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Energy Consumption

in Germany in 2017

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Energy Consumption Increased Slightly in 2017

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Energy Consumption Increased Slightly in 2017

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 13,550 petajoules (PJ), which translates into 462.3 million tons of coal equivalents (Mtce), in 2017. This equals an increase of 0.9 % compared to the previous year.

There are several reasons for this increase: It was primarily due to the significant macroeconomic growth (price-adjusted: +2.2 %), the substantial increase in the manufacturing industry (+2.7 %) as well as the growth in population (+0.33 million people); albeit the latter's increase was slightly lower when compared to the previous year. The temperature influence, though, hardly played any role in this at all; as measured by the degree day figures, 2017 was on average only marginally warmer than 2016 so that the demand for heating energy actually tended to be slightly lower. The fact that 2017 exhibited one "energy consumption day" less than the leap year 2016 had a similar effect. Adjusted to the weather conditions and the leap year effect, the increase in last year's energy consumption probably would have amounted to roughly about one percent.

As measured by the original values and when compared to the previous year, the macroeconomic energy productivity almost doubled in 2017 (1.3 % versus 0.7 %). But just as the temperature-adjusted value (at 1.2 %), it still fell significantly below the long-term average of 1.8 %.

Consumption of the individual energy carriers developed very differently in 2017. Renewable energy, natural gas, and mineral oil recorded, to some extent, significant growth when compared to the previous year: Renewable energy +6.1 %, natural gas +6.2 %, mineral oil +2.7 %. With -0.6 % and -0.8 % respectively, the consumption of lignite and other energy carriers remained almost stable. With -9.8 % and -11.3 % respectively, the use of nuclear energy and hard coal experienced a sharp decline.

With a share of almost 35 % in primary energy consumption, mineral oil continued to be the most important energy carrier; followed by natural gas which managed to increase its share to about 24 %. Renewable energy carriers ranked third with a current share of more than 13 % – ahead of lignite and hard coal with around 11 % each. The share of nuclear energy decreased to approximately 6 % in 2017.

When it comes to renewables, the changes continued to be very different in 2017 as well: While wind energy increased by around one third which was primarily due to the very favorable wind conditions, the use of geothermal energy increased by 7.7 % and the use of solar energy by 4.7 %. The use of hydropower in 2017 was lower than in the previous year. In contrast, the energetic utilization of (biogenic) waste remained unchanged.

Just like primary energy consumption, gross electricity consumption went up once again in 2017: With about 600 billion kWh, however, the 0.5 % increase was somewhat lower. This was 3.6 % below the highest level to date which amounted to approximately 622 billion kWh in 2007. The macroeconomic electricity productivity, which had increased by an annual average of 1.2 % between 1990 and 2016, improved considerably with a rate of 1.7 % in 2017.

With a 0.6 % increase to about 655 billion kWh in 2017, gross electricity production grew only slightly stronger than gross electricity consumption. In contrast, the structure of electricity production according to energy carriers exhibited a noticeable change: While electricity production based on hard coal (-17.5 %), nuclear energy (-9.8 %), and lignite (-1.4 %) declined, renewable energy carriers accounted for a strong

plus of 15 %. Natural gas was once again able to increase its share as well; this time with a plus of 6.4 %. With a total production volume of 218 billion kWh, which translates into a production share of one third, renewables significantly expanded their top position ahead of lignite (22.5 %), hard coal (14.1 %), natural gas (13.2 %), and nuclear energy (11.7 %).

While the growth rates for gross electricity production and gross electricity consumption remained broadly similar, the surpluses obtained from the exchange of electricity with foreign countries[1] increased to about 55 billion kWh (2016: 53.7 billion kWh). Particularly high export surpluses were recorded for the exchange with Switzerland (17.7 billion kWh), Austria (15.4 billion kWh), and the Netherlands (13.8 billion kWh); while Luxemburg lagged considerably behind with export surpluses between 4 billion kWh and 5 billion kWh. Surpluses in the flow of electric power from abroad traditionally come from France; whereby the import surplus from France once again decreased significantly from 5.6 billion kWh in 2016 to approximately 4 billion kWh in 2017. In contrast, the exchange with other countries was at a comparably low level.

At the moment, it is not yet possible to ascertain the overall development of greenhouse gas emissions in a comprehensive manner for the year 2017. However, a rough estimate of energy-related CO_2 emissions can be made on the basis of the changes in primary energy consumption for the respective emission-bearing and emission-free energy sources.

