AGEB

AG Energiebilanzen e.V.

Energy Consumption

in Germany in 2016

Slight Increase in Energy Consumption Once Again in 2016

Contents

Last Update: February 2017
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 Cologne
uwe.maassen@braunkohle.de

www.ag-energiebilanzen.de

Slight Increase in Energy Consumption Once Again in 2016

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 13,383 petajoules (PJ), which translates into 456.7 million tons of coal equivalent (Mtce), in 2016. This equals an increase of 1.1 % compared to the previous year.

The increase was due to a number of different factors. Among these factors were, for example, the positive economic trend (+1.9 %), the growth in population (+0.8 million people) as well as the weather, which was cooler than the previous year, and the associated higher demand for heating energy. Furthermore, 2016 was a leap year with an additional "energy consuming" day. If adjusted to the weather conditions, last year's energy consumption would have decreased only by an estimated 0.6 %; and including the leap year effect, the increase probably would have amounted to 0.4 %.

As measured by the original values and when compared to the previous year, the macroeconomic energy productivity approximately halved in 2016 (0.7 % versus 1.3 %). Adjusted to the temperature effect and considering the leap year effect, it amounted to about 1.5 % which was still significantly below the long-term average of 2 %.

With the exception of renewable energy (+2.8 %), mineral oil (+1.5 %), and (primarily due to the temperatures) natural gas (+9.5 %), the consumption of all other energy carriers decreased more or less significantly. For example, nuclear power generation exhibited the greatest decrease with 7.8 %. Hard coal consumption decreased by a substantial 5 % and lignite consumption by almost 3 % in 2016.

With a 34 % share in primary energy consumption, mineral oil continued to be the most important energy carrier; followed by natural gas which increased its share to around 23 %. Renewable energy carriers ranked third with a current share of 12.6 % – ahead of hard coal with 12.2 % and lignite with 11.4 %. The share of nuclear energy decreased to below 7 % in 2016.

When it comes to renewables, the changes continued to be very different in 2016 as well: While hydropower with a plus of almost 11 % and geothermal energy with about 9 % substantially increased their consumption, and biomass as well as (biogenic) waste also went up by around 4 % and almost 5 % respectively, the use of wind energy declined by a substantial 2 % due to the more unfavorable wind conditions as did the use of solar energy which decreased by slightly more than 1 %. All told, the increase in the consumption of renewables in 2016 was significantly weaker than in the previous year.

Unlike primary energy consumption, gross electricity consumption remained largely constant in 2016: With about 595 billion kWh, it was only 0.1 % lower than in the previous year. This was 4.3 % below the highest level to date which amounted to approximately 621 billion kWh in 2007. The macroeconomic electricity productivity, which had increased by an annual average of about 1 % between 1990 and 2015, improved with a rate of 1.9 % that was almost twice as high in 2016.

Compared to the previous year, gross electricity production also remained virtually unchanged in 2016 (+0.2 % to 648 billion kWh). In contrast, the structure of electricity production according to energy carriers exhibited a noticeable change: While the shares in electricity production decreased significantly for nuclear energy, lignite, and hard coal and exhibited only a slight plus for renewable energy carriers, natural gas considerably expanded its production share (from 9.6 % to 12.4 %) with an increase in electricity production of about 30 %. With a total production volume of 188 billion kWh, which translates into a production share of well above 29 %, renewables retained their top position ahead of lignite (23.1 %), hard coal (17.2 %), nuclear energy (13.1 %), and natural gas (12.4 %).

While the values for gross electricity production and gross electricity consumption remained largely unchanged, the surpluses obtained from the exchange of electricity with foreign countries[1] increased to a new record level of almost 54 billion kWh (2015: Nearly 52 billion kWh).

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

Particularly high export surpluses were once again recorded for the exchange with the Netherlands (15.5 billion kWh), Switzerland (14.6 billion kWh), and Austria (12.4 billion kWh). Surpluses in the flow of electric power from abroad traditionally come from France; whereby the import surplus from France almost halved from 10.7 billion kWh in 2015 to 5.6 billion kWh in 2016. The import surplus from the Czech Republic, which had usually been the case in previous years, changed to a German export surplus in 2016. This also applied to Denmark, from where Germany had obtained on balance 2.3 billion kWh in 2015, but exhibited a surplus of 2.5 billion kWh in its exports to Denmark in 2016.

At the moment, it is not yet possible to ascertain the overall development of greenhouse gas emissions in a comprehensive manner for the year 2016. 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.

Even though 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 once again by approximately 0.7 % or about 6 million tons when compared to the original values; albeit to a significantly lesser extent than energy consumption. When taking the impact of temperature changes into account, the increase is likely to be well above 2 million tons, which translates into 0.3 %. Insofar as neither any process-related CO_2 emissions nor any other greenhouse gas emissions underwent any fundamentally different developments, Germany has most likely failed once again to attain the aspired target of decreasing emissions. If one were to assume, for the purpose of simplification, a primarily linear direction of the target path, then an annual reduction of about 30 million tons, which translates into 3.6 %, would have actually been necessary for 2015 in order to meet the national objective of reducing greenhouse gas emissions by 40 % below the 1990 levels by 2020 when taking the emission values between 2015 and 2020 into consideration.

Total Primary Energy Consumption

In 2016, primary energy consumption in Germany amounted to a total of 13,383 PJ or 457 Mtce; compared to the previous year, this equaled an increase of 1.1 % which translates into 149 PJ/5.2 Mtce (please see Table 1).

Table 1

AGEB
AG Energiebilanzen e.V.

Primary Energy Consumption in Germany in 2015 and 2016 [1)]

Energy Carrier	2015	2016	2015	2016	Changes in 2016 compared to 2015			Proportions in %	
	Petajoules (PJ)		Million Tons of Coal Equivalent (Mtce)		PJ	Mtce	%	2015	2016
Mineral Oil	4,489	4,550	153.2	155.3	61	2.2	1.5	33.9	34.0
Natural Gas	2,761	3,022	94.2	103.1	261	8.9	9.5	20.9	22.6
Hard Coal	1,718	1,630	58.6	55.6	-88	-3.0	-5.1	13.0	12.2
Lignite	1,567	1,522	53.5	51.9	-45	-1.6	-2.8	11.8	11.4
Nuclear Energy	1,001	923	34.2	31.5	-78	-2.7	-7.8	7.6	6.9
Renewable Energy	1,644	1,689	56.1	57.6	46	1.5	2.8	12.4	12.6
Electricity Exchange Balance	-187	-193	-6.4	-6.6	-6	-0.2	-	-1.4	-1.4
Other	241	240	8.2	8.2	-1	0.0	-0.5	1.8	1.8
Total	**13,234**	**13,383**	**451.5**	**456.7**	**149**	**5.2**	**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)

In addition to the comparably positive economic trend with a macroeconomic growth rate of 1.9 % and an increase in population by about 0.8 million people in 2016, the weather, which was cooler than the previous year, also contributed to the increase in primary energy consumption: For example, even though the degree day figures were only 2.7 % higher (which means "colder") than the previous year when calculated over a year, they were almost 10 % higher than in 2015 during those months which are attributable to the respective heating periods, i.e. January through April and October through December (please see Figure 1). 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 sector [2].

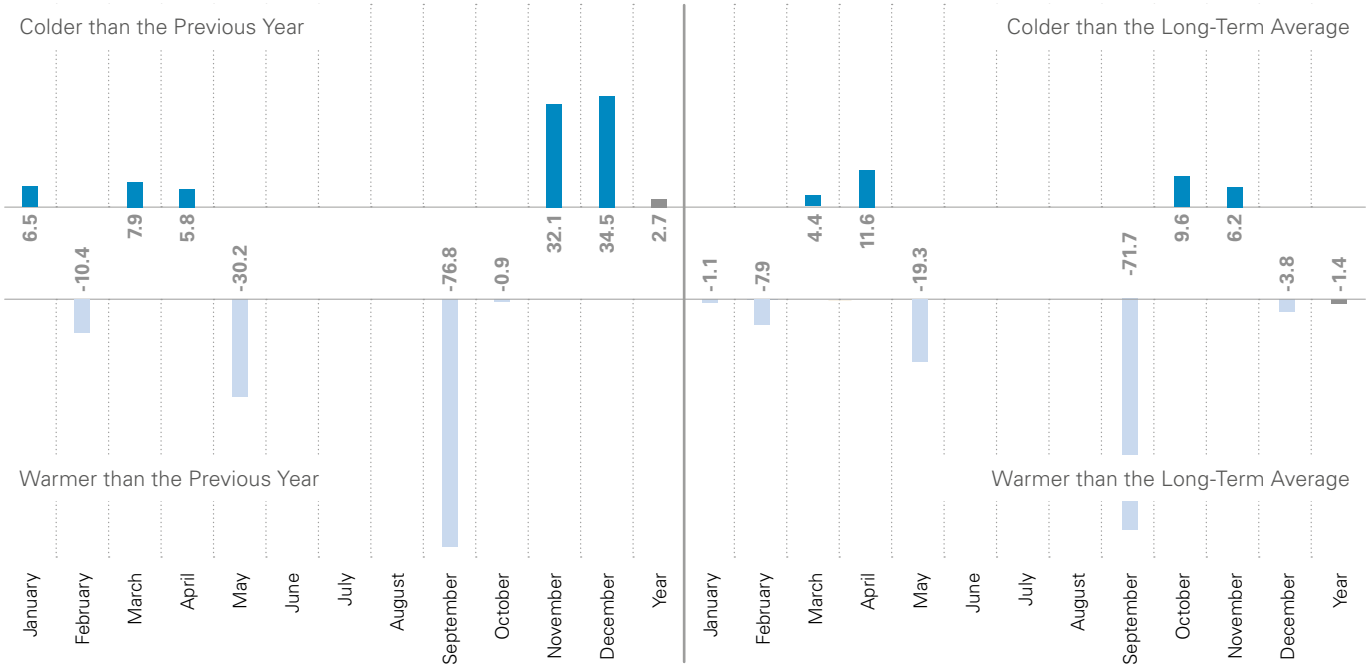
Finally, the leap year effect of 2016 cannot be ignored. On the basis of the simplified assumption that there was an equal distribution, the primary energy consumption would, thus, be "inflated" by approximately 37 PJ and/or by about 1.2 Mtce when compared to a normal year.

2 However, it should also be noted that 2016 was, nonetheless, still noticeably "warmer" when compared to the long-term average. According to Germany's National Meteorological Service, the Deutscher Wetterdienst (DWD), the year 2016 with an average temperature of 9.5 °C was one of the 10 warmest years in Germany since 1881.

Figure 1

Monthly Degree Day Figures in Germany in 2016 (16 Measurement Stations)*

Changes in 2016 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*

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 only by 0.6 %. 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 space heating market (which depends on the outside temperatures). 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 2).

The economic trend also tended to have a beneficial effect on increasing consumption; however, with different outcomes for the individual sectors (Figure 3 shows the annual rates of change in the production indices for 12 important branches of the manufacturing industry between 2014 and 2016):

- The price-adjusted gross domestic product, for example, increased by no less than 1.9 % in 2016 when compared to the previous year; however, production in the processing (+1.1 %) and manufacturing industries (+1.4 %) exhibited noticeably weaker growth. This also applies to machine construction (+0.4 %) and the production of electrical equipment (+1 %).

- Some energy-intensive sectors even recorded a decline in production; for example, the manufacture of chemical products by 3.0 %, metal manufacture and processing by 0.8 %, or the production of paper, cardboard, and resultant goods with a production decline of one percent.

- In contrast, strong growth was exhibited by the manufacture of glass, glassware, ceramics, and the processing of stones and soils (+3.1 %), by quarrying and other mining (without coal mining) with a plus of 2.7 %, by the production of rubber and plastic goods (+2.4 %), by the manufacture of metal products as well as the production of motor

vehicles and motor vehicle parts with a plus of 2.3 % each, by other vehicle construction (+6.7 %) as well as by the manufacture of data processing systems, electronic and optical products by +3.2 %.

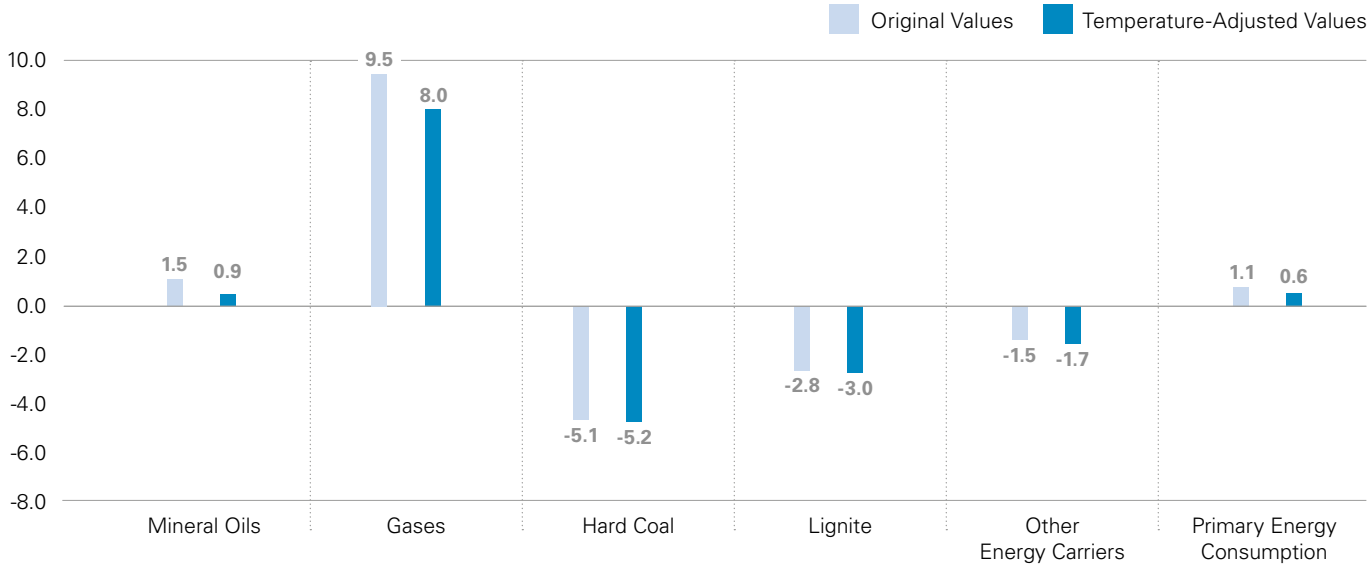
Against this backdrop, it can be assumed that a major portion of the increase in energy consumption accrued primarily outside the manufacturing industry. In addition to the tertiary sector, this is likely to be attributable above all to the heating of buildings as well as, when taking the overall increase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

Figure 2

AGEB
AG Energiebilanzen e.V.

Primary Energy Consumption in Germany According to Energy Carriers

Changes in 2016 Compared to 2015 in %



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

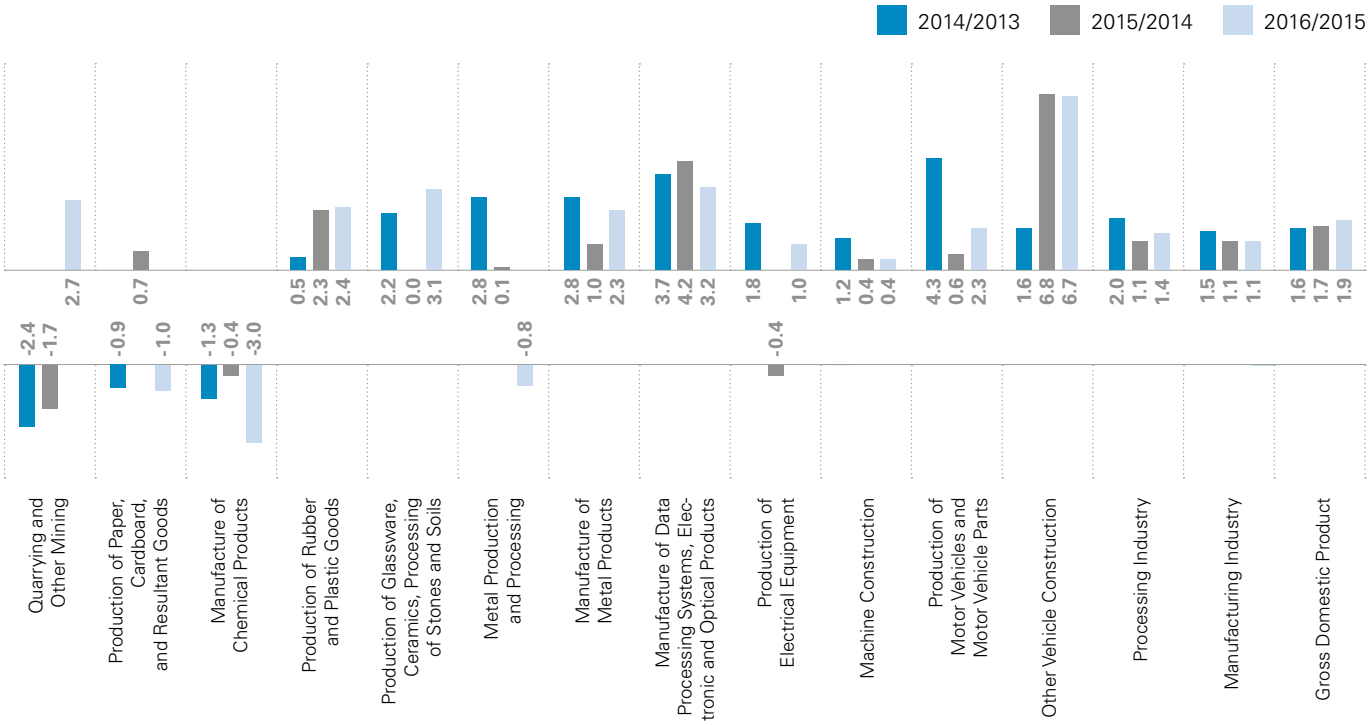
A Brief Discourse on the Problem of Changes in Stockholding:

When assessing the changes in primary energy consumption, particularly with regard to mineral oil consumption, it needs to be kept in mind 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. It applies, above all, to light fuel oil. In the past, the actual energy consumption in these two sectors could only be estimated – albeit in a general manner – on the basis of surveys conducted on the individual fueling behavior and the resultant changes in the refueling rate. Since these surveys are no longer available, this report must forego an estimate of changes in stockholding. Because of the comparably great uncertainties when considering the inventory effect, the following analyses will only refer to temperature-adjusted values.

