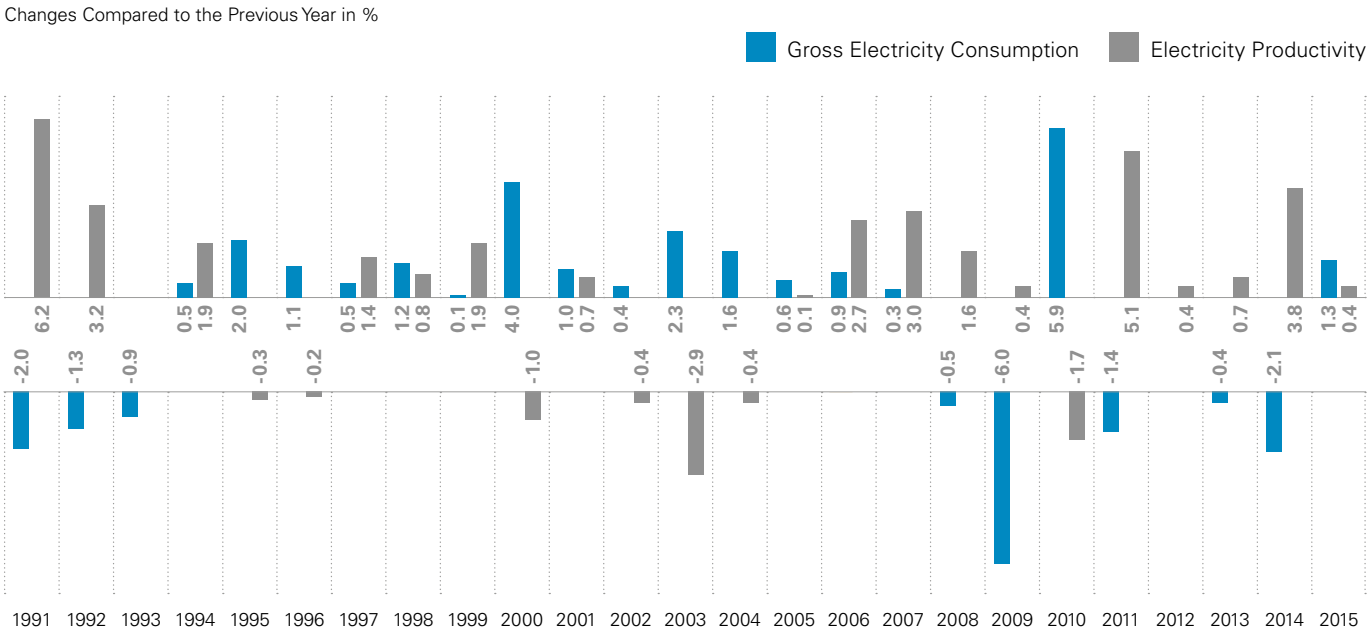
## Changes in Gross Electricity Consumption and Electricity Productivity between 1991 and 2015




Sources: Federal Statistical Office (Destatis); German Association of Energy and Water Industries (BDEW); Working Group on Energy Balances (AGEB)

Figure 17

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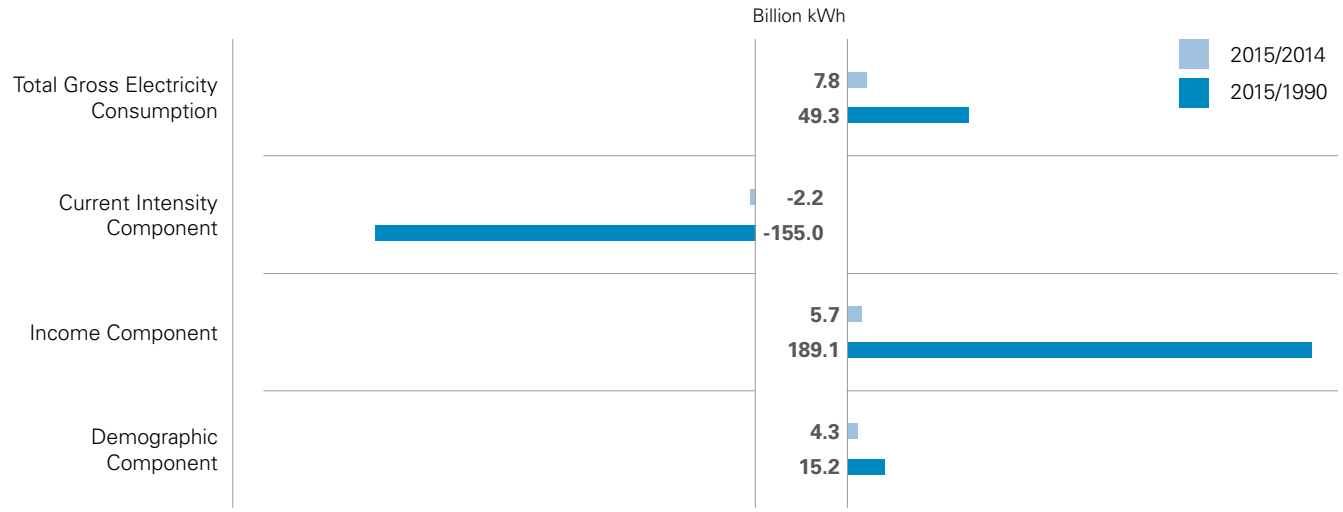
**Contributions of Diverse Influencing Factors to the Changes in Gross Electricity Consumption in Germany**