Since the structure of energy consumption and, above all, of electricity production has shifted further towards emission-free renewables and low-emission natural gas, energy-related CO_2 emissions are likely to have increased only marginally. Assuming that neither any process-related CO_2 emissions in light of the strong growth in industrial production 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. Here, significant differences occur between the energy sector and the other sectors. While emissions in the energy sector decreased already for the fourth year in a row, the final energy sectors – above all transportation – lagged far behind the objectives. If one were to assume, for the purpose of simplification, a primarily linear direction of the target path, then an annual reduction of about 40 million tons, which translates into 4.7 %, would have actually been necessary for 2017 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 2016 and 2020 into consideration. Instead of such reduction, 2017 rather brought another – albeit small – increase.

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

Total Primary Energy Consumption

In 2017, primary energy consumption in Germany amounted to a total of 13,550 PJ or 462.3 Mtce; compared to the previous year, this equaled an increase of 0.9 % which translates into 122 PJ/4.1 Mtce (please see Table 1).

Table 1

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Primary Energy Consumption in Germany in 2016 and 2017 [1)]

Energy Carrier	2016	2017	2016	2017	Changes in 2017 compared to 2016			Proportions in %	
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	Mtce	%	2016	2017
Mineral Oil	4,550	4,675	155.3	159.5	125	4.2	2.7	33.9	34.5
Natural Gas	3,042	3,231	103.8	110.2	189	6.4	6.2	22.7	23.8
Hard Coal	1,662	1,474	56.7	50.3	-188	-6.4	-11.3	12.4	10.9
Lignite	1,519	1,510	51.8	51.5	-9	-0.3	-0.6	11.3	11.1
Nuclear Energy	923	833	31.5	28.4	-91	-3.1	-9.8	6.9	6.1
Renewable Energy	1,678	1,780	57.2	60.7	102	3.5	6.1	12.5	13.1
Electricity Exchange Balance	-193	-198	-6.6	-6.7	-4	-0.2	-	-1.4	-1.5
Other	247	245	8.4	8.4	-2	-0.1	-0.8	1.8	1.8
Total	**13,428**	**13,550**	**458.1**	**462.3**	**122**	**4.1**	**0.9**	**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)

The increase was primarily due to the favorable economic trend (please see below) as well as the growth in population (+0.33 million people) – which was, though, significantly weaker compared to the two preceding years. The temperature influence, however, hardly played any role in this; as measured by the degree day figures, 2017 was on average slightly warmer than 2016 so that the demand for heating energy tended to be slightly lower. But the months of January and September ought to have had a certain temperature-related increasing influence on the demand for heating energy because in 2017, these months were significantly cooler than the previous year (please see Figure 1).

If one merely 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 have barely risen more than about one percent. Thus, the temperature effect had a different impact on the individual energy sources. But when it comes to the energy sources which have a comparably high proportion of heating energy (such as natural gas), the effects are very limited as well; some primary energy sources such as hard coal and lignite as well as nuclear energy exhibit virtually no differences.

When evaluating the development of consumption, it is essential to also consider the fact that 2017 exhibited one "energy consumption day" less than the leap year 2016. Adjusted to the weather conditions and the leap year effect, the overall increase in last year's energy consumption probably would have amounted to roughly an estimated one percent.