Figure 3

Production Index in Germany's Manufacturing Industry between 2014 and 2016

Changes Compared to the Previous Year in %



Source: Federal Statistical Office (Destatis)

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 2016 as well, the most important energy carrier continued to be mineral oil with a share of about 34 %. This was followed by natural gas with a share that increased to 22.6 % (2015: 20.9 %). Decreased shares were recorded for hard coal (from 13.0 % to 12.2 %) and lignite (from 11.8 % to 11.4 %). A more significant decline was reported for nuclear energy; to be precise, it dropped from 7.6 % to 6.9 %. In contrast, renewables increased their share once again; albeit only slightly from 12.4 % to 12.6 %. Nevertheless, renewable energy carriers rank third among all energy carriers today. Just as in the previous year, the other energy carriers contributed less than 2 % towards meeting the energy demand. The large surplus obtained from physical flows of electric power to foreign countries caused primary energy consumption to decrease (by 1.4 percentage points).

While the macroeconomic performance increased by 1.9 %, the energy productivity of the German economy, as measured by the original values, only improved by 0.7 %. Adjusted to the temperature effect, it was significantly higher with 1.2 %, but still far below the long-term trend (1990 to 2015: About 2 %). All told, though, it can be affirmed that energy consumption continues to develop independent of the macroeconomic trend; albeit less so (please see Table 2 and Figure 4).

Table 2

AGEB
AG Energiebilanzen e.V.

Macroeconomic Energy Productivity in Germany between 1990 and 2016

	Unit	1990 [1]	2000	2005	2010	2014	2015 [2]	2016 [2]	Average Annual Change in %			
									2015 to 2016	1990 to 2000	2000 to 2016	1990 to 2016
Gross Domestic Product (price-adjusted, 2010 = 100)	Concatenated Volume Figures in Billion Euros	1,959.1	2,358.7	2,426.5	2,580.1	2,743.9	2,791.1	2,843.5	1.9	1.9	1.2	1.4
Population [3]	1,000	79.5	81.5	81.3	80.3	81.0	81.7	82.5	1.0	0.2	0.1	0.1
Primary Energy Consumption (unadjusted)	Petajoules	14,905	14,401	14,558	14,217	13,180	13,234	13,383	1.1	-0.3	-0.5	-0.4
Primary Energy Consumption (temperature-adjusted)	Petajoules	15,604	14,637	14,515	13,850	13,534	13,386	13,471	0.6	-0.6	-0.5	-0.6
Gross Electricity Consumption	Billion kWh	550.7	579.6	614.1	614.7	591.1	595.1	594.7	-0.1	0.5	0.2	0.3
Energy Productivity (temperature-adjusted)	Euros/GJ	131.4	163.8	166.7	181.5	208.2	210.9	212.5	0.7	2.2	1.6	1.9
Energy Productivity (temperature and inventory adjusted)	Euros/GJ	125.5	161.1	167.2	186.3	202.7	208.5	211.1	1.2	2.5	1.7	2.0
Electricity Productivity	Euros/kWh	3.56	4.07	3.95	4.20	4.64	4.69	4.78	1.9	1.4	1.0	1.1

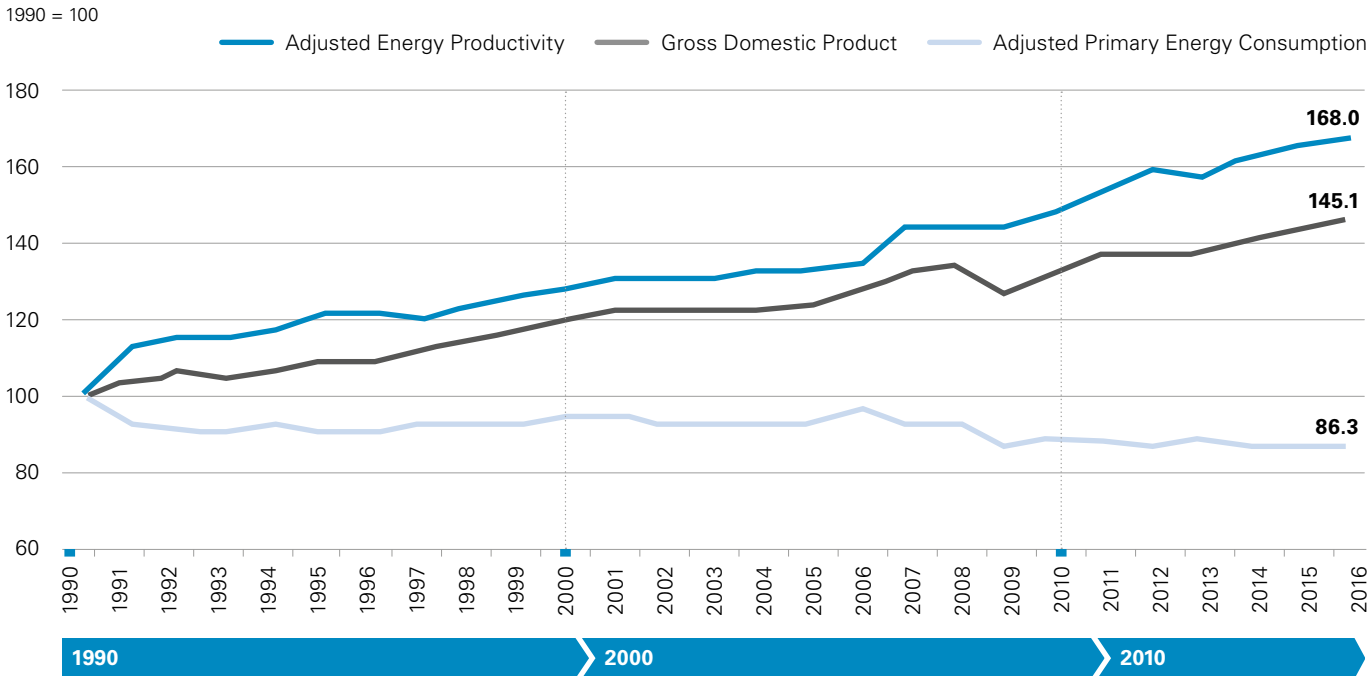
1) Some figures are estimates
2) Preliminary data
3) Average population based on the 2011 census (result as per the closing date May 9, 2011: 80,219,695 inhabitants)

Sources: Federal Statistical Office (Destatis); Germany's National Meteorological Service (DWD); German Association of Energy and Water Industries (BDEW)

Figure 4

AGEB
AG Energiebilanzen e.V.

Gross Domestic Product, Primary Energy Consumption and Energy Productivity in Germany between 1990 and 2016



Sources: Federal Statistical Office (Destatis); BMWi/BMF, Working Group on Energy Balances (AGEB)

When assessing the development of energy productivity, 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. By applying the same logic, the degree of efficiency for the renewable energies water, wind, and photovoltaics as well as 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 the exchange of electricity is lower. The greatest savings effect, thus, occurs if and when the electricity produced by nuclear power plants is replaced completely by renewable energy and/or electricity imports. But this effect, which still had exerted a particularly strong impact in 2010/2012 due to the substantial decline in nuclear energy (-41.1 billion kWh), on the one hand, and the significant increase in using power generated from renewable energy (+38.1 billion kWh), on the other hand, was not very significant in 2016. This was due to the fact that even though the electricity produced in nuclear power plants in 2016 was 7.2 billion kWh lower than in 2015, power generation from wind, water, and solar radiation (PV) only grew by 0.9 billion kWh.

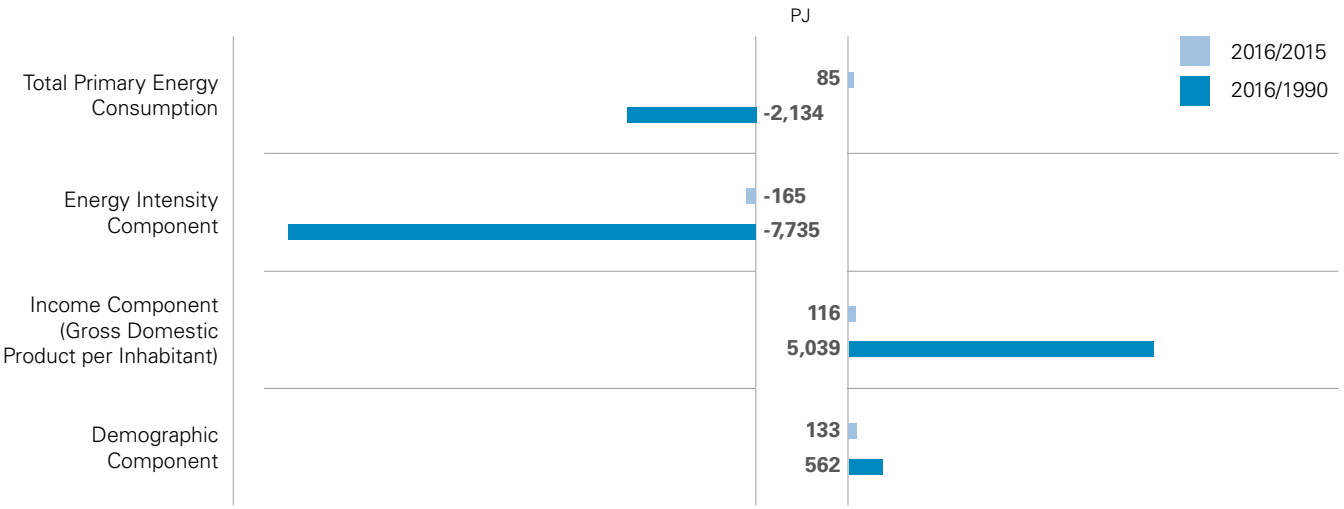
With component decomposition, it is possible to identify the key factors which influence the changes in the (adjusted) primary energy consumption (please see Figure 5). A comparison of the long-term changes between 1990 and 2016 aptly demonstrates the enormous influence of the decreased energy intensity (that is, the improvement in energy efficiency) on the reduction of the (temperature-adjusted) primary energy consumption (-7,735 PJ). This way, it was possible to significantly overcompensate the consumption-enhancing effect of the macroeconomic growth (+5,039 PJ) and the increase in population (+562 PJ). However, this does not apply to a short-term consideration of the changes between 2015 and 2016: Here, not only the economic growth (+116 PJ), but also and to an even greater extent the increase in population (+133 PJ) had a consumption-enhancing effect. Yet it was not possible to counterbalance both effects with improvements in efficiency (-165 PJ) so that this finally resulted in an absolute increase in the (adjusted) primary energy consumption by 85 PJ.

Figure 5

AGEB
AG Energiebilanzen e.V.

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

Changes in 2016 Compared to 2015 and 1990 in Petajoules



Sources: Federal Statistical Office (Destatis); Germany's National Meteorological Service (DWD)

Table 3

AGEB
AG Energiebilanzen e.V.

Balance of Foreign Trade with Energy Carriers in Germany between 2010 and 2016

	2010	2011	2012	2013	2014	2015	Jan/Nov 2015	Jan/Nov 2016	Changes in 2016 Compared to 2015	
	Foreign Trade Balance (Imports ./. Exports) in Billion Euros									%
Coal, Coke, and Briquettes	4.4	5.9	5.1	4.4	4.3	4.0	3.6	2.9	-0.7	-20.3
Petroleum, Petroleum Products, and Related Goods	49.4	64.5	68.0	67.0	57.6	38.0	35.4	26.3	-9.1	-25.7
Gas [1]	20.7	26.7	27.1	26.4	22.8	20.5	18.7	14.3	-4.4	-23.7
Total Fossil Fuels	**74.6**	**97.1**	**100.2**	**97.8**	**84.6**	**62.5**	**57.8**	**43.5**	**-14.3**	**-24.7**
Electric Power	-1.0	-0.4	-1.4	-1.9	-1.7	-2.1	-1.8	-1.6	-0.3	-14.0
Total	**73.5**	**96.7**	**98.8**	**95.9**	**82.9**	**60.4**	**56.0**	**42.0**	**-14.0**	**-25.1**

1) Including transit volumes

Source: Federal Statistical Office (Destatis), Special Series 7, Series 1 (values according to sections of the Standard International Trade Classification) (SITC-Rev. 4)

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 2016 as well, this did not change fundamentally. Significant changes, however, were recorded for import prices of fossil fuels. As a result, the decline in prices caused the import calculation for coal, oil, and gas (pertaining to the import balance, in each case for the months January through November) to decrease substantially from nearly 58 billion euros by about 14 billion euros, which equals a reduction of almost a quarter, to 43.5 billion euros. A similar decline was recorded for oil and natural gas imports (25.7 % and 23.7 % respectively); with about 20 %, the import balance for coal also decreased considerably. Conversely, the export surplus for electrical energy dropped slightly by 14 % (almost 0.3 billion euros) even though the (physical) export of electric power increased at the same time.

Primary Energy Production in Germany

In 2016, domestic energy production decreased for all other energy carriers with the exception of renewable energy so that there was an overall decline by 2.8 % to 3,978 PJ or about 135 Mtce (please see Table 4). The strongest quantitative decline was exhibited by hard coal with a minus of about 73 PJ (39 %), by lignite with -61 PJ (-3.8 %) as well as by natural gas with -22 PJ (-8.0 %) while domestic oil production decreased just slightly (-3 PJ; -2.5 %). Once again, renewable energy carriers managed to slightly expand their position as the most important indigenous energy even ahead of lignite; their proportion of the total domestic production now amounts to about 43 %, followed by lignite with around 39 %. Both rank far ahead of natural gas, hard coals, and petroleum.

When taking into account the primary energy consumption in 2016, the proportion of indigenous energy experienced a noticeable decrease; namely, from 30.9 % in 2015 to now 29.7 % (please see Table 4).

Table 4

AGEB
AG Energiebilanzen e.V.

Primary Energy Production in Germany in 2015 and 2016

	Production				Changes in 2016 compared to 2015		Proportions	
	2015	2016	2015	2016			2015	2016
	Petajoules (PJ)		Million Tons of Coal Equivalent (Mtce)		PJ	%	%	
Mineral Oil	120	117	3.5	3.4	-3	-2.5	2.5	2.5
Natural Gas, Petroleum Gas	270	248	9.2	8.5	-22	-8.0	6.6	6.3
Hard Coal	188	114	6.4	3.9	-73	-39.1	4.6	2.9
Lignite	1,608	1,547	54.9	52.8	-61	-3.8	39.5	38.8
Renewable Energy	1,666	1,712	56.8	58.4	46	2.7	40.9	43.2
Other Energy Carriers	241	240	8.2	8.2	-1	-0.5	5.9	6.1
Total	**4,092**	**3,978**	**139.0**	**135.2**	**-123**	**-2.8**	**100.0**	**100.0**
For information purposes: Proportion of Primary Energy Consumption	-	-	-	-	-	-	30.9	29.7

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; Gesamtverband Steinkohle e.V. (GVST); 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 2016 was 1.5 % higher with 4,550 PJ (155.3 Mtce). At the same time, consumption of the most important mineral oil products developed very differently (please see Table 5): While the consumption of diesel fuels increased significantly once again (+4.1 %), which was primarily due to the higher demand coming from the road transportation and construction sectors, and climbed to a record high with sales amounting to well above 38 million tons, gasoline sales remained virtually unchanged.

Table 5

AGEB
AG Energiebilanzen e.V.

Consumption and Volume of Mineral Oil in Germany in 2015 and 2016

		2015 [1]	2016 [1]	Change
		in Million Tons	in Million Tons	in %
Total Consumption		**104.1**	**105.7**	**1.8**
Self-Consumption and Losses [2]		5.5	5.2	-4.7
Domestic Consumption		98.4	100.5	1.8
Proportion of:	Gasoline	18.2	18.2	0.1
	Diesel Fuel	36.8	38.3	4.1
	Aviation Fuels	8.5	9.0	5.9
	Fuel Oil, Light	16.1	15.8	-2.0
	Fuel Oil, Heavy [3]	4.5	4.4	-1.0
	Naphtha	16.3	16.4	0.3
	Liquid Gas	3.0	3.0	0.6
	Lubricants	1.1	1.0	-2.6
	Other Products	4.1	4.3	3.2
	Recycling (to be deducted)	-6.6	-6.5	-1.8
	Biofuels [4] (to be deducted)	-3.6	-3.5	-3.7
Total Volume		**104.1**	**106.1**	**1.8**
Refinery Production		103.5	105.0	1.4
Generated from:	Input of Crude Oil	93.4	94.2	0.9
	Input of Products	10.1	10.8	6.2
Foreign Trade Products (Balance)		15.1	15.7	-
	Imports	37.4	37.8	1.0
	Exports	22.3	22.1	-1.0
Compensation [Balance (Bunker, Differences)]		-14.6	-17.1	-
Refining Capacity		103.4	102.1	-
Utilization of Refining Capacity in %		90.3	92.0	-
Primary Energy Consumption of Mineral Oil (Mtce)		153.2	155.3	1.5

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)

In contrast, the consumption of aviation fuels experienced once again strong growth with a rate of almost 6 %. The total demand for fuels, which had held a share of almost 62 % in Germany's total oil consumption, went up by about 3 %.