Changes in 2015 Compared to 2014 and 1990 in Billion kWh




*Sources: Federal Statistical Office (Destatis); Working Group on Energy Balances (AGEB); German Association of Energy and Water Industries (BDEW)*

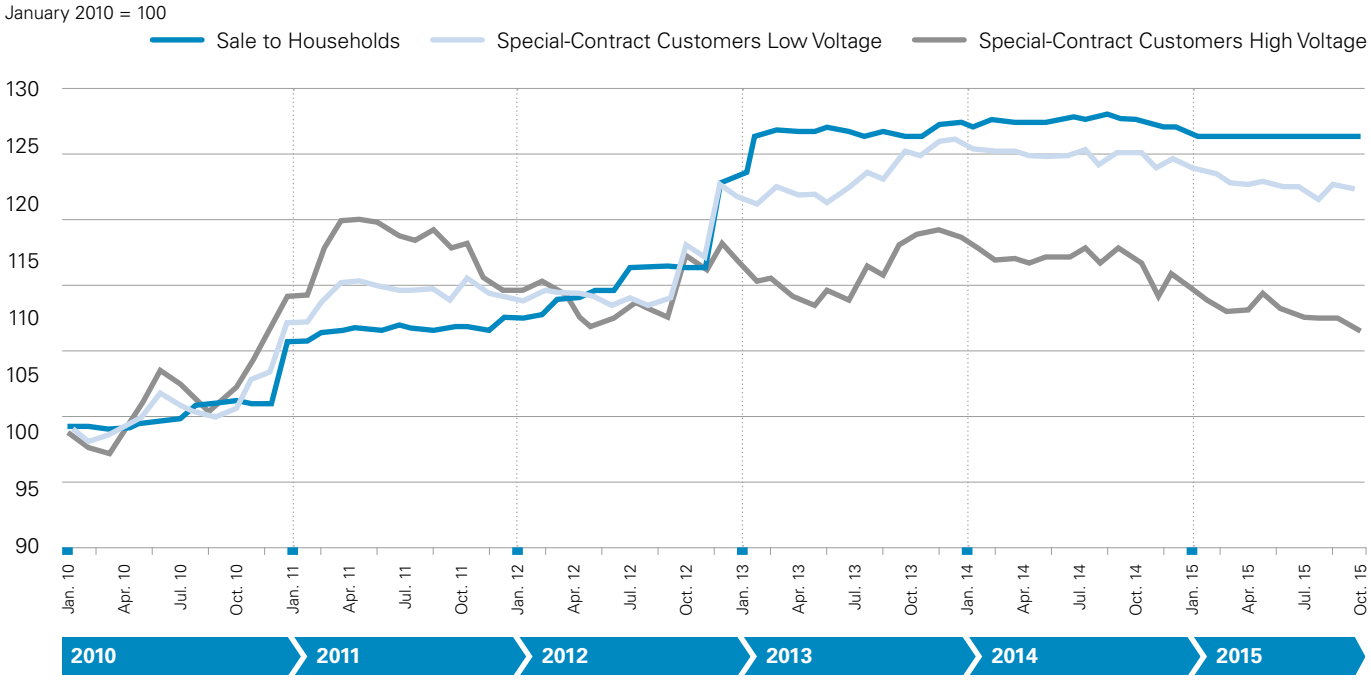
An analysis of the influence of the different components that changed the power consumption between 1990 and 2014 and also between 2014 and 2015 demonstrates that the increase in gross electricity consumption of 7.8 billion kWh in 2015 compared to 2014 was mainly due to the growing economy and the increased population. With an allocable minus of 2.2 billion kWh, the effect of electricity productivity (current intensity component) remained at a very low level. Yet over the entire period of time between 1990 and 2015, increased electricity productivity essentially contributed to the fact that it was possible to limit gross electricity consumption by 189 billion kWh to 49 billion kWh in 2015 even though the growing economy caused electricity consumption to increase substantially (please see Figure 17).