Figure 1

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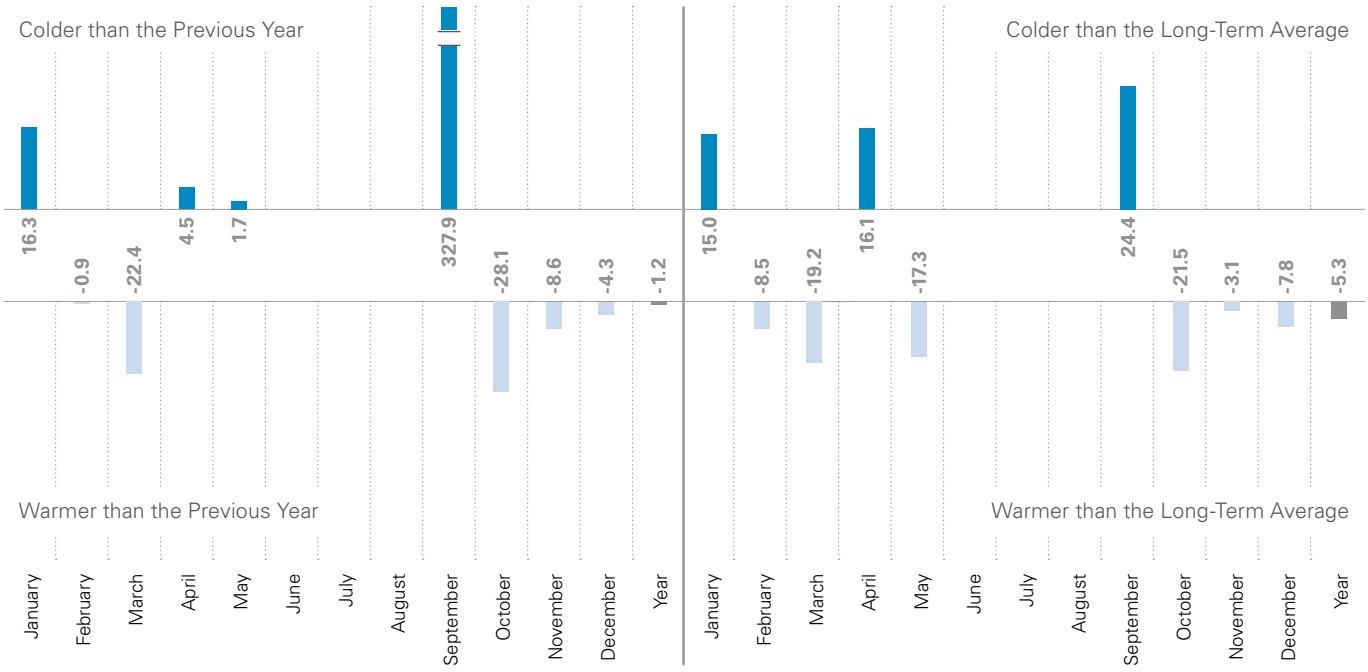
Monthly Degree Day Figures in Germany in 2017 (16 Measurement Stations)

Changes in 2017 Compared to the Previous Year and to the Long-Term Average (1980-2017) in %.
Due to their limited informative value, the months of July and August are not included.



Source: Germany's National Meteorological Service (DWD)

A major cause for the increase in consumption was the strong macroeconomic and sectoral trend, as is shown by Figure 2 on the basis of the annual rates of change in the production indices for 12 key economic branches of the manufacturing industry between 2015 and 2017:

- The price-adjusted gross domestic product, for example, increased by 2.2 % in 2017 when compared to the previous year; whereby the overall production in the manufacturing industry with a plus of 2.7 % and in the processing industry with no less than 3.0 % even exhibited significantly stronger growth. This also applies to the manufacture of data processing systems (+6.9 %), metal products (+4.7 %), electrical equipment (+4.2 %) as well as the production of rubber and plastic goods (+3.5 %). But machine and vehicle construction substantially increased their production volumes as well with a plus of 2.9 % each; and when it comes to metal manufacture and metal machining, the production volume increased by 2.3 % in 2017.
- Unlike these growth sectors, only very few branches recorded declines in production. In the energy sector, these branches included, above all, the production of petroleum and natural gas (-5.9 %), the provision of services to the mining industry and quarrying (-5.7 %) plus coal mining (-2.9 %) as well as a number of sectors in the food, beverage, and tobacco industry and the manufacture of clothing. The manufacturing industry recorded significant production losses in ship and boat building (-8.2 %), rail vehicle construction (-4.7 %) as well as the manufacture of jewelry et al. (-2.9 %) and of musical instruments (-2.2 %).

All told, positive production trends became more apparent in those economic branches which consume high amounts of energy while negative trends primarily affected those economic branches which are less significant for the macroeconomy and energy industry.