In contrast, the demand for light and heavy fuel oil exhibited a downward trend. Although the prices decreased once again by an annual average of about 17 % in 2016 after having already been 26 % lower in 2015 when compared to 2014, and despite the significantly cooler weather in 2016 when compared to the previous year, less light fuel oil was sold than the year before (-2.0 %). Reasons include the continuously increasing efficiency of modern oil condensing heating systems, the conversion of existing heaters into heat pump or natural gas systems as well as early purchases of fuel oil in 2015 due to the significantly decreased fuel oil prices already in effect back then. Deliveries of heavy fuel oil also went down despite further reductions in prices (compared to 2015, by about 17 % in 2016); albeit only slightly by approximately one percent.

Conversely, naphtha, which is primarily used in chemistry, experienced a minor increase (+0.3 %). After all, naphtha is the third most important sales product of the mineral oil industry behind diesel and gasoline and even ahead of light fuel oil.

Refinery production increased almost parallel to the total oil consumption by around 1.4 %; refinery production from crude oil with its proportion of about 90 % went up by only 0.9 % while the volume of product usage increased by more than 6 %. With 92.0 %, the refining capacity, which slightly decreased to 102.1 million tons in 2016, was utilized to a higher degree than in 2015 (90.3 %).

In 2016, foreign trade of mineral oil products changed very little. On balance, the imports were predominant; with almost 38 million tons, they topped the exports of about 22 million tons by approximately 16 million tons in 2016.

Due to its very limited domestic petroleum resources, Germany is primarily dependent on crude oil imports which fell just slightly below the previous year's level by 0.2 % with 91.1 million tons in 2016. In 2016, the three most important countries supplying crude oil to German refineries continued to be Russia (with a share of almost 40 %), Norway (nearly 12 %), and the United Kingdom (about 10 %); these countries contributed more than 60 % to German crude oil imports also in 2016 (please see Table 6). Important supplier countries continue to be Kazakhstan, Azerbaijan, Nigeria, Algeria, Iraq as well as Libya and Egypt.

Divided into individual oil producing 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 49 % in 2015 to nearly 55 % in 2016. In contrast, substantial losses were recorded by the OPEC states (in 2016: About 14 %) and the countries bordering on the North Sea (in 2016: More than 22 %). With the exception of Russia, Kazakhstan, and Iraq, supplies from other important oil exporting countries dropped noticeably (please see Table 6).

In 2016 as well, international oil prices and the Euro/US Dollar exchange rate exhibited an unstable development; 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 (US $/bbl; 1 barrel = 159 liters) in 2012 (the monthly peak in July 2008 had been about 133 US $/bbl), the average price in 2013 and 2014 dropped to 109 US $/bbl and 99 US $/bbl respectively. The development in 2015 also showed a clear downward trend: Particularly since May, when the crude oil price reached its annual peak of about 64 US $/bbl, prices dropped and only reached about 38 US $/bbl in December 2015. This development initially continued in early 2016, but then gave way to an upward trend which was interrupted by fluctuations before it finally reached a price of well above 53 US $/bbl in December.

German crude oil import prices developed to a large extent parallel to the global market prices. Differences are also influenced above all by fluctuations in the exchange rate of the Euro (to the US Dollar). Since mid-2014, the Euro exchange rate has deteriorated considerably. Compared to December 2014, the exchange rate had dropped by 12 % from 1.2331 US dollars per Euro to 1.0877 US dollars by December 2015. After a slight recovery in 2016, however, the downward trend continued at the end of the year; the exchange rate of 1.0543 US dollars in late 2016 even

Table 6

AGEB
AG Energiebilanzen e.V.

Germany's Crude Oil Imports in 2015 and 2016 according to Countries of Origin

Important Supplier Countries/ Production Regions	2015	2016 [1]	2015	2016 [1]	Changes 201672015
	in Million Tons		Proportions in %		in %
Russia	32.6	36.0	35.7	39.6	10.7
Norway	12.5	11.1	13.6	12.2	-10.8
United Kingdom	10.0	9.1	10.9	10.0	-8.3
Kazakhstan	6.4	8.4	7.0	9.2	31.0
Azerbaijan	5.3	5.1	5.8	5.6	-3.5
Nigeria	6.7	3.8	7.3	4.2	-43.1
Algeria	3.5	3.3	3.8	3.6	-6.2
Iraq	2.4	3.1	2.6	3.5	31.5
Libya	2.9	1.8	3.1	2.0	-38.1
Egypt	2.9	1.7	3.2	1.9	-39.9
Other Countries	6.2	7.5	6.8	8.3	20.7
Total	91.3	91.1	100.0	100.0	-0.2
OPEC	17.1	14.1	18.7	15.5	-17.4
North Sea [2] (excld. FRG)	24.1	22.1	26.5	24.2	-8.6
Former CIS	44.3	49.7	48.5	54.6	12.3
Other	5.7	5.1	6.3	5.7	-10.4
Total	**91.3**	**91.1**	**101.1**	**100.0**	**-0,2**

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

Sources: Federal Office of Economics and Export Control (BAFA); RohölINFO December 2016

fell noticeably below last year's low level. Hence, German crude oil import prices actually declined much slower than the actual changes in the global market prices for crude oil.

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. Thereafter, the import prices even hit rock bottom at 214 €/t in February 2016. With the prices subsequently beginning to rise again, an annual average of about 287 €/t had to be paid – approximately 20 % less than in the previous year. While the import volumes for crude oil remained virtually unchanged, the expenses for crude oil imports decreased from 32.5 billion euros to 26.1 billion euros.

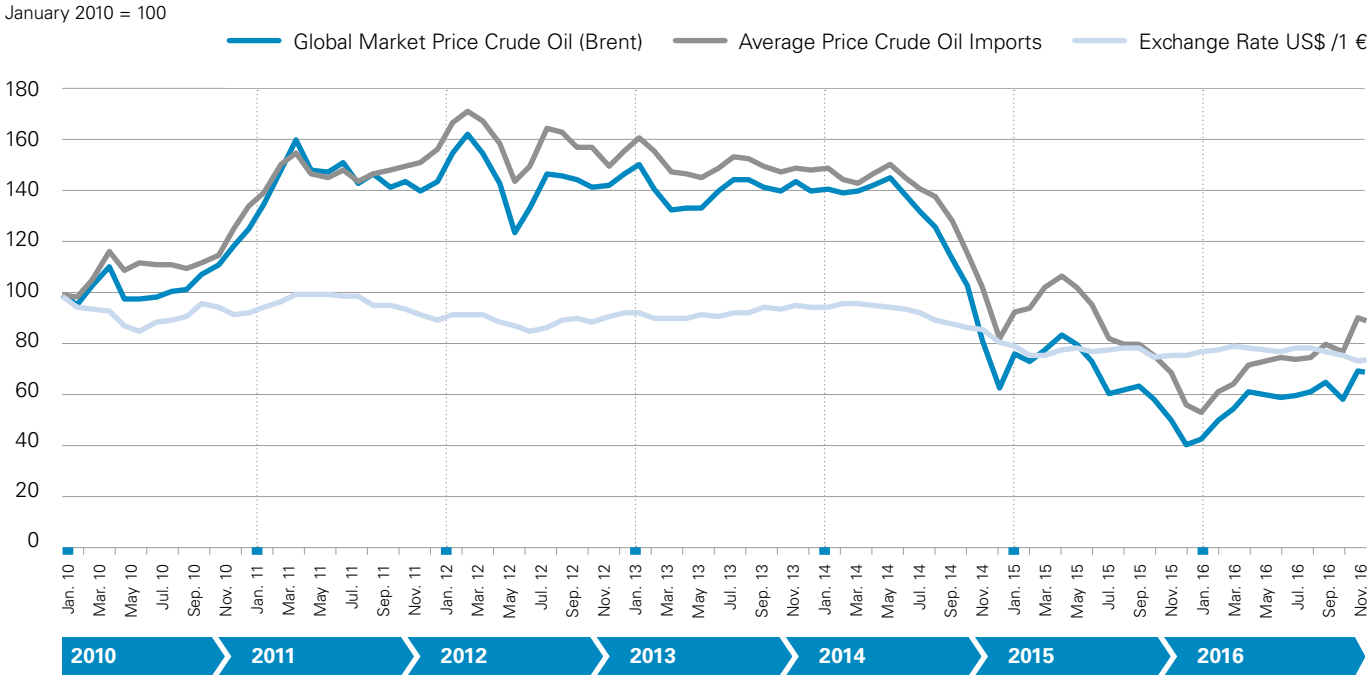
Prices for oil products in Germany followed primarily the reduced costs for crude oil and the decline in international product quotations; albeit at different rates (please see Figure 7).

While the prices for premium gasoline, diesel fuel, and light fuel oil had decreased significantly already since 2015, they experienced another decline in 2016: On average, the annual prices for premium gasoline decreased by 7.0 %, for diesel fuel by 8.4 %, and for light fuel oil due to the lower tax proportion even by 16.9 %. As measured by the producer price index, mineral oil products in Germany were on an annual average and in total almost 10 % more favorable in 2016 than in 2015. However, it cannot be ignored that the price index in December 2016 was once again about 11 % higher than in the corresponding month of the previous year; for premium gasoline, it was 10 %, for diesel fuel 5 %, and for light fuel oil even 22 % higher.

Figure 6

AGEB
AG Energiebilanzen e.V.

Global Market Prices for Crude Oil (Brent) [1], Border-Crossing Prices for German Crude Oil Imports [2], and Exchange Rates between January 2010 and December 2016



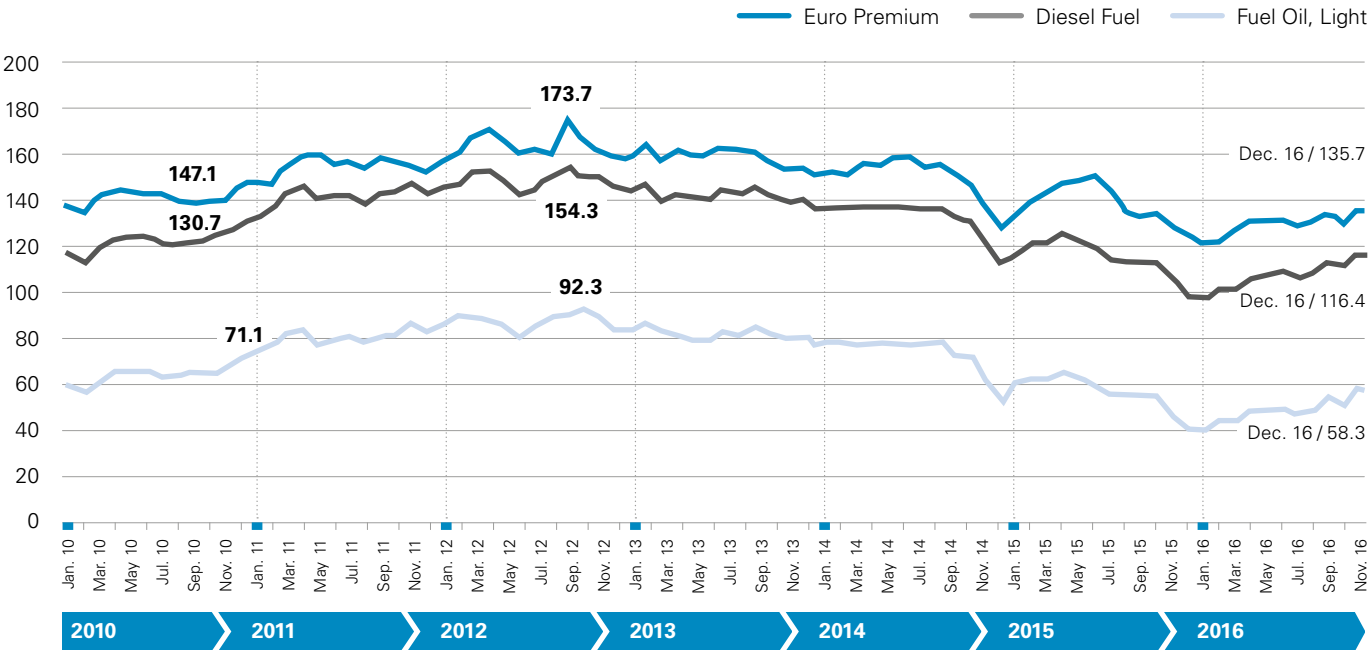
1) Original values in US Dollars per barrel
2) Original values in Euros per ton

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

Figure 7

AGEB
AG Energiebilanzen e.V.

Prices for Fuels and Light Fuel Oil in Germany between 2010 and 2016



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

Natural Gas

In 2016, natural gas consumption in Germany increased by about 9.5 % to 930 billion kWh. This growth was influenced by diverse factors. For example, the average temperature in 2016 amounted to 9.5 °C, which exceeded the long-term average measured between 1981 and 2010 by 0.6 degrees, but was significantly below last year's average (2015: 9.9 °C). The weather trend during the year was inconsistent, though. For example, there were strong deviations from the previous year's temperatures primarily at the beginning of the year: Even though January was colder than in 2015, February was actually much too warm both when compared to the same month last year and when compared to the long-term average. The latter also applies to September 2016. The last, heating-intensive quarter, however, was continuously colder than the same quarter of the previous year and the long-term average.

A second aspect which caused natural gas consumption to rise was the increased use of natural gas in the plants of utility companies for the supply of electric power and heat. Price trend and efficiency are the two main reasons for this: Compared to other energy carriers, the price of natural gas developed, to some extent, much more favorably in 2016. In addition, the combined production of electricity and heat permits the highly efficient use of natural gas. The proportion of electricity generated from natural gas with regard to gross electricity production in Germany increased by almost 3 percentage points to 12.4 %. This equals an increase of nearly 30 % when compared to the previous year's value. Considerably larger volumes of natural gas were also used for the generation of heat in heating and thermal power stations in 2016.

Another factor that needs to be mentioned here is the continuous construction of new dwellings which are either directly or indirectly (district heating) heated with natural gas. According to preliminary figures, construction approvals for 328,000 new homes were granted in 2016. 44.4 % of them will get their heat from a gas-powered heating system; 23.8 % of them will be connected to the district heating grid.

When it comes to the use of natural gas in the individual consumption sectors, the following trends have been identified for 2016 so far (please see Table 7):

- The space heating market repeatedly recorded a significant increase in sales after a sharp decline in 2014 and a moderate upswing in 2015. The natural gas consumed by private households as well as by commercial and service enterprises increased by 11 %. The number of natural gas heating systems continued to increase. By the end of 2016, a total of almost 20.5 million homes or 49.4 % of the existing homes were equipped with a gas heating system.

- 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 1 %.

- The use of natural gas in power plants and heating stations supplying the general public recorded strong growth: The favorable price trend for natural gas when compared to other energy carriers as well as the selectively reduced availability of renewable energy caused electricity production from natural gas to increase significantly for the first time again. According to preliminary figures, 33 % more natural gas was used as a fuel in the power plants and thermal power stations of the electricity suppliers and providers. In 2016, over 20 % more natural gas was used by combined heat and power plants supplying the general public whereas the uncoupled generation of electricity even recorded a rate of 125 %; albeit in limited quantities. The above mentioned cooler temperatures during the heating period and the rising numbers of district heating connections resulted in an increased use in heating stations. All told, the use of natural gas in the supply and provision of electric power and heat recorded an increase of 32.5 %. The use of natural gas in smaller, decentralized plants (CHP) and industrial plants also continued to grow.

Table 7

AGEB
AG Energiebilanzen e.V.

Volume and Use of Natural Gas in Germany in 2015 and 2016

	Unit	2015	2016 [1]	Change in %
Domestic Production	Billion kWh	83.1	76.5	-8.0
Imports	Billion kWh	1,110.3	1,101.3	-0.8
Total Volume of Natural Gas	Billion kWh	1,193.4	1,177.8	-1.3
Storage Balance [2]	Billion kWh	8.4	1.6	-
Exports	Billion kWh	352.0	249.1	-29.2
Primary Energy Consumption of Natural Gas	Billion kWh	849.8	930.2	9.5
	Petajoules (H_u)	2,761.0	3,022.0	-
	Mtce (H_u)	94.2	103.1	-
Structure of Natural Gas Volume According to Countries of Origin				
Domestic Production	%	7	6	
Netherlands	%	30	22	
Norway	%	21	31	
Russia, Denmark, Others [3]	%	42	41	
Structure of Natural Gas Consumption According to Consumer Groups				
Private Households and Small Trade	Billion kWh	385.7	428.1	11.0
Industry (Including Industrial Power Plants)	Billion kWh	352.4	355.0	0.7
Power Plants, Thermal Power and Heating Stations Supplying the General Public	Billion kWh	107.9	143.0	32.5
Self-Consumption and Statistical Differences	Billion kWh	3.8	4.1	-

1) Preliminary data; some figures are estimates
2) Minus = storage
3) For reasons of data protection, the values are only cumulative; in 2015, Russia had a share of 39 %
Discrepancies in the totals are due to rounding off

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

Compared to 2015, the proportion of natural gas of the total primary energy consumption increased by 1.7 percentage points to 22.6 % in 2016.

Compared to the previous year, Germany's natural gas volume decreased slightly by 1.3 % to 1,178 billion kWh in 2016. More than 6 % of the natural gas volume in Germany came from domestic production, almost 94 % were imported. Domestic production decreased by 8 % to 76 billion kWh. Germany's natural gas imports decreased by 1 %. After a considerable increase in 2015, Germany's natural gas exports dropped by about 29 % in the reporting year.

On balance, almost 2 billion kWh of natural gas were taken from storage facilities in 2016. In the previous year, on balance 8.4 billion kWh were stored.