In 2015, electricity prices for industrial clients decreased slightly by 0.6 %, which was primarily due to the marginal decline in taxes, duties, and levies. The proportion of governmental charges included in the electricity price for industrial clients, which had amounted to 50 % in 2014, decreased to 47 % in 2015 (excluding electricity tax).

Electricity prices for households also decreased by almost 1 %. Similar to industrial clients, the slight decline in taxes, duties, and levies was also noticeable for household clients. In addition, the procurement costs for distributors also decreased due to declining futures market prices which actually benefitted consumers. However, since taxes, duties, and levies as well as the suppliers' proportion of the electricity price decreased to almost the same extent, the proportion of governmental charges included in the electricity price remained constant at 52 % when compared to 2014. In 2016, though, the proportion of taxes, duties, and levies will increase once more since not only the apportionment imposed by the German Renewable Energies Act (EEG), but also the surcharge for cogeneration plants, the apportionment pursuant to § 19 of the German Electricity Grid Charges Ordinance (StromNEV) as well as the offshore liability levy increased again. Due to its small dimension, the suspension of the levy on interruptible loads in 2016 is not noticeable.

Figure 18

**Electricity Producer Price Index for Special-Contract Customers and Sale to Households in Germany between 2010 and 2015**




*Source: Federal Statistical Office (Destatis)*

As measured by the producer price index, electricity prices developed quite differently in 2015 for each respective customer group: While there was a slight decline of 0.9 % each for households and commercial customers (previous year: +1.3 % and +1.0 % respectively), they decreased by 2.0 % for special-contract customers at the low voltage level (previous year: +2.4 %) and even by 3.9 % for those at the high voltage level (previous year: +1.5 %). With 10.5 % (previous year: 9.2 %), the producer price index for sales to redistributors dropped even more. The stock exchange price for electricity exhibited a similar trend; it decreased by 8.9 % in 2015 when compared to 2014 (previous year: -11.8 %). The stock exchange price for electricity was 57.6 % lower in 2015 than in 2008; the year it reached its highest level to date (please see also Figure 18).

If one observes the development of electricity prices on the futures market (serving as an example, Figure 19 shows January 2017 as the delivery period), then one will see a clear tendency towards price reductions commencing during the first half of 2011 and ceasing at the end of 2015.

Since approximately April 2013, the Base Year Future had been below the level of 40 €/MWh and actually moved to less than 30 €/MWh in the fall of 2015. The Peak Year Future has been permanently below the 50 €/MWh level since the fall of 2013 and even approached the 30 €/MWh mark in late 2015. This price trend, which provides hardly any incentives for power plant investments, explains why there are discussions as to whether the electricity market needs to be reformed.

Figure 19

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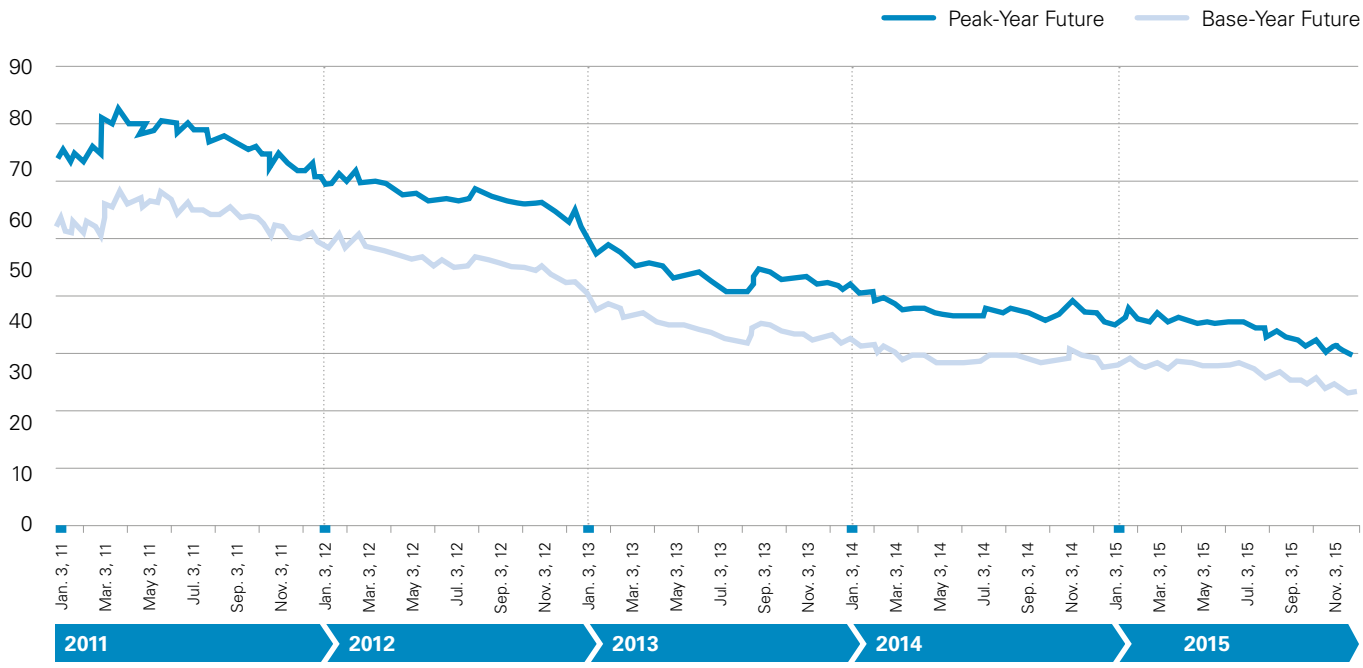
**EEX Futures for Electricity between 2011 and 2015 for the Delivery Period January 2017**