Figure 2

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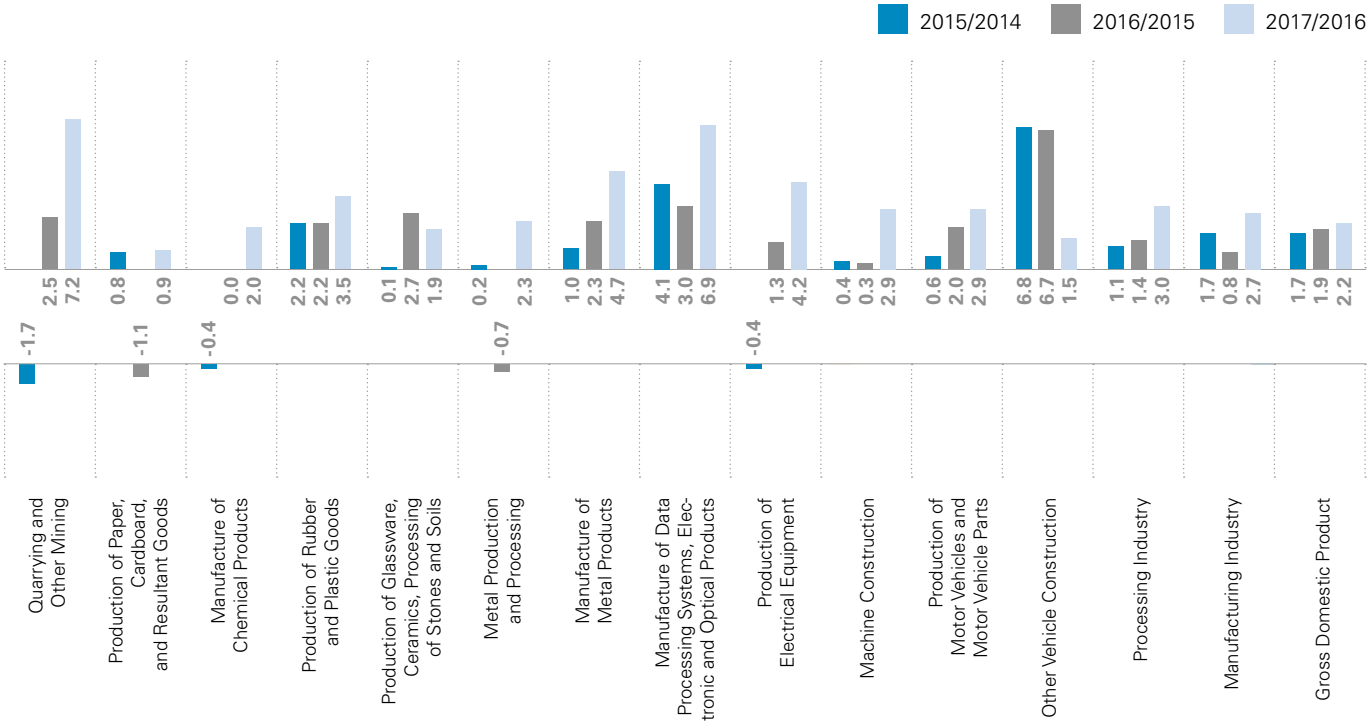
Production Index in Germany's Manufacturing Industry between 2015 and 2017

Changes Compared to the Previous Year in %



Source: Federal Statistical Office (Destatis)

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 into the requisite consumption calculation. This is not the case for private households as well as the trade, commerce, and service sector. This 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.

The Federal Government's energy policy decisions on the continued support of renewable energy and the exit from nuclear power are reflected in the changing structure of primary energy consumption also in 2017. In 2017 as well, the most important energy carrier continued to be mineral oil with a share of 34.5 %, followed by natural gas with a share that increased to 23.8 % (2016: 22.7 %). In contrast, a significant decrease was recorded for hard coal (from 12.4 % to 10.9 %). Thus, hard coal only ranked fifth among all energy carriers in 2017 even behind lignite whose share decreased just slightly from 11.3 % to 11.1 %. Nuclear energy participated in primary energy consumption in 2017 with a mere proportion of 6.1 % – compared to 6.9 % in the previous year. In contrast, renewables were once again able to significantly increase their share; namely, from 12.5 % to 13.1 %. This consolidated their third position in the ranking of energy carriers. Just as in the previous year, the other energy carriers contributed less than 2 % towards meeting the energy demand.

The large surplus obtained from the physical flows of electric power to foreign countries caused primary energy consumption to decrease (by 1.4 percentage points and 1.5 percentage points respectively) in both years. All told, and especially under climate protection aspects, it can be ascertained that despite all changes in the energy carrier structure, the proportion of fossil fuels continues to amount to about 80 %.

While the macroeconomic performance increased by 2.2 %, the primary energy productivity of the German economy, as measured by the original values (but also by the temperature-adjusted values), improved by 1.3 % and 1.2 % respectively; however, this was once again below the long-term trend of 1.9 % (1990 to 2016). Irrespective of this, though, it can be affirmed that the decoupling of the macroeconomic trend and energy consumption continued to develop in 2017; albeit less so (please see Table 2 and Figure 3).