According to initial figures, 9.4 billion kWh of biogas upgraded to natural gas quality were fed into the German natural gas grid during the year under review. In 2015, the feeding volume amounted to 8.4 billion kWh. About 8 billion kWh of which went into electricity production, about 0.4 billion kWh were used as a fuel, about 0.3 billion kWh were sold on the space heating market. Another 0.7 billion kWh were, for example, utilized as a material, exported, or used otherwise.

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.

The number of companies active in the gas industry continued to increase. At the end of 2015, there were 1,214 enterprises; at the end of 2016, there were 1,238. A closer look reveals that seven of these enterprises were active as natural gas producers, 38 as storage operators, 69 as mere wholesalers, 16 as long-distance gas grid operators, 728 as gas distribution grid operators, and 926 as distribution companies in the end customer business [3]. The number of employees in the gas industry increased as well. According to preliminary figures, 36,670 people were employed at the end of 2016 which represented an increase of almost 3 % when compared to the same time last year.

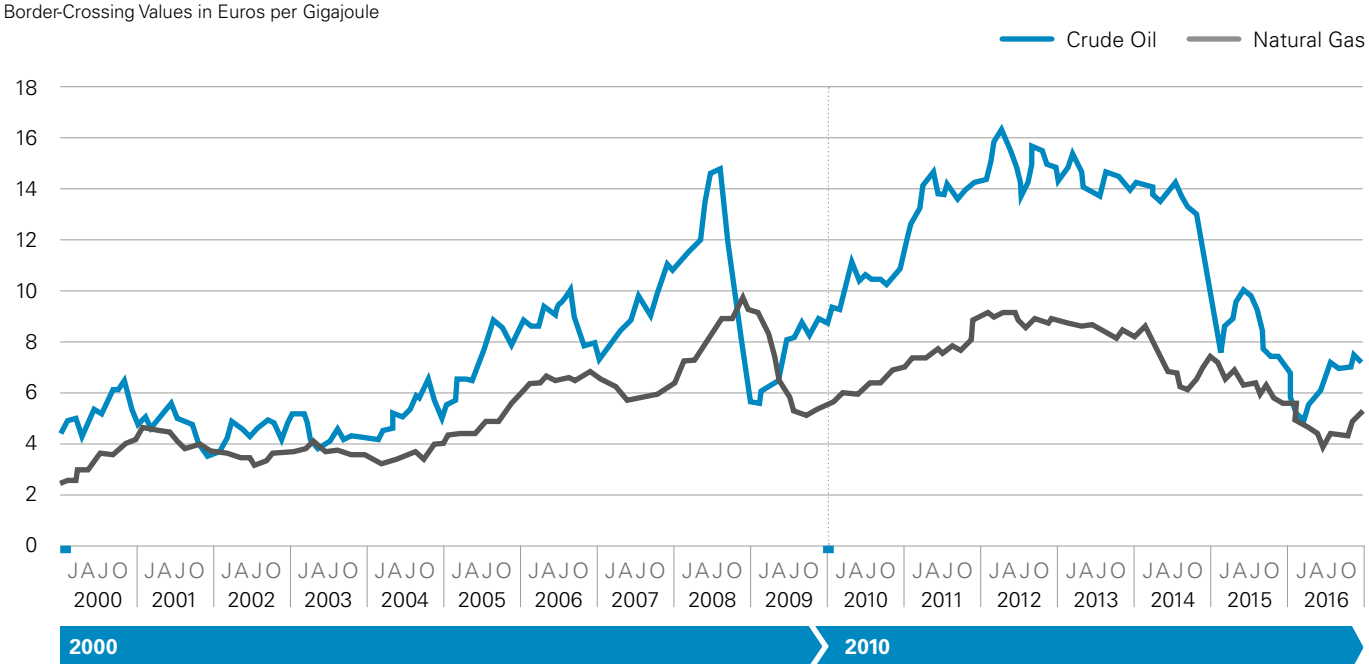
Since the liberalization of the energy markets, spot and futures markets for natural gas have developed rapidly. All told, gas trading at the European hubs exhibits significant growth. At these virtual trading points, essential supply and demand based price signals are created for the European and, thus, 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. 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

Figure 8

AGEB
AG Energiebilanzen e.V.

Monthly Border-Crossing Values for Crude Oil and Natural Gas between 2000 and 2016



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

almost continuously until the end of 2012. The year 2013 entailed a reduction in prices which continued in 2014 and 2015: At an annual average and compared to the previous year, the import prices for natural gas fell by a total of 15 % in 2014 and by almost another 12 % in 2015. This trend was initially continued in 2016, but then reversed at the beginning of the fourth quarter. Nevertheless, the average import prices for natural gas still decreased significantly by about a quarter in 2016.

3 It is not possible to add up the corporate figures because many of the companies are active at multiple stages of the value creation chain and are, thus, recorded several times.

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 decreased by nearly 29 % at the energy exchange while the sales prices to power plants dropped by almost 20 %. For large industrial clients (annual supply: More than 500 GWh), the prices decreased by about 17 % compared to the previous year; small industrial gas consumers (supply: 11.63 GWh/a) also paid about 17 % less than before. In contrast, the gas prices for the trade, commerce, and service sector went down by only 5.2 % and those for private households by only 2.8 %.

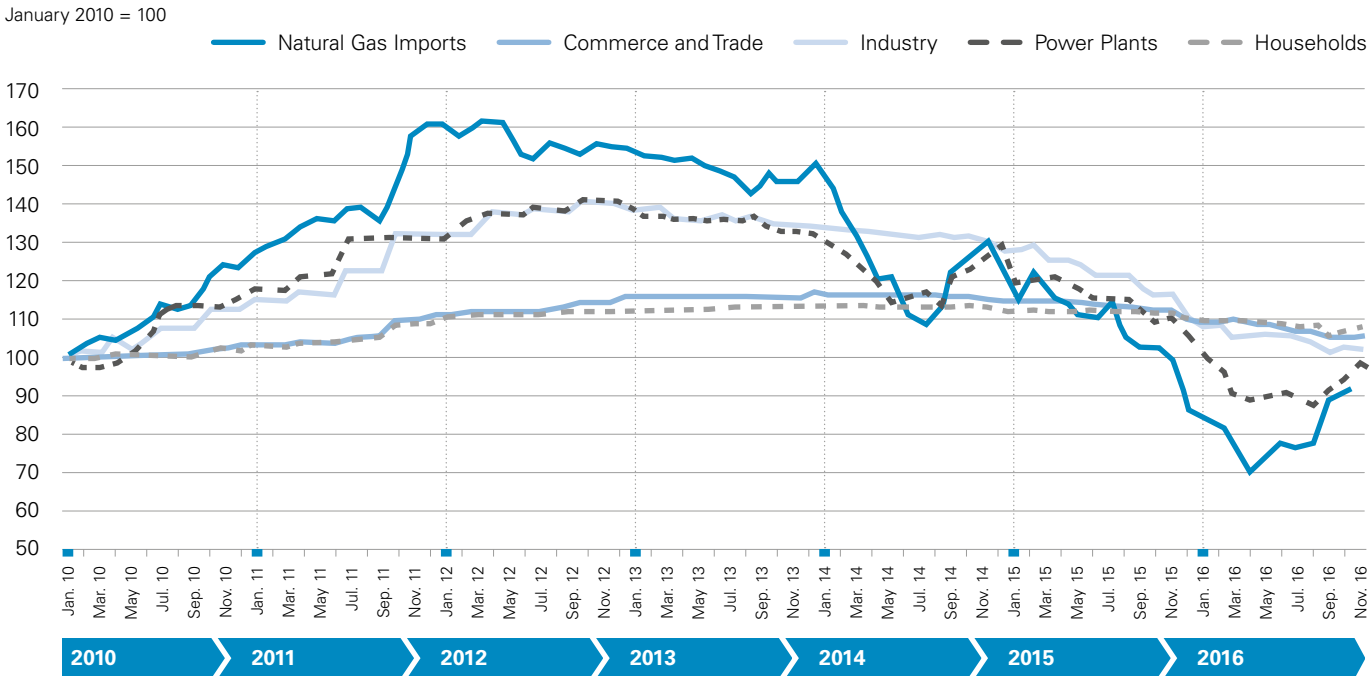
The diverging development of the energy exchange and distribution prices for various customer groups is associated with the composition of end customer prices and different contract periods. Procurement costs on the wholesale market actually reflect only a part of the end customer price. It also includes 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 energy exchange have a weaker impact on price changes for end customers.

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 levelled 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.

Figure 9

AGEB
AG Energiebilanzen e.V.

Prices for Natural Gas Imports and Natural Gas Sales in Germany between 2010 and 2016



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

Hard Coal

According to preliminary estimates and compared to the previous year, Germany's hard coal consumption decreased by a total of approximately 5 % to 1,630 PJ (which translates into 55.6 Mtce). Calculated in absolute terms, the hard coal used in power plants for electricity and heat production accounted for the highest decline in consumption in 2016. With 36.8 Mtce, about 2 Mtce (which translates into 5.2 %) less hard coal was used here than in 2015. All told, power plants supplying the general public as well as industrial power plants generated 111.5 billion kWh of electricity (2015: 117.7 billion kWh). According to preliminary calculations, 27.0 million tons of crude iron were produced in the German steel industry for which 17.6 Mtce of hard coal and hard coal coke (coke converted into coal) were used. Compared to the previous year, this equals a decline of 4.9 %. The small amount used in the heating market (foundries, district heating plants, small businesses, and private households) declined further; precisely, by an estimated 7.7 % to 1.2 Mtce (please see Table 8).

Table 8

AGEB
AG Energiebilanzen e.V.

Volume and Use of Hard Coal in Germany in 2015 and 2016

		2015 [1]	2016 [1]	Change
	Unit			in %
Primary Energy Consumption	Mtce	58.6	55.6	-5.1
Power Plants and Thermal Power Stations	Mtce	38.8	36.8	-5.2
Steel Industry	Mtce	18.5	17.6	-4.9
Heating Market	Mtce	1.3	1.2	-7.7
Import of Hard Coal and Coke [2]	Mtce	51.3	48.4	-5.7
Hard Coal Production	Mtce	6.4	3.9	-39.1

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

Source: The German Coal Industry's Statistical Office

Since 2013, the primary energy consumption of hard coal has been following a continuous downward trend which is essentially due to structural and economic effects, but in part also to improvements in efficiency. In 2016, hard coal assumed fourth place behind mineral oil and natural gas as well as renewable energy carriers in the energy mix designed to cover Germany's primary energy consumption. Even with a declining absolute contribution and a decreasing proportion of its share, hard coal still ranked third in electricity production right behind renewable energy carriers and lignite. The structural changes which take place in the course of the energy turnaround had a particularly beneficial impact on renewables. And finally, shifts in the price constellations between hard coal and natural gas also resulted in a decreased gross electricity production based on hard coal while the use of natural gas was fostered by price reductions as well as by the amendment of the Combined Heat and Power Act (KWKG). In 2016, for example, the average price for power plant coals free at Northwest European ports of landing (MCIS [4] price) amounted to 60.09 US$/t (= 63.66 €/tce) which was 6.1 % higher than in the previous year. The price increased in particular during the second half of the year after it had continued to fall until then. By the end of 2016 (December 23), it finally reached its highest level in over four years at 95.54 US$/t (= 106.70 €/tce).

4 McCloskey's Coal Information Service

Correspondingly, Germany's hard coal imports also decreased by 5.7 % to 48.4 Mtce last year. Due to the planned decommissioning of the Auguste Victoria mine in Marl (AV) as per January 1, 2016, the number of active hard coal mines dropped to two (Prosper-Haniel and Ibbenbüren). This measure was implemented within the scope 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. The AV shutdown entailed a decrease in domestic hard coal production of nearly 40 % to 3.9 Mtce. For Germany, this results in a hard coal volume of 52.3 Mtce in 2016, which equals a decline of 9.4 % compared to the previous year. When subtracting the exports and adding the not so minor reduction in stocks totaling about 3.3 Mtce, Germany's primary energy consumption of hard coal amounts to 55.6 Mtce.

The following table, which includes data from a survey conducted by the German Federal Statistical Office on German hard coal and coke imports according to countries of origin (pursuant to the data defined by the German Energy Statistics Act (En-StatG)), only shows the period between January and November.

Supplies from the so-called indeterminable countries are not recorded. Projected for the entire year, Germany's hard coal and coke imports amounted to 48.4 Mtce. 43.8 Mtce of these supplies were classified according to individual countries whereas a volume of 4.6 Mtce could not be assigned to specific countries. As per the cumulative data captured for the period between January and November and similar to the same period in the previous year, Russia continued to be the most important country of origin for German hard coal and coke imports with a share of 34 %. This was due to its dominating position when it comes to power plant coal imports, of which 38 % came from Russia. The second most important supplier country were the United States, which accounted for 15 % of the power plant coal imports and 25 % of the coking coal imports as well as for nearly 17 % of the total imports. With a proportion of 16 % of the total imports, Australia continued to rank third, closely followed by Columbia which also had a share of almost 16 %. Considered separately, Australia was the most relevant provider of coking coal imports with a share of almost 42 % while Poland with more than 40 % was by far the most important supplier for German hard coal coke imports (please see Table 9).

Table 9

AGEB
AG Energiebilanzen e.V.

German Hard Coal Imports According to Supplier Countries in 2015 and 2016
(January to November; Including Coke; Excluding Non-Identifiable Countries)

	2015	2016	2015	2016	Change
	in Million Tons		Proportions in %		in %
Russia	12.5	13.7	31.5	34.1	9.2
USA	6.9	6.6	17.4	16.5	-4.2
Australia	5.9	6.4	15.0	16.1	8.4
Columbia	5.6	6.3	14.0	15.8	13.7
Poland	3.9	2.9	9.7	7.1	-26.1
Canada	1.2	1.5	3.1	3.8	23.9
South Africa	2.0	1.1	5.1	2.7	-47.6
Other Third Countries	1.0	1.0	2.7	2.6	-3.1
Other EU Countries	0.6	0.6	1.5	1.3	-6.5
Total Imports	**39.6**	**40.1**	**100.0**	**100.0**	**0.9**

Discrepancies in the totals are due to rounding off

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

The continuous growth of global hard coal production (coking coal and steam coal) for more than one decade had already come to a standstill in 2015 when it amounted to around 7 billion tons. In 2016, production continued to decline and decreased to 6.7 billion tons. In particular, China reduced its production by approximately 240 million tons in 2016. In the USA, production declined by 140 million tons. In relative terms, production in China decreased by 7 %; in the USA, even by 18 %.

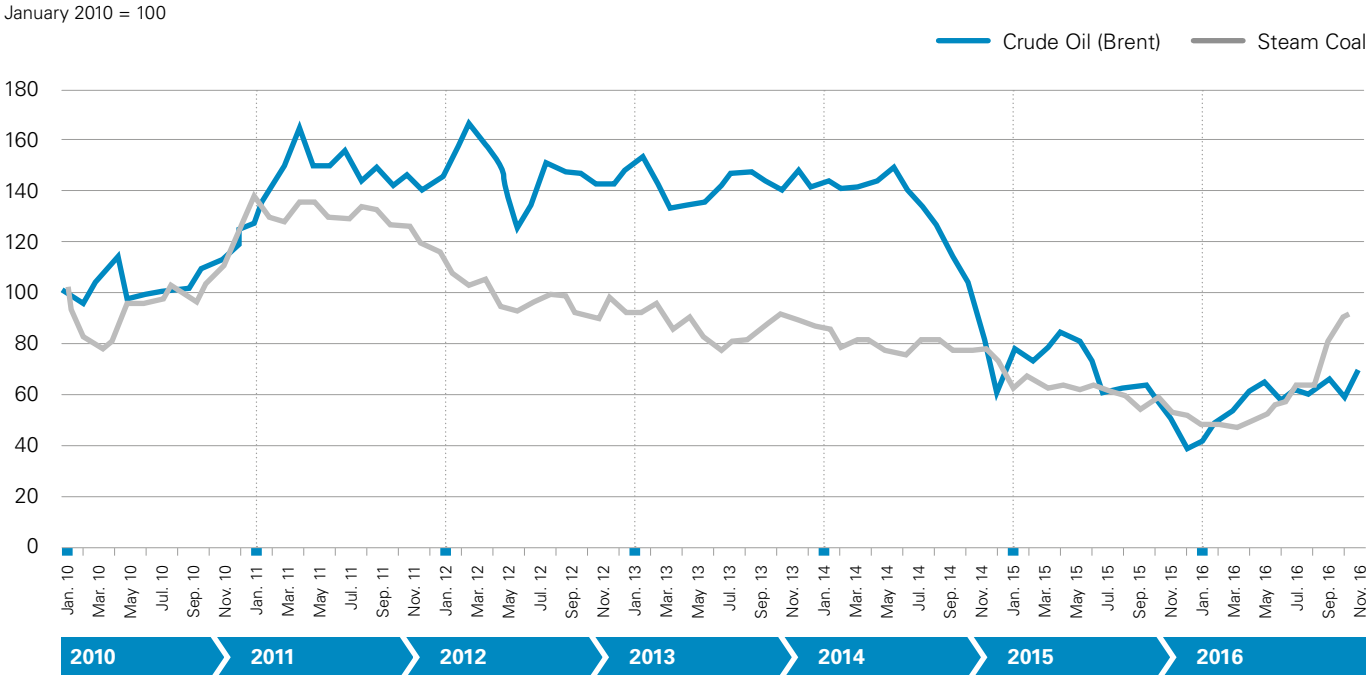
From the beginning of 2016 (48.16 US$/t or 51.73 €/tce on January 8, 2016) until the end of the year, the price for power plant coal free at Northwest European ports based on weekly rates almost doubled to 91.81 US$/t or 101.61 €/tce on December 30, 2016 (+91.1 %). While the overall European demand remained relatively weak throughout the year, one reason for the price increases were temporary disruptions of the supply in the two major supplier countries Russia and Columbia. Russian coal exporters had to struggle above all with logistic problems in inland transportation, primarily in the Kuzbass Region. Columbian coal exports suffered, for example, from strikes and adverse weather conditions. Another reason is the fact that the Central Government in Beijing accelerated its course of reducing the Chinese production capacity in 2016 which had already been introduced in 2015. Based on the legislation concerning health and safety at work, the number of working days was reduced considerably from 330 to 276. With a certain time lag, the BAFA price for German power plant coal imports from non-EU countries was also affected by these developments. This was noticeable primarily during the third quarter of 2016, when the BAFA price increased by about 16 % to 65.03 €/tce compared to the previous quarter.