Phelix-Power Futures Peak and Base in EUR/MWh




*Source: EEX*

For the electric power industry, the development of certificate prices for $CO_2$, which are determined within the scope of European emissions trading, continues to be significant as well. This is documented by a closed time series of $CO_2$ certificate prices which is available for the second trading period between 2008 and 2012 and now also for the first three years of the third trading period between 2013 and 2020. After prices of more than 20 €/t $CO_2$ had initially been recorded, the onset of the global economic crisis in 2008 marked a dramatic decline in prices which first decreased to values of less than 10 €/t $CO_2$ until early 2009. This was then followed by a longer phase during which the prices remained relatively stable within a range of approximately 13 €/t $CO_2$ to 16 €/t $CO_2$ until May 2011. However, it became all the more apparent that due to the crisis, companies participating in emissions trading had a considerable surplus of additional certificates which was augmented even further by certificates acquired within the scope of CDM projects. This overallocation, which became increasingly more evident, finally resulted in prices which have continuously been – and often significantly – below 5 €/t $CO_2$ since early 2013. Only in the course of 2014 was there a slight upward trend in the direction of 8 €/t $CO_2$ to 9 €/t $CO_2$ which lasted until the end of 2015 (please see Figure 20). It should be noted that, irrespective of the amount of the certificate prices, the specified quantitative limit (cap) guarantees that the annually decreasing $CO_2$ objective is attained.

Obviously, the intended shortage signals which were to be given by emissions trading no longer have their desired effect. The development of $CO_2$ certificate prices on the futures market for the delivery period of December 2017 was similar to spot prices. These certificate prices can hardly be distinguished anymore from those on the spot market and exhibit a similar slight upward trend all the way towards 8 €/t $CO_2$ to 9 €/t $CO_2$ as of the first half of 2014 (please see Figure 21). It should be noted, though, that the current data which are available for the first two months of 2016 both for the spot and futures markets once again point towards a decline in prices amounting to 5 €/t. Apparently, the market has responded to statements made by the Polish Government according to which it is not willing to give its consent to pushing forward the commencement of the market stabilization reserve.