Table 2

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Macroeconomic Energy Productivity in Germany between 1990 and 2017

	Unit	1990 [1]	2000	2005	2010	2015	2016 [2]	2017 [2]	Average Annual Change in %			
									2016 to 2017	1990 to 2000	2000 to 2017	1990 to 2017
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	2,800.9	2,855.4	2,919.1	2.2	1.9	1.3	1.5
Population [3]	1,000	79.5	81.5	81.3	80.3	81.7	82.3	82.7	0.4	0.2	0.1	0.1
Primary Energy Consumption (unadjusted)	Petajoules	14,905	14,401	14,558	14,217	13,262	13,428	13,550	0.9	-0.3	-0.4	-0.4
Primary Energy Consumption (temperature-adjusted)	Petajoules	15,043	14,666	14,509	13,827	13,406	13,540	13,674	1.0	-0.3	-0.4	-0.4
Gross Electricity Consumption	Billion kWh	550.7	579.6	614.7	615.8	596.3	596.9	599.8	0.5	0.5	0.2	0.3
Energy Productivity (temperature-adjusted)	Euros/GJ	131.4	163.8	166.7	181.5	211.2	212.6	215.4	1.3	2.2	1.6	1.8
Energy Productivity (temperature and inventory adjusted)	Euros/GJ	130.2	160.8	167.2	186.6	208.9	210.9	213.5	1.2	2.1	1.7	1.8
Electricity Productivity	Euros/kWh	3.56	4.07	3.95	4.19	4.70	4.78	4.87	1.7	1.4	1.1	1.2

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)

Some Remarks on the Methodology and Application of Assessing the Significance of Nuclear Energy and Renewables as Primary Energies

When assessing the development of primary energy consumption and energy productivity, it is essential to not only consider the temperature influence (and the leap year effect), but also a statistical effect which results from the fact that international conventions require the application of the so-called efficiency method ("physical energy content" method) for balancing the energy sources without considering the requisite calorific value[2]. 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. When it comes to solid, liquid, or gaseous biogenic renewables, the requisite input materials are directly assessed on the basis of their calorific value; however, this does not apply to the renewable energies water, wind, and photovoltaics as well as to the electricity trade balance with foreign countries because here the respective energy input is equated with the calorific value of the generated electrical energy which equals a degree of efficiency of 100 %.

Compared to the previously used so-called substitution method, which assessed nuclear energy and the aforementioned renewable energy carriers used for power generation as well as the electricity trade balance with foreign countries on the basis of the average specific fuel consumption in conventional thermal power stations, the transition to the efficiency method results in higher primary energy consumption for nuclear energy whereas the calculated primary energy consumption is lower for the aforementioned renewables and for the exchange of electricity. 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. For example, if the entire electricity produced in nuclear power plants in 2017, which amounted to 76.3 billion kWh, would have been replaced completely in this manner, then this would have resulted in "savings" of 67 % with regard to the efficiency difference. This would have reduced the anticipated primary energy consumption for 2017 by 558 PJ, which translates into approximately 4 %.

Conversely, of course, it is also true that, when applying the substitution method for the complete replacement of nuclear energy by renewables, this will result in considerably higher total primary energy consumption. Assuming an average degree of utilization of 45 % for conventional thermal power stations, primary energy consumption would have increased from 13,550 PJ to 14,062 PJ in 2017; hence, by 512 PJ which translates into 3.8 %.

Applied to the depicted changes in primary energy consumption between 2016 and 2017 and considering the decline in electricity production based on nuclear power (-8.3 billion kWh), on the one hand, as well as the significantly increased electricity production based on the renewables under consideration here (+28.0 billion kWh) and the moderately higher electricity trade balance (+1.3 billion kWh), on the other hand, and given an average degree of utilization of 45 % for both energy carriers, the substitution method would result in an increase in primary energy consumption of 128 PJ for 2016 and of 270 PJ for 2017. When comparing the years 2017 and 2016, this equals an increase of 2.2 % (instead of 0.9 %) in the total primary energy consumption. With regard to energy productivity, this would result in an increase of only 0.3 % (instead of 1.3 %). Thus, the statistical effect exerts a substantial impact on the assessment of **primary** energy productivity. It should be stressed at this point that the discussion on **final** energy productivity is not affected by the methodological problems outlined here because the statistical effect outlined here does not occur.