Figure 10 shows the long-term development of the global market prices for steam coal in comparison to crude oil. Figure 11 conveys an indication of the price trend for energy imports in Germany for hard coal/hard coal coke, natural gas, and crude oil.

Figure 10

AGEB
AG Energiebilanzen e.V.

Global Market Prices for Crude Oil (Brent) and Steam Coal between 2010 and 2016

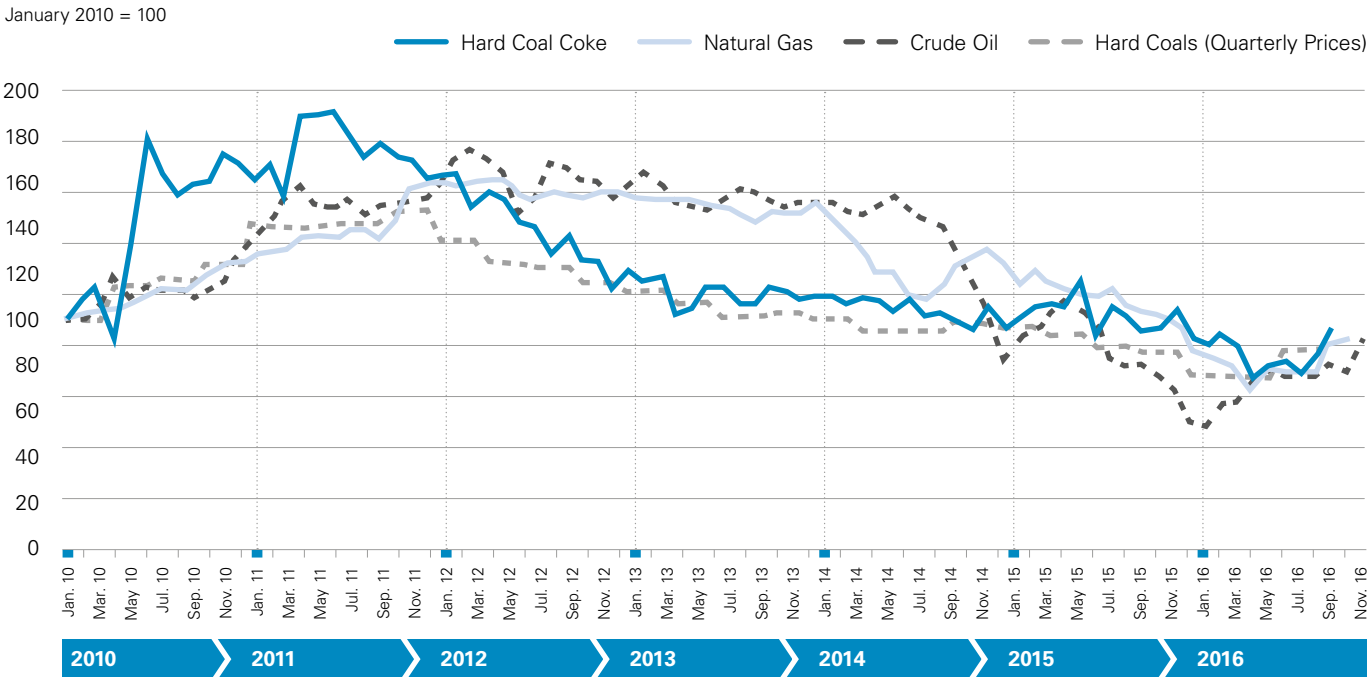


Sources: The German Coal Importer Association (Mc Closkey's Coal Report); Association of the German Coal Industry (MWV)

Figure 11

AGEB
AG Energiebilanzen e.V.

Development of Energy Import Prices between 2010 and 2016



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

Substantial price turbulences were also recorded for coking coal. For example, the weekly quotations for Australian premium coking coal quadrupled from 77 US$/t fob Queensland (on January 8, 2016) to more than 305 US$/t fob (on November 25, 2016). From late November to mid-December 2016, the price quotes for coking coal weakened slightly again and amounted to 247.50 US$/t fob at the end of 2016 (December 30, 2016). The dramatic increase in coking coal prices was caused by massive cutbacks in worldwide production in early 2016 and by the already mentioned state interventions in the Chinese coking coal and steel industries during the remainder of the year.

Freight rates in 2016 ranged between 2.30 US$/t and 8.40 US$/t for capesize vessels traveling on the benchmark route Richards Bay – Rotterdam. Between October and December 2016 as well as in January 2017, freight rates were more stable.

Lignite

With 171.5 million tons, lignite production in 2016 remained 3.7 % below the previous year's result. However, the development in the individual mining districts varied: In Central Germany (-6.3 %) and the Rhineland area (-5.0 %), coal extraction declined. In Lusatia, however, it was almost at the previous year's level (-0.3 %). Coal mining in the Helmstedt District ended in the fall of 2016.

Table 10

AGEB
AG Energiebilanzen e.V.

Volume and Use of Lignite in Germany in 2015 and 2016

	Unit	2015	2016 [1]	Change in %
Domestic Raw Lignite Production According to Mining Districts				
Rhineland	Million Tons	95.2	90.5	-5.0
Lusatia	Million Tons	62.5	62.3	-0.3
Central Germany	Million Tons	18.9	17.7	-6.3
Helmstedt	Million Tons	1.5	1.1	-27.2
Total Lignite Production	**Million Tons**	**178.1**	**171.5**	**-3.7**
	Mtce	**54.9**	**52.8**	**-3.8**
	PJ	**1,608**	**1,547**	**-3.8**
Use of Indigenous Lignite				
Total Sales	**Million Tons**	**160.9**	**156.0**	**-3.1**
to Power Plants Supplying the General Public	Million Tons	159.3	155.2	-2.6
to Other Customers	Million Tons	1.6	0.8	-51.9
Use for Refinement	Million Tons	14.9	14.2	-4.3
Use in Lignite Mining Power Plants	Million Tons	2.0	1.7	-17.2
Change in Stocks	Million Tons	0.2	-0.2	-
Total Volume of Refined Products from Domestic Production	**1,000 tons**	**6,657**	**6,418**	**-3.6**
Foreign Trade				
Total Imports	1,000 tce	46	33	-27.1
Total Exports	1,000 tce	1,395	990	-29.0
Foreign Trade Balance	1,000 tce	-1,349	-957	-
Primary Energy Consumption of Lignite	Mtce	53.5	51.9	-2.8
	PJ	1,567	1,522	-2.8
Electricity Production from Lignite [1]				
Power Plants Supplying the General Public	Billion kWh	151.1	147.0	-2.7
Industrial Power Plants	Billion kWh	3.3	3.0	-9.7
Total	Billion kWh	154.5	150.0	-2.9

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

Source: The German Coal Industry's Statistical Office

The Buschhaus power plant has been transferred into a standby mode for backup purposes since October 1. These changes generally correspond to the respective development of deliveries to power plants supplying the general public (155.2 million tons; -2.6 %) which receive around 90 % of the production.

On average, the overall calorific value of the produced coals was slightly lower than in the previous year. With 52.8 Mtce (1,547 PJ), the energy content of the extracted lignite fell, thus, 3.8 % short of the previous year's result. Lignite's contribution to domestic energy production amounted to nearly 39 %.

With 150 billion kWh, power generation from lignite was almost 3 % lower than in the previous year.

Lignite's share in power generation decreased to 23.1 % (previous year: 23.9 %). 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 3.6 % to about 6.4 million tons. Increases were reported for fluidized bed coal (+4 %). Briquette production (-6 %), the production of pulverized coal (-3 %), and coke production (-6 %), however, remained below the previous year's result.

With 51.9 Mtce (1,522 PJ), lignite-based primary energy consumption was almost 3 % lower than in the previous year. Lignite, thus, met more than 11 % of the entire domestic demand for energy (please see Table 10).

Table 11

Lignite Balance for Germany in 2015 and 2016

in 1,000 tce

AGEB
AG Energiebilanzen e.V.

		2015 [1]	2016 [1]	Change
				in %
Domestic Production		54,863	52,771	-3.8
+	Imports	47	33	-3.8
=	Volume	54,910	52,804	-29.8
+/–	Change in Stocks (Reduction: +, Replenishment: -)	-64	131	-
–	Exports	1,395	990	-29.0
=	Primary Energy Consumption	53,451	51,945	-2.8
–	Use in Power Plants	49,772	48,480	-2.6
–	Other Conversion Input	4,930	4,710	-4.5
+	Conversion Output	4,871	4,690	-3.7
–	Consumption during Production and Conversion as well as Non-Energetic Consumption	770	570	-26.0
=	Final Energy Consumption	2,850	2,875	0.9
	Industry	2,370	2,420	2.1
	Households, Trade, Commerce, Services, Concessionary Coal	480	455	-5,2

1) Preliminary data; some figures are estimates

Source: The German Coal Industry's Statistical Office

With a total consumption of 2.9 Mtce in 2016, the final energy sectors used only slightly more lignite and lignite products than in the previous year (+0.9 %). When it comes to industry, the use of lignite increased by more than 2 % while private households, etc. exhibited another decline of more than 5 %.

With 19,852 people, the number of employees in the German lignite industry at the end of 2016 was 892 below the previous year's level. This figure includes more than 1,300 apprentices and approximately 5,160 employees who work in the lignite companies' power plants supplying the general public. The number of employees decreased in all mining districts.

The employment statistics listed 8,961 employees in the Rhineland area, 8,278 in Lusatia, and 2,414 in Central Germany. After the end of coal mining, only about 200 employees worked on behalf of the lignite industry in the Helmstedt District.

If one takes the employment indicator ascertained in the study *Die Rolle der Braunkohlenindustrie für die Produktion und Beschäftigung in Deutschland* [The Role of the Lignite Industry for Production and Employment in Germany], which was conducted by the Energy Environment Forecast and Analysis (EEFA) Institute in 2011, as a basis, a total of almost 70,000 jobs in Germany can be attributed either directly or indirectly to lignite mining and power generation from lignite.

The Electric Power Industry

In 2016, the gross generation of electricity in Germany amounted to 648.4 billion kWh. Electricity production was, thus, almost on par with the previous year's level (+0.2 %). The contributions of the individual energy carriers, though, developed very differently when compared to the previous year (please see Table 12). Declines in power generation from nuclear energy, lignite and hard coal as well as onshore wind turbines and photovoltaic systems were to some extent contrasted by substantial increases for natural gas and offshore wind energy, biomass and hydropower. According to the available figures, electricity consumption remained almost stable at 594.7 billion kWh (2015: 595.1 billion kWh).

The electricity produced by lignite power plants amounted to 150.0 billion kWh in 2016. This equals a decline of 2.9 % when compared to the previous year's value. According to preliminary calculations, a net capacity of about 21,000 MW was installed at the end of the year. The contribution of lignite fired power plants to the gross electricity production amounted to 23.1 %. Lignite, thus, continued to be the most important energy carrier in the German electricity mix right after the group of renewables also last year.

In 2016, hard coal fired power plants also delivered less electricity than in the previous year; they produced 111.5 billion kWh. This equals a decline of 5.3 % when compared to the previous year. A capacity of approximately 27,900 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 17.2 %.

During the reporting year, the nuclear power plants in Germany generated 84.6 billion kWh of electricity (-7.8 %); this equals a share of 13.1 % in Germany's gross electricity production. In light of the fact that no additional power plant was decommissioned in 2016, the installed capacity (net) amounted to 10,799 MW by the end of the year.

The use of natural gas as a fuel in power plants and thermal power stations designed to supply electricity increased significantly in 2016. According to initial figures, a total of 80.5 billion kWh of electricity was produced from natural gas; this equals a plus of almost 30 % when compared to 2015. After electricity production from natural gas had experienced a continuous decline between 2008 and late 2015, it increased considerably once again in 2016. This was due, for example, to the price spread which was actually more favorable for natural gas when compared to other energy carriers. Additional power plant capacities reinforced this trend. When compared to the previous year, for example, the installed capacity (net) in 2016 increased by around 950 MW to 29,350 MW by the end of the year. According to initial calculations, natural gas accounted for a share of 12.4 % in Germany's gross electricity production in 2016.

With a total of 188.3 billion kWh, 0.5 % more electricity was generated from renewable energy in 2016 than was the case in the preceding year. The individual renewable energy sources contributed to that amount in varying quantities. Due to the comparably less favorable wind conditions in 2016, onshore wind turbines generated 65.0 million kWh of electricity and, thus, fell 8.3 % below the previous year's level. In contrast, offshore wind turbines supplied 12.4 billion kWh which is a significantly higher amount of electricity than in the previous year (+49.3 %) due to the installation of additional capacities during the year under review. All told, wind energy has a share of 11.9 % in the German electricity mix. In 2016, the installed capacity of onshore wind turbines increased by almost 4,300 MW while more than 800 MW were newly connected to the grid off shore. Thus, the total wind capacity installed in Germany now amounts to about 49,750 MW.

In the reporting year, 45.6 billion kWh of electricity were produced from solid, liquid, and gaseous biomass (including landfill gas, sewage gas as well as sewage sludge). This equaled an increase of 2.3 % compared to the previous year. Power plants generating electricity from biomass accounted for a share of 7.0 % in electricity production. In addition to the proportional power generation in waste fueled power plants (from biogenic waste), 51.6 billion kWh of electricity were produced from biogenic energy sources in Germany in 2016. Their total contribution to the German electricity producers' mix of energy sources, thus, amounted to 8.0 %.

Table 12

AGEB
AG Energiebilanzen e.V.

Gross Electricity Production, Electricity Exchange, and Gross Electricity Consumption in Germany between 1990 and 2016 According to Energy Carriers

	1990	2000	2005	2010	2014	2015 [1]	2016 [1]	2015 to 2016	1990 to 2000	2000 to 2016	1990 to 2016
	in Billion kWh							Average Annual Change in %			
Lignite	170.9	148.3	154.1	145.9	155.8	154.5	150.0	-2.9	-1.4	0.1	-0.5
Nuclear Energy	152.5	169.6	163.0	140.6	97.1	91.8	84.6	-7.8	1.1	-4.3	-2.2
Hard Coal	140.8	143.1	134.1	117.0	118.6	117.7	111.5	-5.3	0.2	-1.5	-0.9
Natural Gas	35.9	49.2	72.7	89.3	61.1	62.0	80.5	29.8	3.2	3.1	3.2
Mineral Oil	10.8	5.9	12.0	8.7	5.7	6.2	5.9	-5.0	-5.9	0.0	-2.3
Renewables	19.7	37.9	62.5	104.2	162.4	187.4	188.3	0.5	6.8	10.5	9.1
Other	19.3	22.6	24.1	26.8	27.0	27.3	27.5	0.9	1.6	1.3	1.4
Gross Electricity Production	**549.9**	**576.6**	**622.6**	**632.4**	**626.7**	**646.9**	**648.4**	**0.2**	**0.5**	**0.7**	**0.6**
Electricity Flows from Foreign Countries	31.9	45.1	53.4	42.2	38.9	33.6	27.0	-19.6	3.5	-3.2	-0.6
Electricity Flows into Foreign Countries	31.1	42.1	61.9	59.9	74.5	85.4	80.7	-5.5	3.1	4.2	3.7
Foreign Electricity Exchange Balance	0.8	3.1	-8.5	-17.7	-35.6	-51.8	-53.7	3.7	14.3	-	-
Gross Electricity Consumption	**550.7**	**579.6**	**614.1**	**614.7**	**591.1**	**595.1**	**594.7**	**-0.1**	**0.5**	**0.2**	**0.3**
Change versus Previous Year in %	-	4.0	0.6	5.8	-2.1	0.7	-0.1				
	Structure of Gross Electricity Production in %										
Lignite	31.1	25.7	24.7	23.1	24.9	23.9	23.1				
Nuclear Energy	27.7	29.4	26.2	22.2	15.5	14.2	13.1				
Hard Coal	25.6	24.8	21.5	18.5	18.9	18.2	17.2				
Natural Gas	6.5	8.5	11.7	14.1	9.8	9.6	12.4				
Mineral Oil	2.0	1.0	1.9	1.4	0.9	1.0	0.9				
Renewables	3.6	6.6	10.0	16.5	25.8	29.0	29.0				
Other	3.5	3.9	3.9	4.2	4.3	4.2	4.2				
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)

With 38.2 billion kWh, photovoltaic systems also supplied less electricity than was the case in 2015 (38.7 billion kWh). Compared to 2015, this equaled a minus of 1.4 %. 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. The contribution of solar energy to the German electricity mix amounted to 5.9 %.

According to preliminary estimates, an additional photovoltaic capacity of about 1,400 MWp was installed in 2016; thus, a total of approximately 41,200 MWp was installed at the end of the year.

A significant plus was recorded by power generation in run-of-the-river and hydroelectric storage plants which, with 21.0 billion kWh, delivered 10.7 % more electricity than in the previous year. Their contribution to the electricity mix, thus, amounted to 3.2 %.

In total, 188.3 billion kWh of electricity were generated from renewable energy in the reporting year.

According to initial figures, renewable energy's contribution to meeting the gross domestic electricity consumption, thus, amounted to approximately 32 % in 2016 (2015: 31 %).