Figure 20

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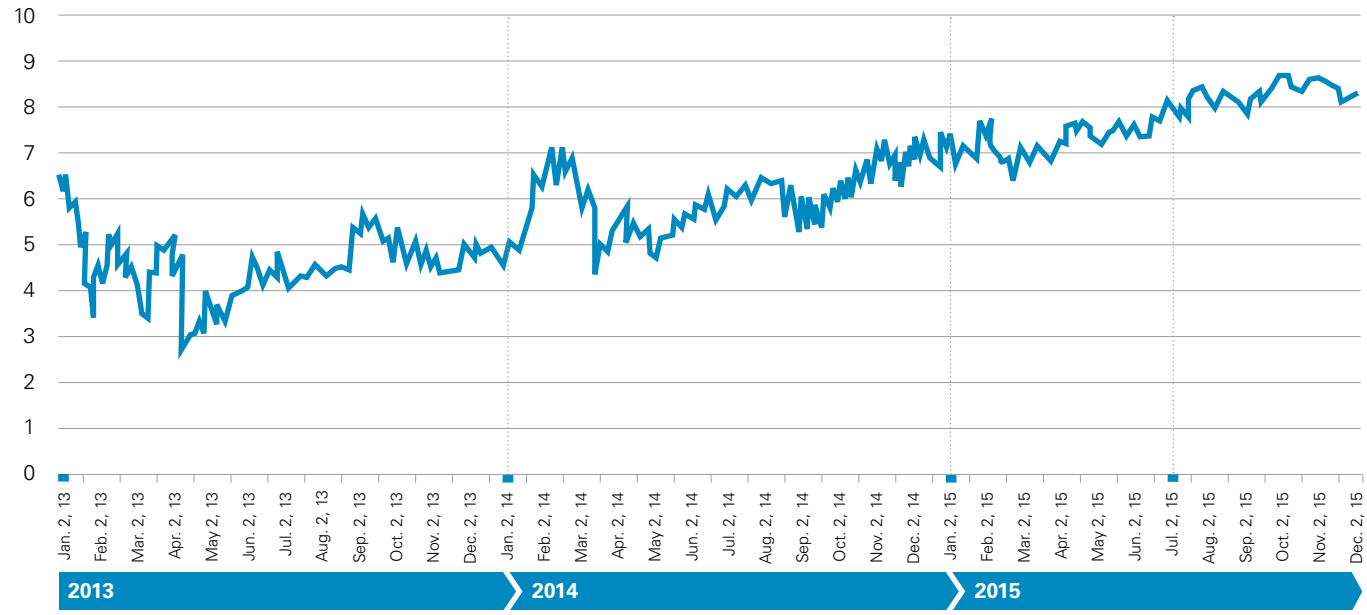
## $CO_2$ Certificate Prices on the EEX Spot Market between 2013 and 2015

Settlement Prices in Euros/EU Allowances (EUR/EUA)




*Source: EEX*

Figure 21

AGEB
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## $CO_2$ Certificate Prices at the EEX on the Futures Market between 2013 and 2015 for the Delivery Period December 2017

Settlement Prices in Euros/EU Allowances (EUR/EUA)


*Source: EEX*

## Renewable Energy

Renewable energy sources can be roughly divided into six categories (please see Table 14). In addition to the fluctuating energy sources hydropower, wind energy, and solar energy, terrestrial heat (geothermal energy), diverse biomasses as well as biogenic waste are currently used in power plants not only for electricity and heat production, but also as final energy in the sectors private households; trade, commerce, and service; industry; and transportation. Biomasses consist of solid, liquid, and gaseous fuels whereby wood in the form of wood logs, wood chips, pellets, or briquettes is the most important. Biogas is either used on site in biogas plants with an attached combined heat and power plant or freed from impurities in processing plants and fed into the natural gas grid as biomethane. Liquid fuels such as palm kernel oil or rapeseed oil as well as biofuels such as biodiesel and bioethanol assume a secondary role.

Estimates made by the Working Group on Renewable Energies-Statistics (AGEE Stat) at Germany's Federal Ministry for Economic Affairs and Energy (BMWi), by the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) as well as by the German Association of Energy and Water Industries (BDEW) come to the conclusion that the consumption of all renewable energy sources increased by about 10 % to 1,669 PJ (56.9 Mtce) in 2015 when compared to 2014. Since the consumption of all other energy carriers except for natural gas declined, the proportion of renewable energy of the primary energy consumption increased from 11.5 % in 2014 to 12.5 % in 2015 (please see Table 1 and Table 14).

Concerning the structure of renewable energy's primary energy consumption according to different fields of application, its use in electricity production dominates with a proportion of 56 % (change 2014/2015 : +15 %), followed by the heating sector with 36 % (2014/2015: +7 %), and the transportation sector with about 8 % (2014/2015: -5 %). When considering the primary energy consumption of renewable energy with regard to all forms of its use, biomass continued to dominate the field in 2015 with a proportion of almost 57 %, followed by wind energy with 19 %, and solar energy with approximately 10 % as well as biogenic waste with about 8 %; hydropower had a share of 4 % and geothermal energy nearly 3 % (please see Figure 22).

In 2015, the use of renewable energy in private households, industry as well as the trade, commerce, and service sector increased by 6.2 % which was primarily due to the cooler weather (albeit still at a comparably low level).

When it comes to the use of renewable energy in electricity production, wind energy exhibited by far the greatest increase with a plus of 50 % compared to 2014 which was due to the strong wind year and the additionally installed capacity of almost 6 GW (please see also the section on the electric power industry). Power generation from solar energy increased by almost 7 %.