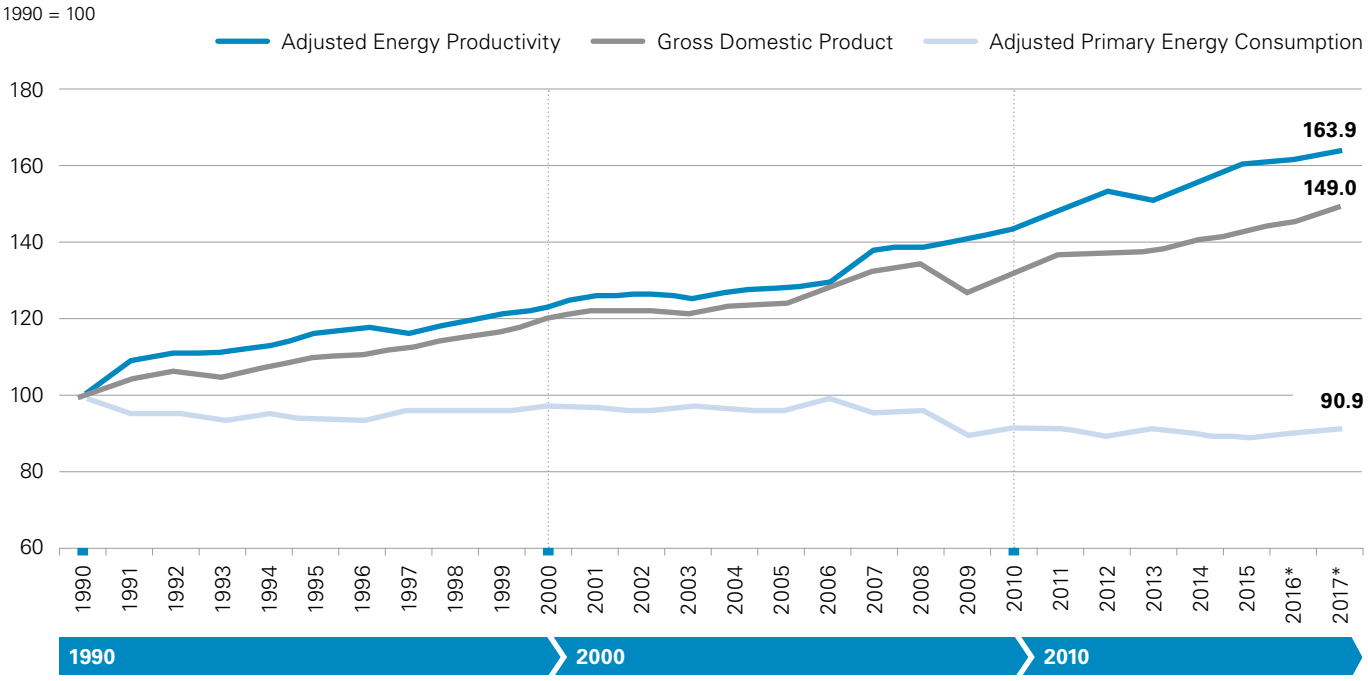
By taking the years 2016 and 2017 as an example, the impact of the two assessment methods on the shares of nuclear energy and/or renewables in the total primary energy consumption is as follows (figures in %):

	Nuclear Energy		Renewables	
	2016	2017	2016	2017
Efficiency Method	6.9	6.1	12.5	13.1
Substitution Method	6.8	6.0	16.9	18.2

2 *For methodological questions on balancing the primary energy consumption of the different energy carriers, please see Arbeitsgemeinschaft Energiebilanzen. Energie in Zahlen, Arbeit und Leistungen der AG Energiebilanzen, Berlin 2012; in particular, p. 12 and pp. 24/25 as well as OECD/IEA and Eurostat: Energy Statistics Manual, p. 135 et seq.*

Figure 3

Gross Domestic Product, Primary Energy Consumption, and Energy Productivity in Germany between 1990 and 2017



**) preliminary*

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

With component decomposition, it is possible to identify the key factors which influence the changes in the (adjusted) primary energy consumption (please see Figure 4). A comparison of the long-term changes between 1990 and 2017 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 (-7,287 PJ). This way, it was possible to significantly overcompensate the consumption-enhancing effect of the macroeconomic growth (+5,332 PJ) and the increase in population (+585 PJ). However, this does not apply to a short-term consideration of the changes between 2016 and 2017: Here, the economic growth (+246 PJ) and the increase in population (+54 PJ) also had a consumption-enhancing effect. Yet it was not possible to counterbalance both effects with improvements in efficiency (-167 PJ) so that this ultimately resulted in an absolute increase in the (adjusted) primary energy consumption by 133 PJ. It must, however, be noted in the assessment of these results, that the changes in energy consumption may of course be essentially characterized by structural changes between individual energy consumption sectors that have a different energy intensity. Such structural effects are not included in the breakdown of the components which is assumed here for simplification purposes.