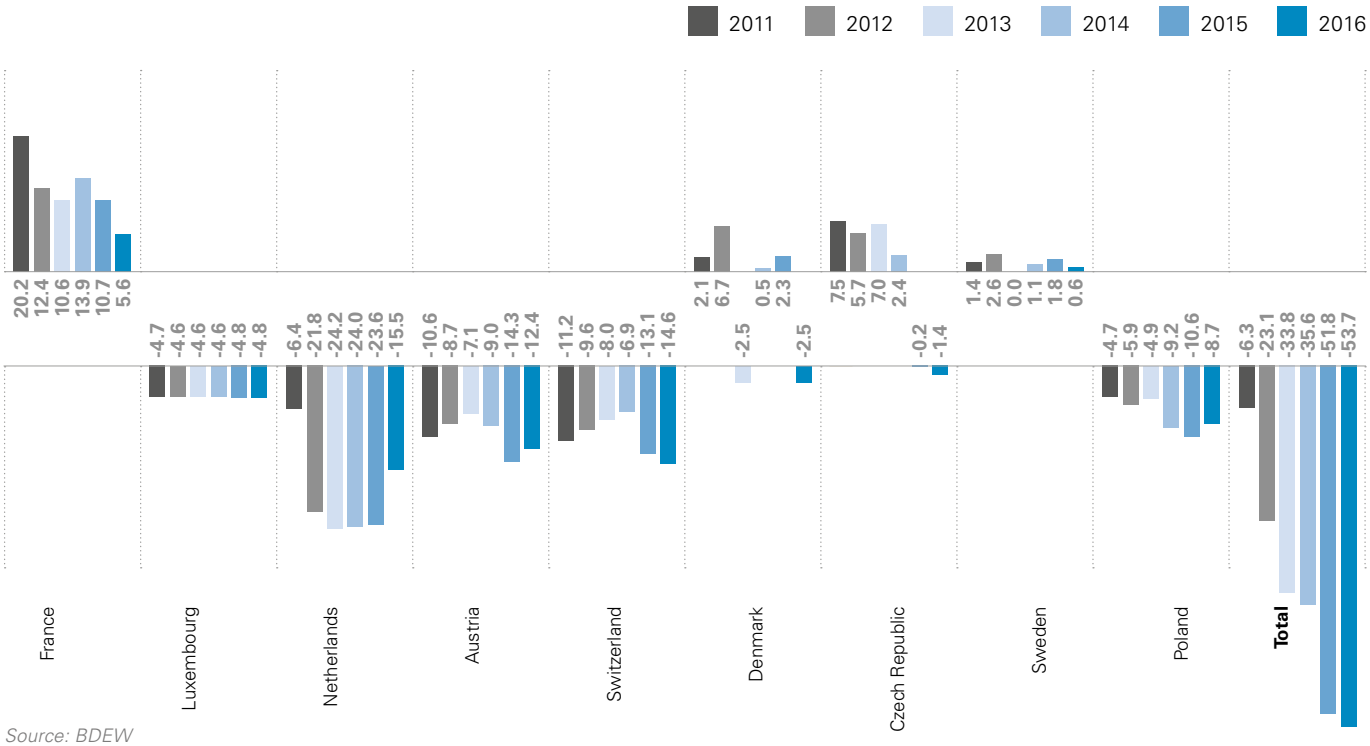
After Germany's negative balance in the electricity exchange with its neighboring countries had initially decreased in 2011, and then increased again considerably during the subsequent years, it reached its highest level so far in the reporting year 2016 with 53.7 billion kWh (please see Figure 12). In 2016, the largest amount of electricity flowed to Switzerland, followed by the Netherlands and Austria (Switzerland: 17.0 billion kWh, Netherlands: 16.9 billion kWh, Austria: 16.6 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 Austria (France: 8.3 billion kWh, Czech Republic: 5.0 billion kWh, Austria: 4.2 billion kWh). All told, 80.7 billion kWh of electricity flowed from German power grids to foreign countries (2015: 85.4 billion kWh) while

Figure 12

AGEB
AG Energiebilanzen e.V.

Germany's Electricity Exchange Balance with Neighboring Countries between 2011 and 2016

Electricity Flows in Billion kWh



Source: BDEW

Germany sourced 27.0 billion kWh from abroad (2015: 33.6 billion kWh). With an export surplus of 53.7 billion kWh, the balance for 2016 once again exceeded the previous year's level (2015: 51.8 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.

The electricity exchange balances are shown in Figure 12. In 2016, the highest "export surplus" amounting to 15.5 billion kWh was recorded for the exchange with the Netherlands, ahead of Switzerland with 14.6 billion kWh, Austria with 12.4 billion kWh, and Poland with 8.7 billion kWh. "Import surpluses" exist almost exclusively with France (5.6 billion kWh; previous year: 10.7 billion kWh), followed by Sweden which is far behind with 0.6 billion kWh.

Background information on the topic "exchange of electricity with foreign countries" is provided by a publication of the German Association of Energy and Water Industries (BDEW [5]).

According to first estimates and based on the economic trend, industrial power consumption increased from 245.8 billion kWh in 2015 by 0.4 % to 246.7 billion kWh in the reporting year. Electricity-intensive industries, though, exhibited very diverse developments. In comparison, power consumption

Table 13

AGEB
AG Energiebilanzen e.V.

Electricity Balance of Germany's Power Supply between 2000 and 2016

	2000	2008	2010	2013	2014	2015 [1]	2016 [1]	2015/ 2016	2008 to 2016
	Billion kWh							Change in %	
Gross Electricity Production	**576.6**	**640.7**	**632.4**	**637.7**	**626.7**	**646.9**	**648.4**	**0.2**	**1.2**
Self-Consumption in Power Plants	-38.1	-39.7	-38.1	-36.8	-35.9	-36.7	-36.5	-0.5	-8.1
Net Electricity Production	**538.5**	**601.0**	**594.4**	**600.9**	**590.7**	**610.2**	**611.9**	**0.3**	**1.8**
Electricity Flows from Foreign Countries	45.1	40.2	42.2	38.4	38.9	33.6	27.0	-19.6	-32.9
Electricity Flows into Foreign Countries	42.1	62.7	59.9	72.2	74.5	85.4	80.7	-5.5	28.7
Net Domestic Electricity Volume	**541.5**	**578.5**	**576.7**	**567.1**	**555.2**	**558.4**	**558.2**	**0.0**	**-3.5**
Pump Current Consumption	6.0	7.9	8.6	7.8	8.0	8.1	7.5	-6.9	-5.6
Grid Losses and Unrecorded Factors	34.1	32.2	27.5	23.6	23.2	25.8	25.6	-0.7	-20.5
Net Electricity Consumption	**501.4**	**538.4**	**540.6**	**535.7**	**524.0**	**524.6**	**525.1**	**0.1**	**-2.5**
Proportion of:									
Mining and Manufacturing Industries	239.1	252.4	249.7	245.1	244.4	245.8	246.7	0.4	-2.3
Households	130.5	139.5	141.7	137.0	129.7	128.7	128.5	-0.2	-7.9
Commerce and Trade, Public Institutions	118.6	135.4	137.1	141.6	138.3	138.8	138.7	-0.1	2.4
Transportation	13.1	11.1	12.1	12.0	11.6	11.3	11.3	-0.3	1.0
Gross Domestic Electricity Consumption	**579.6**	**618.2**	**614.7**	**603.9**	**591.1**	**595.1**	**594.7**	**-0.1**	**-3.8**

1) Some figures are preliminary and estimates

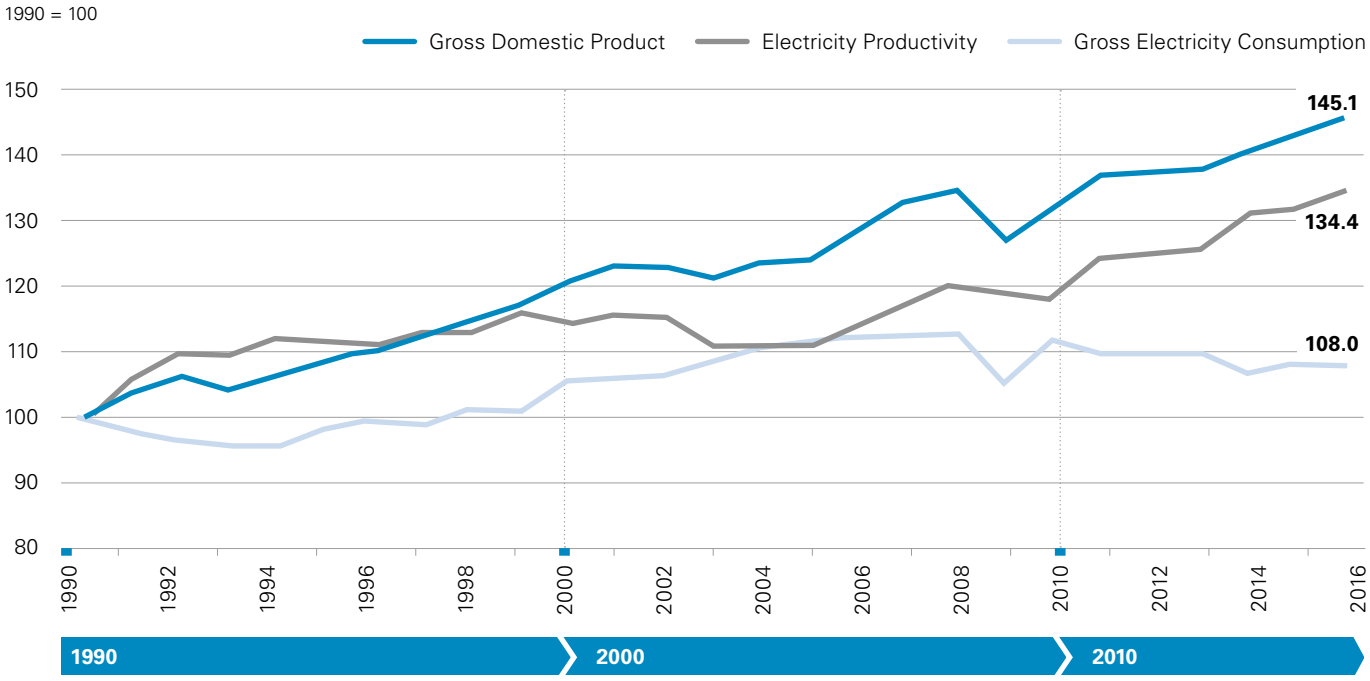
Source: German Association of Energy and Water Industries (BDEW)

5 BDEW background information on the exchange of electricity with foreign countries (PDF): https://bdew.de/internet.nsf/id/20140114-pi-mueller-grund-legende-reform-des-eeg-ist-eine-kernaufgabe-der-neuen-bundesregierung-2014/$file/BDEW%20Hintergrundinformationen%20Stromaustausch%20mit%20dem%20Ausland.pdf

Figure 13

AGEB
AG Energiebilanzen e.V.

Gross Domestic Product [1], Gross Electricity Consumption, and Macroeconomic Electricity Productivity [2] in Germany between 1990 and 2016



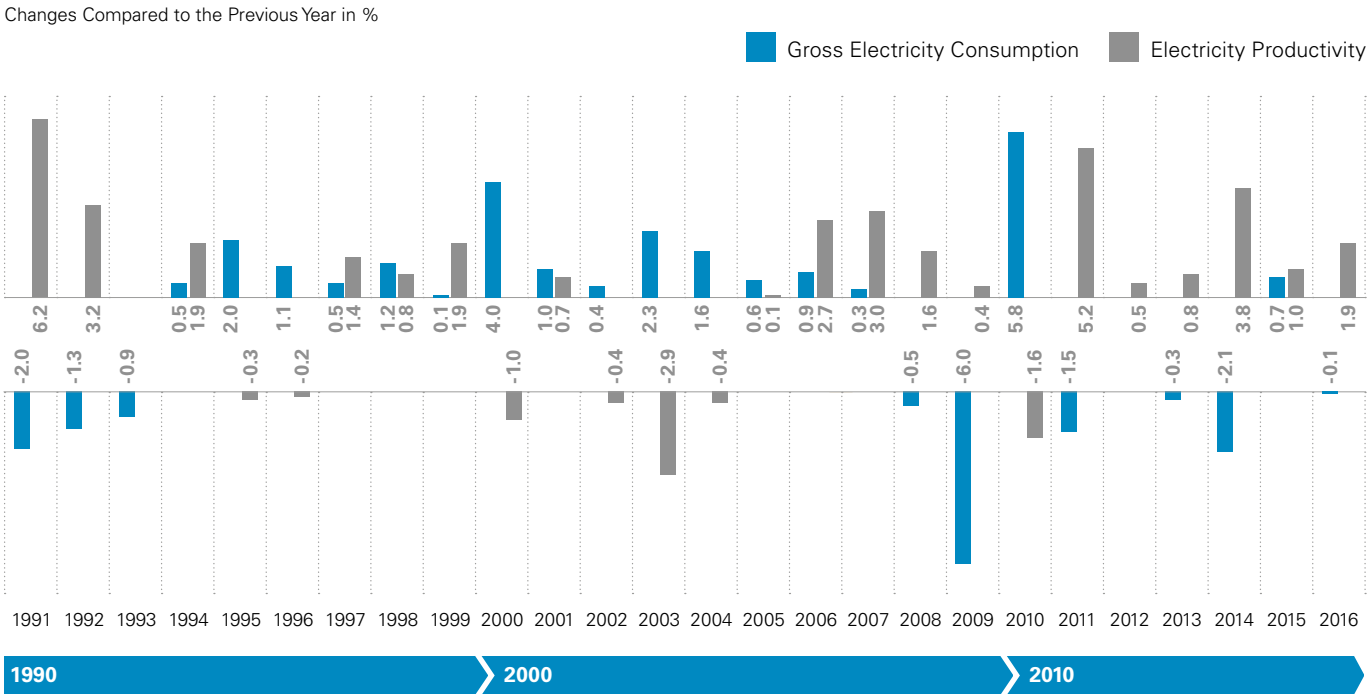
1) Price-adjusted
2) Gross domestic product per unit of gross electricity consumption

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

Figure 14

AGEB
AG Energiebilanzen e.V.

Changes in Gross Electricity Consumption and Electricity Productivity between 1991 and 2016



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

in the trade, commerce, and service sector declined marginally by 0.1 %. The consumption of electric power in private households decreased to a similar extent by 0.2 % from 128.7 billion kWh to 128.5 billion kWh. The primary reasons for the decline in power consumption are considered to be savings measures on part of the consumers as well as improvements in efficiency. Consumption in the transportation sector dropped slightly below the previous year's figure. In total, net electricity consumption amounted to 525.1 billion kWh which was almost on par with the previous year's level (+0.1 %) (please see Table 13).

Due to the marginal 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 as well by 1.9 % in 2016 when compared to the previous year. This was almost twice the average annual production increase of 1.1 % which had been achieved during the period between 1991 and 2015 (please see Table 2 and Figure 13). For the annual changes in gross electricity consumption and electricity productivity, please turn to Figure 14.

The influence of the different components for the changes in power consumption from 1990 and/or 2015 to 2016 are shown in Figure 15.

It indicates that the 2016 decline of 0.4 billion kWh in gross electricity consumption when compared to 2015 was primarily caused by the higher electricity productivity (current intensity component).

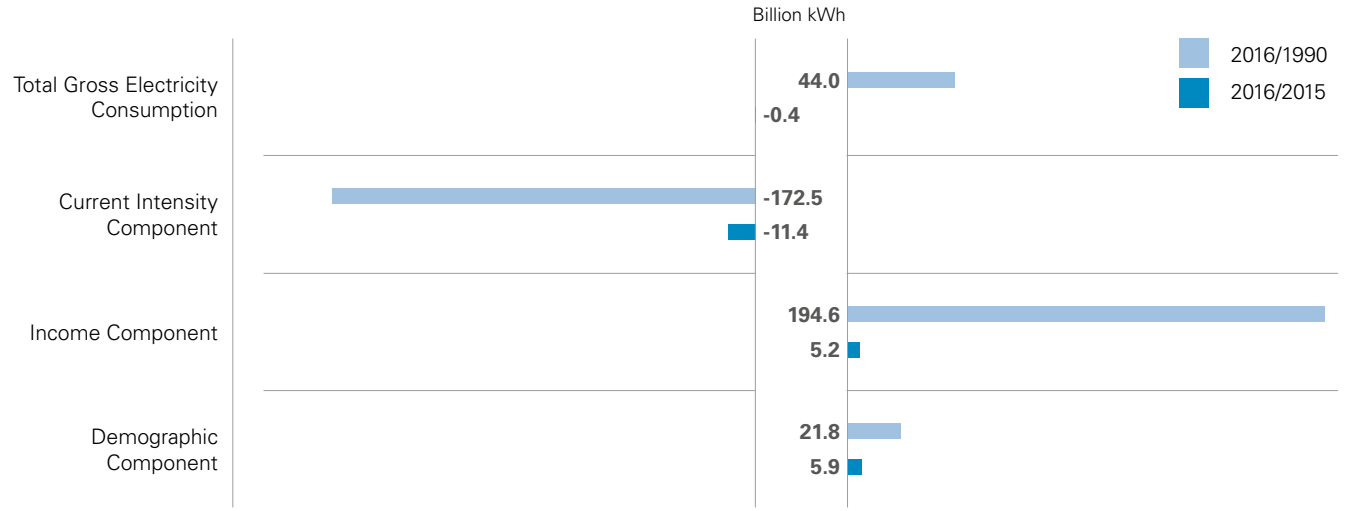
Correspondingly, the associated reductions in consumption were higher than the effects of enhanced consumption due to the growing economy and the increasing population. Over the entire period between 1990 and 2016, however, the long-term increase in electricity productivity did not result in an absolute decrease in electricity consumption. After all, the electricity productivity essentially contributed to the fact that it was possible to limit the increase in gross electricity consumption between 1990 and 2016 by 195 billion kWh to about 44 billion kWh or a plus of nearly 8 % even though the growing economy caused electricity consumption to increase substantially (please see Figure 15).