Figure 22

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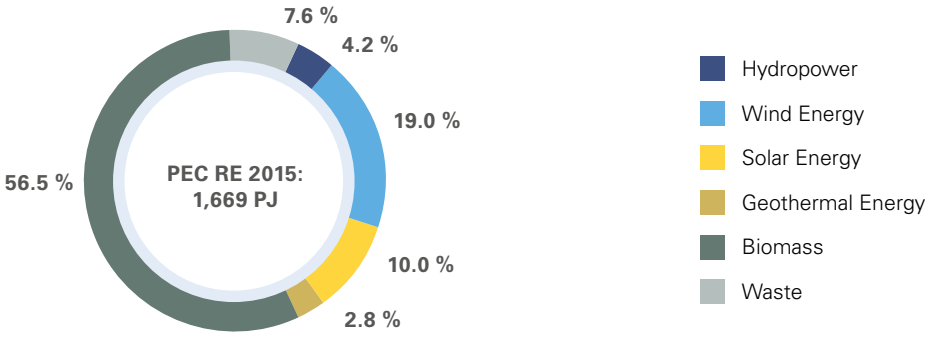
**Structure of Renewable Energy Sources' Contribution to Primary Energy Consumption**




*Source: Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW); Updated: February 2016*

Table 14

## Renewable Energy in Germany in 2014 and 2015 According to Its Use and Energy Sources

| | Hydropower | | | Wind Energy (Onshore and Offshore) | | | Solar Energy [1] | | | Geothermal Energy | | | Biomass | | | Waste | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | Changes | 2014 | 2015 | Changes | 2014 | 2015 | Changes | 2014 | 2015 | Changes | 2014 | 2015 | Changes | 2014 | 2015 | Changes | 2014 | 2015 | Changes |
| | Petajoules | | % | Petajoules | | % | Petajoules | | % | Petajoules | | % | Petajoules | | % | Petajoules | | % | Petajoules | | % |
| Domestic Production | 71 | 70 | -1 | 206 | 317 | 53 | 156 | 166 | 6 | 42 | 47 | 11 | 942 | 977 | 4 | 127 | 126 | -1 | 1,544 | 1,702 | 10 |
| Foreign Trade Balance | - | - | - | - | - | - | - | - | - | - | - | - | -26 | -33 | 31 | - | - | - | -26 | -33 | 31 |
| **Primary Energy Consumption** | **71** | **70** | **-1** | **206** | **317** | **53** | **156** | **166** | **6** | **42** | **47** | **11** | **916** | **944** | **3** | **127** | **126** | **-1** | **1,519** | **1,669** | **10** |
| Use in Power Plants (Electricity) | 71 | 70 | -1 | 206 | 317 | 53 | 130 | 138 | 7 | 4 | 5 | 37 | 342 | 346 | 1 | 64 | 61 | -5 | 817 | 936 | 15 |
| Use in Power Plants (Heat) | - | - | - | - | - | - | 0.011 | 0.013 | 18 | 0.61 | 1.25 | 105 | 42 | 48 | 15 | 48 | 50 | 4 | 90 | 99 | 10 |
| **Consumption during Conversion, Losses** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **22** | **22** | **-1** | **0** | **0** | **18** | **23** | **22** | **-1** |
| **Final Energy Consumption** | **-** | **-** | **-** | **-** | **-** | **-** | **26** | **27** | **5** | **38** | **41** | **7** | **509** | **528** | **4** | **15** | **15** | **0** | **589** | **611** | **4** |
| Industry | - | - | - | - | - | - | - | - | - | - | - | - | 99 | 99 | 0 | 15 | 15 | 0 | 114 | 114 | 0 |
| Transportation | - | - | - | - | - | - | - | - | - | - | - | - | 117 | 110 | -6 | - | - | - | 117 | 110 | -6 |
| Households, Trade, Commerce, Services | - | - | - | - | - | - | 26 | 27 | 5 | 38 | 41 | 7 | 294 | 319 | 9 | - | - | - | 358 | 388 | 8 |

*1) Photovoltaics and Solar Thermal Energy*

*All values for 2015 are preliminary.*

*Sources: Working Group on Renewable Energies-Statistics (AGEEStat); ZSW*

## $CO_2$-Emissions

According to an estimate of the German Association of Energy and Water Industries (BDEW), the specific $CO_2$ emissions of power generation plants supplying the general public (which neither include the power generation plants of mining facilities nor those of the manufacturing industry) amounted to 0.475 kg $CO_2$/kWh net in 2015, which represented a decrease of about 5.7 % compared to the previous year. The downward trend for specific emissions is primarily due to the cutback in electricity production from lignite and hard coal and to the increased use of renewable energy. Similar to the previous years, the continuous decline in electricity production from natural gas counteracted this trend a little since the average emissions of natural gas fired power plants fall below the average values achieved by the electricity production mix as a whole.