Figure 4

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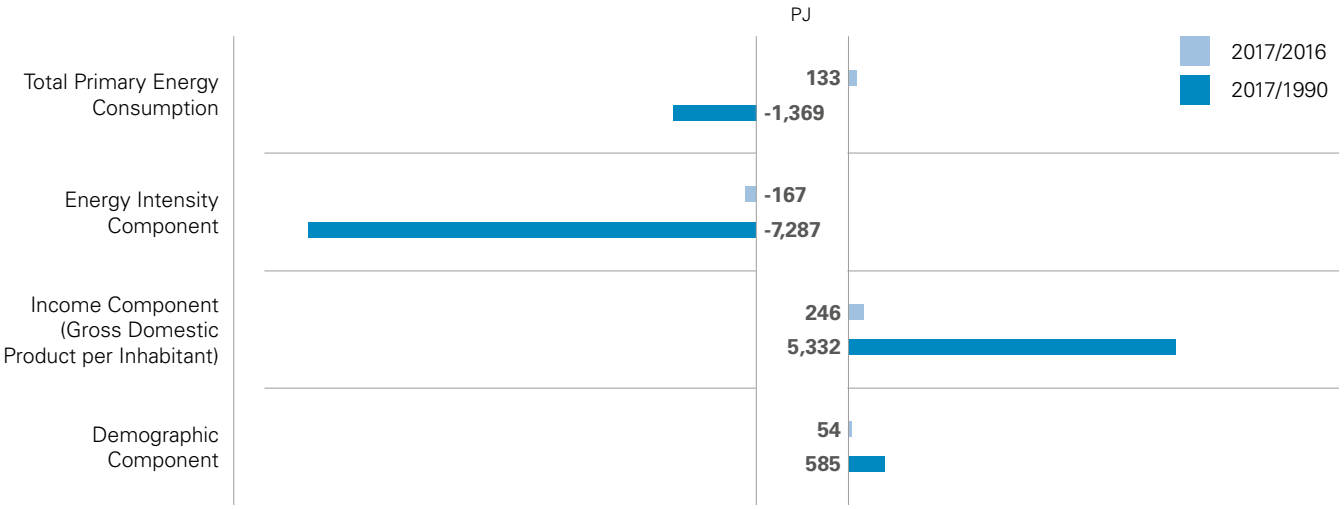
Contributions of Diverse Influencing Factors to the Changes in the Adjusted Primary Energy Consumption in Germany

Changes in 2017 Compared to 2016 and 1990 in Petajoules



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

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 the different coals, mineral oil, and natural gas), Germany is a considerable net importer. In 2017 as well, this did not change fundamentally. Significant changes, however, were recorded in the import prices of fossil fuels. On an annual average, for example, the import prices for crude oil in 2017 were about a quarter higher than in 2016, and the import prices for natural gas went up by almost 11 %. Compared to 2016, the price increases for hard coals were even considerably higher: Power plant coal +43.6 %, coking coal +91.8 %, and hard coal coke +59.4 %. As a result, the price increases caused the import calculation for coal, oil, and gas to increase substantially from 48.6 billion euros in 2016 by about 11 billion euros, which equals an increase of almost a quarter, to 59.7 billion euros in 2017. At the same time, oil imports went up by almost 24 %, natural gas imports by a substantial 15 %, and coal imports actually by about 48 %. Conversely, the export surplus for electrical energy increased slightly by 1.8 billion euros (2016: 1.7 billion euros) in 2017, and a slight increase was also recorded for the (physical) export of electric power.