Figure 15

AGEB
AG Energiebilanzen e.V.

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

Changes in 2016 Compared to 2015 and 1990 in Billion kWh



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

The number of companies which are active in the electric power industry has been growing continuously since the start of the liberalization process in 1998. At the end of 2015, there were 1,734 companies; by the end of 2016, the number increased to 1,747. At closer examination, it is revealed that 88 of these companies were active as electricity producers with a power plant park larger than 100 MW, 921 of which worked as power distribution grid operators, four as transmission grid operators, 134 as electricity wholesalers, and 1,195 as distributors in the ultimate consumer business[6]. The number of employees working in the electric power industry increased in 2016. According to preliminary figures, there were 129,200 employees at the end of 2016 which was an increase of 1.1 % when compared to the end of 2015.

Electricity prices for industrial clients went up by 1.5 %, which was primarily due to the increases in taxes, duties, and levies. The proportion of governmental charges included in the electricity price for industrial clients, which had amounted to 48 % in 2015, increased once again to 50 % in 2016 (excluding the electricity tax).

Electricity prices for households increased slightly by 0.3 %. Similar to industrial clients, the increase in taxes, duties, and levies was also noticeable for household clients. Network charges also exhibited an increase in 2016. Procurement costs for distributors continued to decrease due to declining futures market prices which actually benefited consumers. This caused the proportion of taxes, duties, and levies on electricity prices to increase from 52 % in the previous year to 54 % in 2016. In 2017, the proportion of governmental charges included in the electricity price will go up once again by about 0.7 ct/kWh which will, thus, increase the tax burden for consumers.

As measured by the producer price index, electricity prices developed quite differently in 2016 for each respective customer group: While there was an increase of 1.0 % for households and just a marginal increase of 0.6 % for commercial customers (previous year: +1.3 % and +1.0 % respectively), the prices for special-contract customers at the low voltage level now went up by 1.9 % which was different from the previous year's decrease of 2.0 %. In contrast, the prices for special-contract customers at the high voltage level decreased even though the reduction of only 0.2 % was significantly weaker than one year earlier (-3.9 %; please see Figure 16). The producer price index for electricity sales to redistributors, however, dropped by 8.2 % which was only slightly less than last year's decline of 10.5 %. After a significant decline of 11.8 % already in 2015, the price for electricity on the exchange exhibited another particularly hefty 13.4 % decrease in 2016. The price for electricity on the exchange was 63.3 % lower in 2016 than in 2008; the year it reached its highest level to date.

If one observes the development of the prices for electricity on the exchange, then one will see a clear tendency towards price reductions both on the spot market and the futures market commencing during the first half of 2011 and ceasing in mid-2016 (please see Figure 17). However, the subsequent price upswing remained mostly below the limit of 40 €/MWh until the end of 2016. Nonetheless after the turn of 2016/2017, there was considerable turmoil with price fluctuations of up to more than 100 €/MWh.

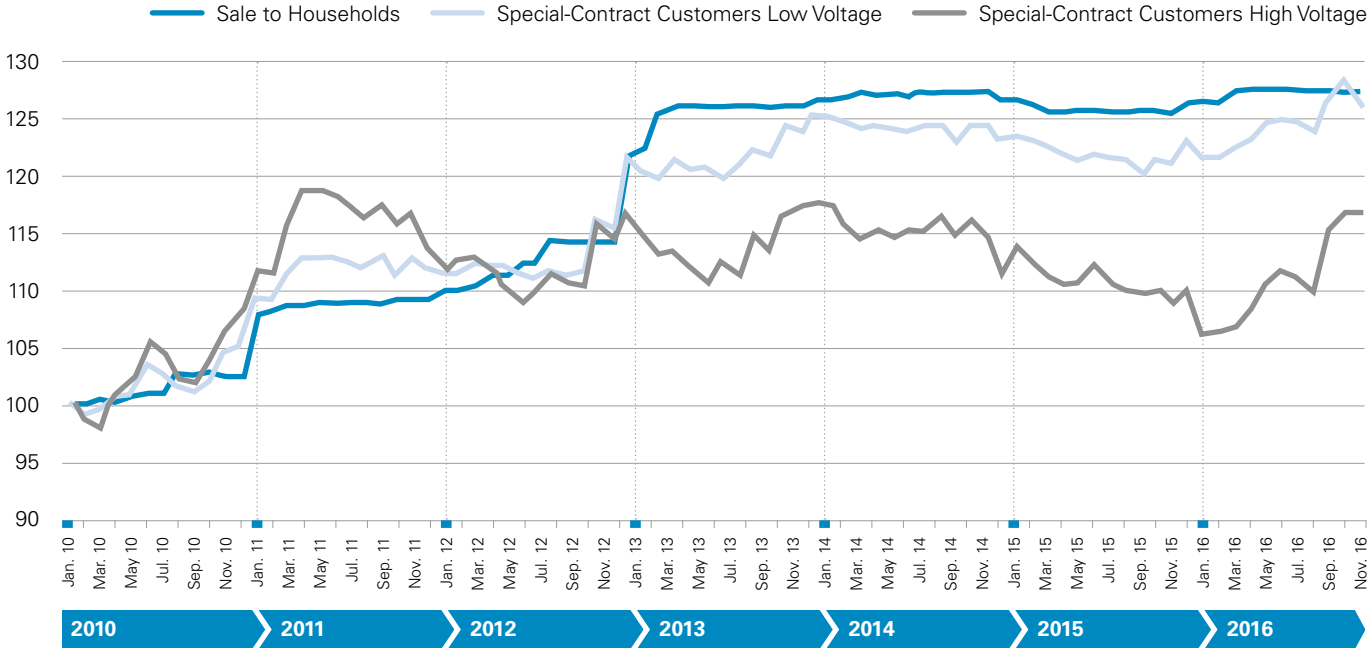
6 It is not possible to add up the corporate figures because many of the companies are active at multiple stages of the value creation chain and are, thus, recorded several times.

Figure 16

AGEB
AG Energiebilanzen e.V.

Electricity Producer Price Index for Special-Contract Customers and Sale to Households in Germany between 2010 and 2016

January 2010 = 100



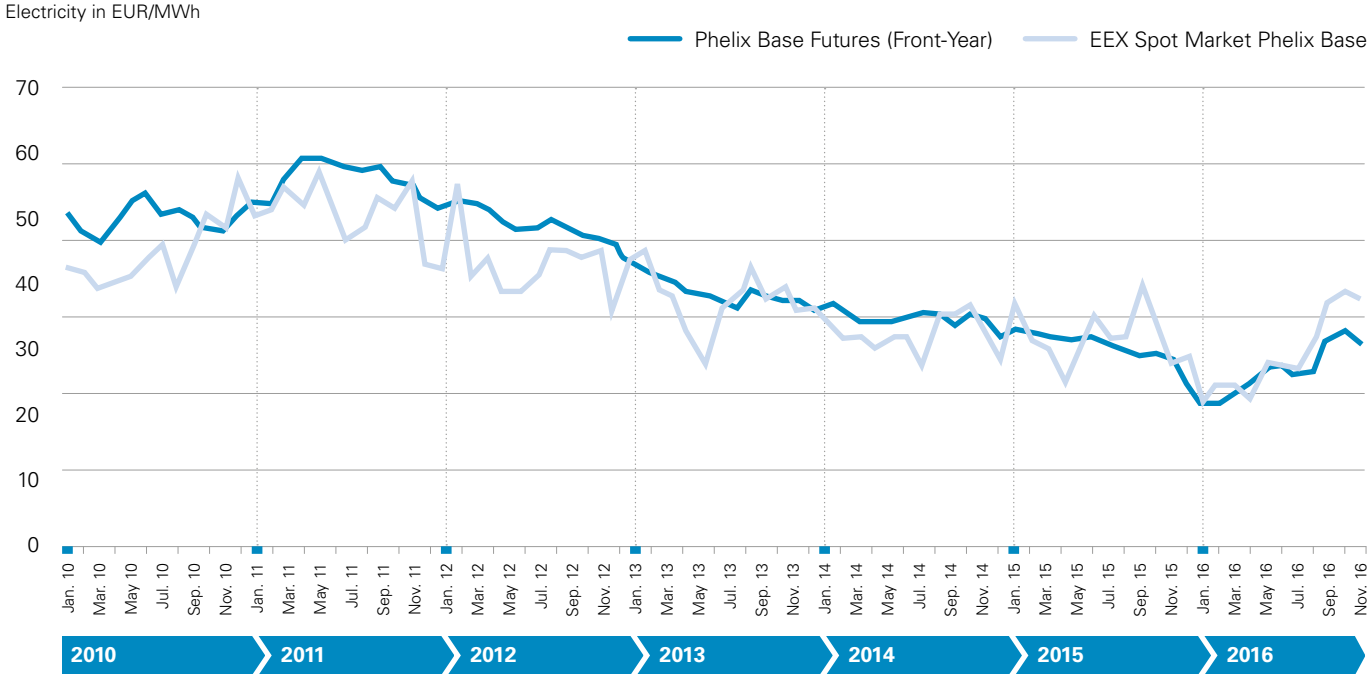
Source: Federal Statistical Office (Destatis)

Figure 17

AGEB
AG Energiebilanzen e.V.

Development of Electricity Prices on the EEX Spot Market and Term Market (Front Year) between 2012 and 2016

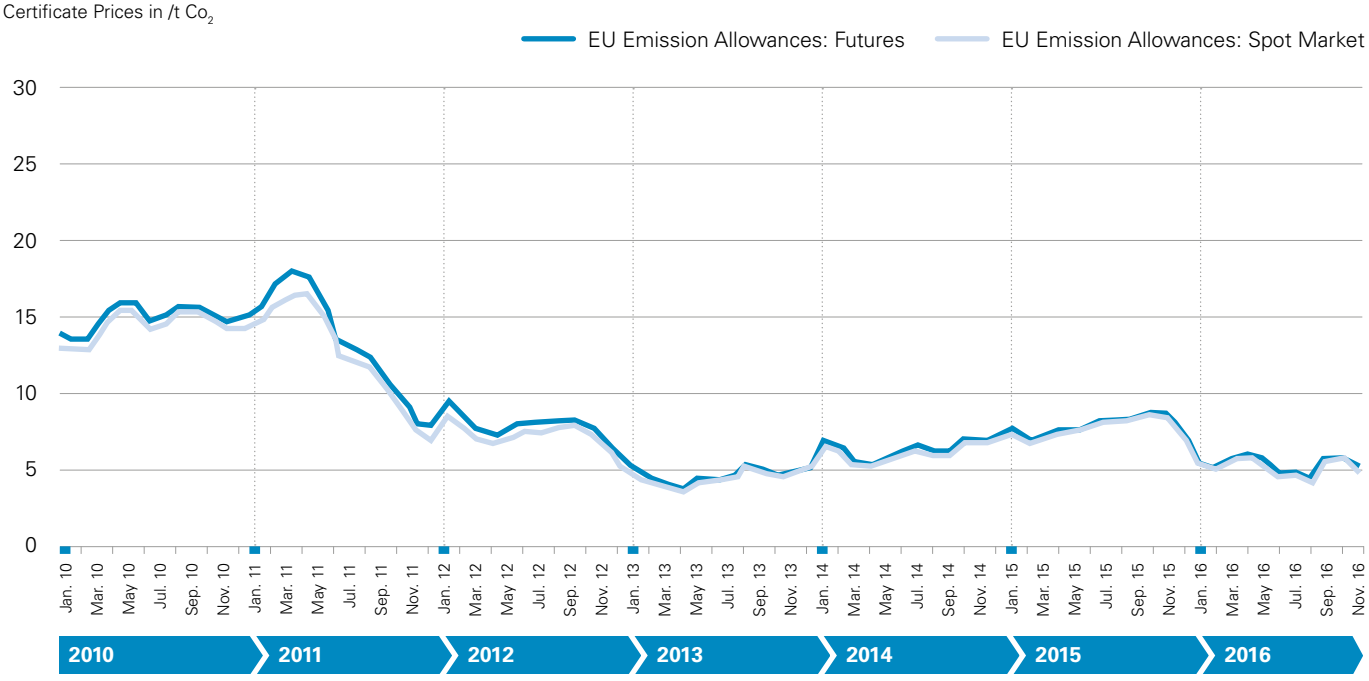
Electricity in EUR/MWh



Source: BMWi

Figure 18

Development of the European Emission Allowances on the EEX Spot Market and Term Market between 2010 and 2016



Source: BMWi

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. 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 on hand for the first four 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 15 €/t CO_2 by 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 17 €/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 below 5 €/t CO_2 since early 2013. Only in the course of 2014 was there a slight upward trend in the direction of 7 €/t CO_2 to 9 €/t CO_2 which lasted until the end of 2015, but came to a new standstill in 2016: This year, the prices ranged between 4 €/t CO_2 and 6 €/t CO_2 again (please see Figure 18). Obviously, the intended signals of shortages which were to be given by emissions trading no longer have their desired effect.

It should be noted that, irrespective of the amount of the certificate prices, the specified quantitative limit (cap) guarantees that the objective of annually decreasing CO_2 is actually attained.

Provision of District Heating and Cooling

According to first estimates, district heating and district cooling suppliers produced 130 billion kWh of net heat [7] in 2016; an additional 7 billion kWh came from other producers of heat. A total of 137 billion kWh was fed into the heating/cooling grid (please see Table 14). Compared to 2015, production increased by 2.5 %. Today, more than two thirds of the net heat production come from cogeneration plants. According to initial calculations and after deducting the operating consumption, grid losses as well as statistical differences, the net heat consumption sourced from the energy suppliers' grids amounted to 119 billion kWh. The increased consumption compared to the previous year is primarily due to the cooler temperatures during the heating months. The increased number of new utility connections in the housing market fostered this trend.

Due to the increased production of heat, the use of fuel in heating and thermal power stations supplying the general public also went up by around 2.5 % to a total of 148 billion kWh. When it comes to the use of fuel, natural gas experienced the highest increase; compared to 2015, its contribution improved by 7.5 % to 57 billion kWh. Thus, natural gas had a share of over 38 % in the fuel which was used to supply district heating in 2016. According to initial estimates, the use of hard coal exhibited a downward trend (-9.4 %) whereas lignite and renewable energy (including the renewable proportion of residential waste) recorded a plus of approximately 3 % each. In 2016, renewables contributed more than 28 billion kWh, which translates into 19.1 %, as a fuel which was used in Germany's heating and thermal power stations.

As mentioned above, the cooler temperatures during the heating period of 2016 resulted in an increased demand for thermal energy. According to initial estimates, the heat consumed by private households and the heat supplied to residential buildings went up by 3.7 % to 49 billion kWh. This plus was further reinforced by an increase in the number of homes supplied with district heat. The issuing of construction permits for new homes serves as an indicator here. A connection to district heating is intended for 23.8 % of the new residential units for which a construction permit was granted in the reporting year. In correlation to the economic trend, industrial consumers purchased 48 billion kWh of thermal energy which was approximately 2 % more than in 2015. The consumption of heat by other customers in 2016 increased by more than 1 % to an anticipated amount of 21.7 billion kWh.

Table 14

AGEB
AG Energiebilanzen e.V.

Balance of Heating and Cooling Companies

	2015	2016 [1]	Changes
	Billion kWh		in %
Net Production	**133.7**	**136.9**	**+2.4**
Mains Losses and Operating Consumption; Stat. Differences	18.1	18.4	+1.7
Net Consumption District Heating/Cooling	**115.6**	**118.6**	**+2.5**
Industry	47.1	48.0	+1.9
Households	47.3	49.1	+3.7
Other	21.2	21.5	+1.3

1) Some figures are preliminary and estimates

Sources: Federal Statistical Office (Destatis); BDEW

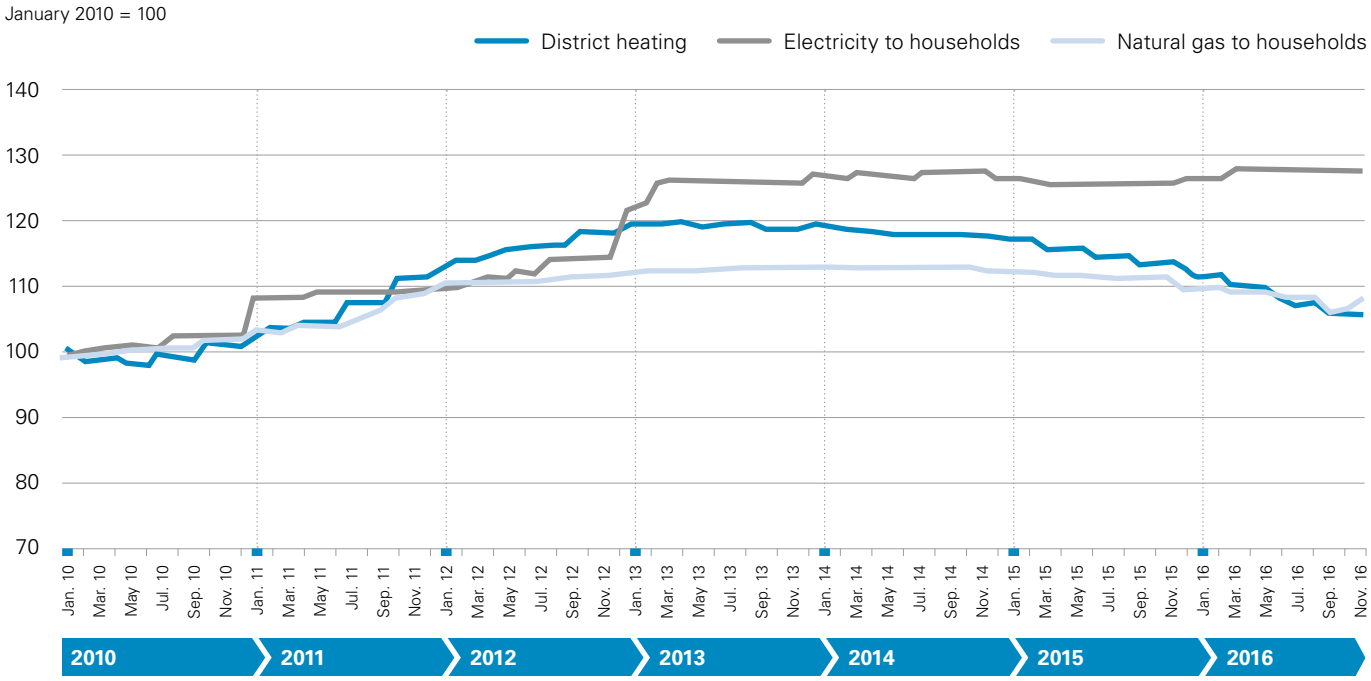
7 Here: District heating always includes district cooling.