However, the decrease in specific emissions still does not permit any conclusions to be drawn on the development of absolute emissions in electricity production. After all, gross electricity production in 2015 was 24 billion kWh higher than in 2014, which translates into an increase of almost 4 %. However, it must be kept in mind that electricity production from emission free energy sources increased by approximately 28 billion kWh while that from emission-generating fuels actually decreased by 4 billion kWh. All told, though, a rough calculation indicates a slight reduction of $CO_2$ emissions in the electric power sector.

Currently, it is not yet possible to ascertain the overall development of carbon dioxide emissions in 2015 in a more comprehensive manner. However, a rough estimate of energy-related $CO_2$ emissions can be made on the basis of the changes in primary energy consumption for the respective emission-bearing and emission-free energy sources. Since the structure of energy consumption has shifted further towards emission-free and/or low-emission energy sources, $CO_2$ emissions are likely to have increased slightly less (0.7 %) than consumption when compared to the original values or conversely are likely to have declined slightly more (-0.8 %) when taking the temperature influences into account. Insofar as process-related $CO_2$ emissions as well as other greenhouse gas emissions developed similar to the trend from the respective base year until 2014, then the total greenhouse gas emissions in 2015 would have to be approximately one percentage point, which translates into 9 million tons of $CO_2$ equivalents, lower than in 2014 when taking the temperature-adjusted changes in energy-related $CO_2$ emissions into account. If the calculation were to be based on the original values of the energy-related $CO_2$ emissions, while assuming that all other variables remain unchanged, then a slight increase in greenhouse gas emissions by 0.2 %, which translates into about 2 million tons of $CO_2$ equivalents, could be presumed. In any case, though, the development would deviate from the path that needs to be taken to reach the requisite target.

In order to achieve the national objective of reducing greenhouse gas emissions by 40 % between 1990 and 2020, and by taking the emission values into account which are only roughly estimated here, another absolute decline by about 142 million tons to 153 million tons of $CO_2$ equivalents would be required between 2015 and 2020. On an annual average, this would be approximately 28 million tons to 31 million tons of $CO_2$ equivalents, which translates into 3.4 % to 3.6 %. Compared to the previous (2000 to 2014) reduction rate of 1.0 %, which equals around 10 million tons of $CO_2$ equivalents per year, the requisite emission reduction measures would need to be intensified considerably in order to maintain and attain this objective.

In this context, a problem should be highlighted which, seen from the emissions' perspective, is associated with the fact that those emissions which are accompanied by the high export surplus ought to be allocated to Germany according to the territorial principle. At the same time, emission-generating electricity production in the supplied countries is most likely to be displaced by the respective emission reduction effects which, in turn, will lead to lower emissions in those countries. But it is questionable whether the emissions balance will be positive when viewed from a transnational perspective. This depends primarily on the specific emissions of the export flow in relation to the specific emissions of the electricity displaced in the individual recipient country.

## Conclusion

The major causes for the increased primary energy consumption in Germany were due to weather that was cooler than the previous year, the comparably good economic situation, and also the growing population. Of course, this development was also fostered, in part, by the substantially decreasing prices particularly for fossil fuels. While consumption in the previous year had still declined considerably primarily due to the weather, it increased once again in 2015; albeit only slightly by 1.1 % – adjusted to the temperature effect, it was even a minor reduction. The macroeconomic energy productivity – as measured by the original values – improved only marginally (by 0.5 %). Adjusted to the temperature effect, it was close to the long-term average which ranges around 2 % per year.

Similar to primary energy consumption, electricity consumption also increased once again in 2015 when compared to the previous year; namely, by 1.3 %. Thus, the macroeconomic electricity productivity increased just barely in 2015 (+0.4 %). The individual end user sectors also exhibited more or less distinctive increases in electricity consumption. While electricity consumption in industry increased by only 0.5 % and in commerce and trade by 1.6 %, households used 1.8 % more electricity and public institutions even 3.3 %. It is uncertain whether this development ended the downward trend in electricity consumption, which had existed over the past couple of years, or whether it reversed it already again.