It is interesting to compare the development of the producer prices for supplying electricity, natural gas, and district heat to households (please see Figure 19). Here, the trends for natural gas and district heat exhibit more or less similar curves whereas the producer price index for electricity does not follow the downward trend of these two energy carriers. Unlike the producer price indices for natural gas and district heat which have exhibited a downward trend since 2014, the producer price index for electricity has stabilized at the level it had already been attained in 2014.

Figure 19

AGEB
AG Energiebilanzen e.V.

Producer Price Indices for District Heating, Electricity, and Natural Gas Charges to Households in Germany between January 2010 and December 2016



Source: Federal Statistical Office (Destatis)

Renewable Energy

Renewable energy sources can be clearly divided into six major categories (please see Table 15). In addition to the fluctuating energy sources hydropower, wind energy (on land and at sea), and solar energy, terrestrial heat (geothermal energy), diverse biomasses as well as biogenic waste are currently used not only in power plants 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 continues to be the most important. Usually, biogas is either used on site in biogas plants with an attached combined heat and power plant or freed from impurities in specific processing plants and fed into the natural gas grid as biomethane. In contrast, landfill and sewage gases are – similar to biogas – above all energetically recycled on site. Liquid fuels such as palm kernel oil or rapeseed oil as well as biofuels such as biodiesel and bioethanol actually assume only a secondary role.

According to current estimates, the primary energy consumption of renewables amounted to 1,689 PJ (57.6 Mtce) in 2016. Compared to the previous year, this equaled a plus of 46 PJ or 2.8 %. The increase is primarily due to biomass (37 PJ or 3.9 %), and it was in particular the cooler weather which was responsible for this development. Yet the additional capacity of about 200 MW which was installed in the course of the year was almost exclusively designed to provide more flexibility for plants and systems and is, thus, only partially relevant for the consumption. Despite the progressing expansion of capacities, declines were recorded for wind energy (-6.5 PJ and/or -2.3 %) as well as, for the first time ever, solar energy (-3 PJ and/or -1.2 %).
The current status is such that even though it was possible to put around 4.3 GW of wind turbines on land and 0.8 GW at sea as well as 1.4 GW_p of rooftop and open space photovoltaic systems into operation in 2016, the more unfavorable wind conditions and the significantly shorter duration of sunshine resulted in a lower yield from these systems when compared to 2015. Considering the overall situation, the proportion of renewables of the total primary energy consumption in Germany still increased from 12.4 % in 2015 to 12.6 % in 2016 (please see Tables 1 and 15).

Table 15

Renewable Energy in Germany in 2015 and 2016 According to Its Use and Energy Sources

	Hydropower			Wind Energy (Onshore and Offshore)			Solar Energy			Geothermal Energy			Biomass			Waste			Total		
	2015	2016	Changes	2015	2016	Changes	2015	2016	Changes	2015	2016	Changes	2015	2016	Changes	2015	2016	Changes	2015	2016	Changes
	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%
Domestic Production	68.3	75.6	10.7	285.1	278.7	-2.3	167.5	165.5	-1.2	46.2	50.4	9.0	973.6	1,010.4	3.8	125.2	131.0	4.7	1,666	1,712	2.7
Foreign Trade Balance	-	-	-	-	-	-	-	-	-	-	-	-	-22.3	-22.2	-0.2	-	-	-	-22	-22	-0.2
Primary Energy Consumption	**68.3**	**75.6**	**10.7**	**285.1**	**278.7**	**-2.3**	**167.5**	**165.5**	**-1.2**	**46.2**	**50.4**	**9.0**	**951.4**	**988.2**	**3.9**	**125.2**	**131.0**	**4.7**	**1,644**	**1,689**	**2.8**
Use in Power Plants (Electricity)	68.3	75.6	10.7	285.1	278.7	-2.3	139.4	137.4	-1.4	4.8	5.4	12.6	343.9	350.7	2.0	60.4	64.7	7.1	902	912	1.2
Use in Power Plants (Heat)	-	-	-	-	-	-	0.01	0.01	-	1.3	1.4	15.7	46.5	47.0	1.1	48.5	49.7	2.4	96	98	2.0
Consumption during Conversion, Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**23.1**	**23.6**	**2.2**	**0.3**	**0.4**	**3.5**	**23**	**24**	**2.2**
Final Energy Consumption	**-**	**-**	**-**	**-**	**-**	**-**	**28.1**	**28.0**	**-0.1**	**40.1**	**43.5**	**8.4**	**537.9**	**566.9**	**5.4**	**15.9**	**16.2**	**2.1**	**622**	**655**	**5.2**
Industry	-	-	-	-	-	-	-	-	-	-	-	-	93.8	94.4	0.7	15.9	16.2	2.1	110	111	0.9
Transportation	-	-	-	-	-	-	-	-	-	-	-	-	107.5	108.4	0.6	-	-	-	107	108	0.6
Households, Trade, Commerce, Services	-	-	-	-	-	-	28.1	28.0	-0.1	40.1	43.5	8.4	336.7	364.1	8.2	-	-	-	405	436	7.6

All values for 2016 are preliminary.

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

With a share of 58.5%, biomass clearly dominated the energy carrier structure of renewables' primary energy consumption once again in 2016 (2015: 57.9 %). The next runners-up were wind energy with 16.5 % (2015: 17.3 %), solar energy with 9.8 % (2015: 10.2 %) as well as biogenic waste with 7.8 % (2015: 7.6 %; whereby it should be noted that only 50 % of the total energy consumption in waste incineration plants is classified as renewable energy). Hydropower and geothermal energy accounted for 4.5 % (4.2 %) and 3.0 % (2.8 %) respectively (please see Figure 20).

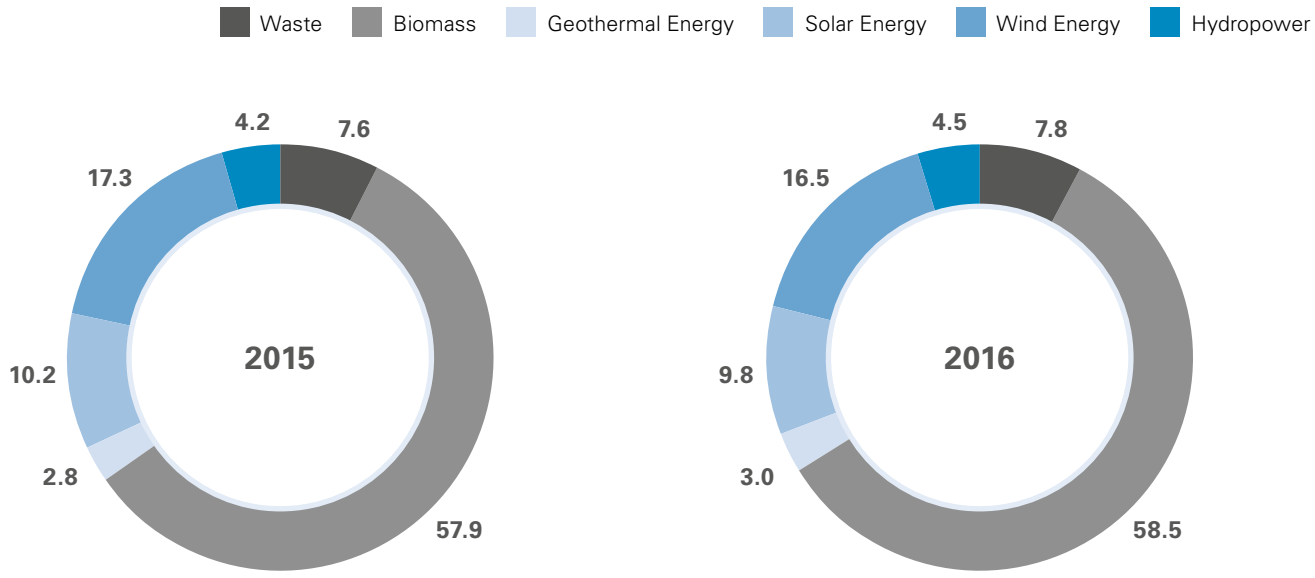
If one takes the individual consumption sectors as a basis for comparison, then it will become apparent that the use in power plants for the production of electricity is the most important aspect with a share of 54.0 % as measured by the primary energy consumption (2015: 54.9 %); whereby biomass with 38.4 %, wind energy with 30.5 %, and solar energy with 15.1 % assume top positions among the energy carriers. The use in power plants for heat production (district heat), however, accounts for only 5.8 % of the renewables' primary energy consumption. Here, the change compared to the previous year is marginal. The increased decentralized use of renewables entails that 32.3 % of the energy used is attributable to end consumers (2015: 31.3 %). Primarily all individual hearths such as stoves and fireplaces, solar thermal systems or heat pumps in private households as well as combined heat and power plants and micro cogeneration plants in the commercial and industrial sector designed to generate thermal energy need to be mentioned in this context. Another 6.4 % are attributable to the use of biofuels in the transportation sector which are added to gasoline and diesel fuels (2015: 6.5 %).

Figure 20

AGEB
AG Energiebilanzen e.V.

Structure of Renewable Energy Sources in Germany between 2015 and 2016

Shares in Total Renewable Energy in %



Source: Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW); Updated: January 2017

CO_2 Emissions

According to estimates 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 0.890 kg CO_2/kWh net in 2016, which represented a decrease of about 3 % compared to the previous year. The downward trend for specific emissions is primarily due to the higher utilization of gas fired power plants as well as the simultaneously decreasing production of electricity in lignite and hard coal fired power plants because the average emissions of natural gas fired power plants fall below the average values attained by the electricity production mix as a whole.

In 2016, the structure of electricity production shifted further towards low-emission and emission-free energy sources whereas the particularly emission-intensive energy carriers hard coal and lignite recorded substantial losses in their shares. All told, a rough calculation indicates a slight decline in CO_2 emissions in the electricity sector. However, the decrease in CO_2 emissions in the electricity sector does not permit any conclusions to be drawn on the development of emissions in the remaining sectors such as, for example, the heating, building, or transportation sectors. If, for a first estimate of the energy-related CO_2 emissions, the calculation were to be based on the original values of primary energy consumption (2015/2016: +1.1 %), then an increase in greenhouse gas emissions by 0.7 %, which translates into about 6 million tons of CO_2 equivalents, could be anticipated. Provided that the primary energy consumption was adjusted to the temperature effect (2015/2016: +0.7 %), the energy-related CO_2 emissions ought to have increased by approximately 0.3 %, which translates into more than 2 million tons of CO_2 equivalents. Insofar as neither any process-related CO_2 emissions nor any other greenhouse gas emissions underwent any fundamentally different developments, it is apparent that the development of emissions has actually deviated even more from the path that needs to be pursued in order to attain the objective.

If one were to assume for simplicity's sake that the target path follows a linear course, and by taking the known emission values into account, another absolute decline by about 150 million tons of CO_2 equivalents would be required between 2015 and 2020 in order to achieve the national objective of reducing greenhouse gas emissions by 40 % until 2020 compared to 1990. On an annual average, this would amount to approximately 30 million tons of CO_2 equivalents, which translates into 3.6 %. Compared to the previous (2000 to 2015) rate of reduction which was 1.0 %, this translates into almost 10 million tons of CO_2 equivalents per year, the emission reduction measures would need to be intensified substantially – precisely, by the factor 3 – if any chance of attaining the objective were to be realized. Assuming that no additional "relief" could be obtained in 2016, the emissions would even need to be reduced by an annual average of 4.4 %, which translates into 37 million tons, by 2020. This simplified calculation aptly demonstrates the specific challenges that are and continue to be imposed on the requisite reduction measures which are necessary to reach the objective by 2020.

In this context, a problem should once again 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 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 consumption of primary energy in Germany were due to the weather that was cooler than the previous year, the comparably good economic situation, and also the growing population. Consumption also increased because 2016 was a leap year with one additional day. The development in consumption was additionally fostered by the comparably low prices particularly for fossil fuels. As a result, primary energy consumption went up by 1.1 % in 2016; adjusted to the temperature effect, it ought to have increased by about 0.6 %. The macroeconomic energy productivity – as measured by the original values – improved only marginally (by 0.7 %); and even adjusted to the temperature effect, its rate of 1.3 % was significantly below the long-term average which ranges around 2 % per year.

Unlike primary energy consumption, electricity consumption remained virtually stable (-0.1 %) compared to the previous year. Thus, the macroeconomic electricity productivity increased visibly by nearly 2 % – almost twice as much as the long-term average between 1990 and 2015. The individual end user sectors, with the exception of industry, also exhibited more or less distinct decreases in electricity consumption.

Starting in the first half of 2011 and ending in mid-2016, the prices for electricity traded at the exchange indicated a clear tendency towards price reductions both on the spot market and the futures market. However, the subsequent price upswing mostly remained under the limit of 40 €/MWh until the end of 2016. All told, the price on the exchange was 13.4 % lower in 2016 than in 2015. Yet after the turn of 2016/2017, there was considerable turmoil with price fluctuations up to more than 100 €/MWh which were caused by a number of special effects in the neighboring countries. It remains to be seen whether this short-term development is of a lasting nature or whether a return to lower prices on the exchange can be expected after these special effects have been overcome. Thus, uncertainties will probably continue to exist as to whether the prices on the exchange provide sufficient incentives for investments into additional power generation capacities that are needed for the future.

The anticipated development of prices for CO_2 certificates will also play a key role in this. But so far, the certificate prices remain at a low level, ranging between 4 euros and 6 euros per ton of CO_2; and there is no indication that this will essentially change in the short and medium term. Yet this also means that the intended signals of a shortage which were to be given by emissions trading no longer have their desired effect. This is also the background which helps understand the demand for a fundamental structural reform of the European emissions trading system so that the intended incentives to encourage an emission-reducing behavior which were to be given by emissions trading can become effective again.

In light of the objectives pursued by the German Federal Government in conjunction with its energy concept, the first energy-related data for 2016 actually provide mixed results. For example, there are already doubts as to whether the Federal Government's objective of reducing primary energy consumption by 20 % until 2020 compared to 2008 will be attained; the more so as no such contribution was made in 2016. All told, the (unadjusted) primary energy consumption in 2016 was just around 7 % lower than in 2008. In order to still reach the objective for 2020, the reduction would have to be increased to 14 % or to 3.7 % per year in the remaining four years, which means it would have to be more than quadrupled when compared to the annual average reduction achieved between 2008 and 2016 (-0.9 % per year). But it is questionable whether the requisite measures which have been launched by the Federal Government (for example, within the scope of the National Action Plan on Energy Efficiency) so far will suffice within the short time remaining. 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, in order to still attain the objective for 2020, it is necessary for electricity

consumption to be further decreased by a total of 6.4 % or by an annual average of 1.6 % when compared to 2016.

As measured by the actual development between 2008 and 2016, when electricity consumption had declined by an average of only 0.5 %, this equals a reduction rate that is about three times higher. However, when assessing the electricity objective, it should be borne in mind that specifically because of renewable energy's great relevance for the production of electricity, 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 Climate Change Conferences in Paris 2015 and Marrakesh 2016 as well as the agreements concluded there, the objective pursued by Germany to reduce greenhouse gas emissions by 40 % between 1990 and 2020 is of primary relevance. A decline in greenhouse gas emissions by almost 28 % (CO_2 emissions: Nearly 25 %) had already been recorded for the period until 2015. If one keeps the above mentioned considerations in mind, then the greenhouse gas emissions will probably have increased slightly in 2016 compared to the original values. Thus, Germany had once again moved further away from the target. Yet if one were to assume, for simplicity's sake, that the emissions in 2016 would have remained approximately at the previous year's level, then an additional reduction of greenhouse gas emissions of more than 150 million tons of CO_2 equivalents, which translates into nearly 17 %, would need to be attained during the remaining four years until 2020. In the past, such a reduction required about 15 years as happened, for example, between 2000 and 2015. Against this backdrop, considerable doubts exist as to whether the objective for 2020 can be reached.

All told, the development of the level and structure of energy consumption in Germany in 2016, in light of the objectives pursued by the energy concept, reveals a constant great and even more urgent need for action in order to still achieve the ambitious goals of the energy concept for 2020. The facts and figures available for 2016 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.

Finally, to end on a positive note, the German Bundestag adopted the amendment of the Energy Statistics Act (EnStatG) in its session on January 26, 2017. Even though all the wishes of the diverse interest groups were still not satisfied, it was actually possible to successfully complete the longstanding efforts to improve the energy-statistical database. This is, last but not least, also in the interest of a task-oriented and evidence-based monitoring of the energy turnaround.

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