In 2015, the wholesale prices for electricity traded at the stock exchange once again decreased considerably (-8.9 %) and the long-term futures contracts for electric energy also indicate a continuous downward trend. Even though this may well be desirable, this might result in a lack of incentives for investments into electricity production capacities which will be required in the future. As a matter of fact, end consumers also profited from declining electricity prices; albeit considerably less so than electricity consumers who are able to supply themselves at the stock exchange. Electricity prices for households and commercial customers, for example, only decreased by about 1 %.

In 2015 as well, prices for $CO_2$ certificates were at a comparably low level at around 8 €/t $CO_2$.
A significant increase is also not to be expected in the long run if one were to take the development of certificate prices on the futures market as a basis. Obviously, the intended shortage signals which are to be given by emissions trading no longer have their desired effect. That is why it is all the more important to implement an efficient and effective structural reform of the European emissions trading system so that the intended incentives which were designed to foster emission-reducing behavior and which are to be provided through emissions trading can come into play once again. After all, the stricter regulations on the annual $CO_2$ reduction rates, which were concluded by the EU in October 2014, imply long-term zero emissions in the emissions trading sector.

In light of the objectives pursued by the German Federal Government in conjunction with its energy concept, the requisite energy-related data actually provide mixed results. While the macroeconomic energy and electricity productivity weakened significantly as a reflection of the efficiency trend, the structural change of energy carriers in the direction of renewable energy, with regard to electricity production, once again exceeded the pursued objective. However, it cannot be ignored that such special factors as the superb wind conditions also contributed to this outcome. It also needs to be considered that photovoltaics, as measured by the increase in plant capacities, experienced a significant decline in 2015. Unlike electricity, the use of renewable energy in transportation is anything but on target; and even to the heating sector, this only applies to some extent in light of stagnating trends.

There are also doubts as to whether the Federal Government's objective of reducing primary energy consumption by 20 % between 2008 and 2020 will actually be attained. Compared to 2015, consumption would need to be reduced by 13.6 % and/or by an annual average of nearly 3 % until 2020. Thus, the annual consumption reduction rate, which had amounted to only 1.1 % between 2008 and 2015, would need to be almost tripled.

It is uncertain whether the measures (for example, within the scope of the National Action Plan on Energy Efficiency) which have been launched in the meantime will suffice. Furthermore, it is also possible that opposing trends might impede the attainment of this objective; these might be the increasing population figures or the low energy prices and $CO_2$ certificate prices which could dilute the incentives for a more efficient use of energy.

Similar considerations apply to electricity consumption which is to be reduced by 10 % between 2008 and 2020. Here as well, it becomes apparent that additional efforts are necessary. Namely, so that the objective for 2020 could still be attained, it is necessary for electricity consumption to be further decreased by a total of 7.3 % and/or by an annual average of 1.5 % when compared to 2015. As measured by the actual development between 2008 and 2015, when electricity consumption had declined by an average of only 0.4 %, this essentially equals a quadruplication of the reduction rate. However, when assessing the electricity objective, it should be borne in mind that specficially because of renewable energy's great relevance for electricity production, innovative electricity applications based on renewables are also penetrating the market and will, thus, stimulate electricity consumption. In this respect, a reinterpretation of the electricity objective in the direction of "conventional" electricity consumption might be useful.

Last but not least, also in the aftermath of the Paris Climate Change Conference and the agreements concluded there, the objective pursued by Germany to reduce greenhouse gas emissions by 40 % between 1990 and 2020 is of primary importance.
A decline in greenhouse gas emissions by almost 28 % ($CO_2$ emissions: Nearly 25 %) had already been recorded for the period until 2014. If one keeps the above mentioned considerations in mind, then the greenhouse gas emissions ought to have still increased slightly in 2015 compared to the original values; adjusted to the temperature effect, a one percent decline might perhaps be expected. Thus, Germany has hardly come any closer to its objective. Compared to 2015, this would actually require an annual reduction of greenhouse gas emissions within a range of 30 million tons of $CO_2$ equivalents by 2020; however, the annual average reduction that has been recorded since 2000 only amounts to 10 million tons of $CO_2$ equivalents. Against this backdrop, the efforts to reach the climate protection targets would need to be intensified considerably.

All told, the development of the level and structure of energy consumption in Germany in 2015, in light of the objectives pursued by the energy concept, reveals a constant great and urgent need for action in order to still achieve the ambitious goals of the energy concept for 2020. The facts and figures available for 2015 ought to be reason enough to intensify the policy on implementing the energy concept in a target-oriented manner – that's why a specific focus needs to be put, in particular, on the building sector and the transportation sector.

*Edited by: Dr. Hans-Joachim Ziesing (hziesing@ag-energiebilanzen.de)*