Table 3

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Balance of Foreign Trade with Energy Carriers in Germany between 2010 and 2017

	2010	2012	2015	2016	2017	Changes in 2017 Compared to 2016	
	Foreign Trade Balance (Imports ./. Exports) in Billion Euros						%
Coal, Coke, and Briquettes	4.4	5.1	4.0	3.5	5.2	1.7	48.3
Petroleum, Petroleum Products, and Related Goods	49.4	68.0	38.0	29.0	36.0	6.9	23.9
Gas [1]	20.7	27.1	20.5	16.1	18.6	2.5	15.5
Total Fossil Fuels	**74.6**	**100.2**	**62.5**	**48.6**	**59.7**	**11.1**	**22.9**
Electric Power	-1.0	-1.4	-2.1	-1.7	-1.8	-0.1	3.8
Total	**73.5**	**98.8**	**60.4**	**46.9**	**57.9**	**11.1**	**23.6**

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])

Primary Energy Production in Germany

In 2017, domestic energy production increased slightly by 1.6 % to 4,037 PJ or almost 138 Mtce even though all other energy carriers experienced a more or less significant decline. That under these circumstances this upswing actually occurred at all is solely due to the tremendous growth of renewables which increased by a substantial 6 % (please see Table 4). The strongest decline was recorded for natural gas with a minus of 8.4 %, for hard coal with -7.0 %, and for domestic oil production with -5.9 %. In contrast, lignite mining decreased only slightly (-0.2 %).

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 almost 45 %, followed by lignite with around 38 %. Both rank far ahead of natural gas, petroleum, and hard coals.

When taking into account the primary energy consumption in 2017, the proportion of indigenous energy changed only slightly; namely, from 29.6 % in 2016 to now 29.8 %.

Table 4

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Primary Energy Production in Germany in 2016 and 2017

	Production				Changes in 2017 Compared to 2016		Proportions	
	2016	2017	2016	2017			2016	2017
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	%	%	
Mineral Oil	117	110	4.0	3.8	-7	-5.9	2.9	2.7
Natural Gas, Petroleum Gas	251	230	8.6	7.9	-21	-8.4	6.3	5.7
Hard Coal	114	106	3.9	3.6	-8	-7.0	2.9	2.6
Lignite	1,545	1,542	52.7	52.6	-3	-0.2	38.8	38.2
Renewable Energy	1,701	1,805	58.1	61.6	103	6.1	42.8	44.7
Other Energy Carriers	247	245	8.4	8.4	-3	-1.0	6.2	6.1
Total	**3,976**	**4,037**	**135.7**	**137.8**	**62**	**1.6**	**100.0**	**100.0**
For information purposes: Proportion of Primary Energy Consumption	-	-	-	-	-	-	29.6	29.8

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

Sources: German Association of Energy and Water Industries (BDEW); The German Coal Industry's Statistical Office; German Hard Coal Association (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 2017 was about 3 % higher with 4,675 PJ (159.5 Mtce). At the same time, consumption of the quantitatively most important mineral oil products developed differently from one another (please see Table 5).

Thus, the consumption of diesel, gasoline as well as light fuel oil increased by around 2 % each. The favorable economic climate in the chemical industry resulted in a particularly strong increase in the use of naphtha with a plus of 7.4 %.

Table 5

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Consumption and Volume of Mineral Oil in Germany in 2016 and 2017

		2016 [1]	2017 [1]	Change
		in Million Tons	in Million Tons	in %
Total Consumption		**106.2**	**109.4**	**3.0**
Self-Consumption and Losses [2]		6.0	6.0	0.0
Domestic Consumption		100.2	103.4	3.1
Proportion of:	Gasoline	18.2	18.6	2.1
	Diesel Fuel	37.9	38.7	2.0
	Aviation Fuels	9.2	9.2	0.7
	Fuel Oil, Light	15.8	16.1	2.1
	Fuel Oil, Heavy [3]	2.9	2.7	-6.5
	Naphtha	15.8	17.0	7.4
	Liquid Gas	3.1	4.1	31.1
	Lubricants	1.0	1.0	-0.7
	Other Products	5.9	6.2	5.9
	Recycling (to be deducted)	-6.3	-6.9	10.1
	Biofuels [4] (to be deducted)	-3.3	-3.4	0.6
Total Volume		**106.2**	**109.4**	**3.0**
Refinery Production		105.1	104.6	-0.5
Generated from:	Input of Crude Oil	94.2	92.5	-1.8
	Input of Products	10.9	12.1	11.2
Foreign Trade Products (Balance)		15.9	19.6	23.3
	Imports	38.8	43.1	11.2
	Exports	22.8	23.6	3.4
Compensation [Balance (Bunker, Differences)]		-14.8	-14.7	-
Refining Capacity		102.1	102.1	-
Utilization of Refining Capacity in %		92.3	90.6	-
Primary Energy Consumption of Mineral Oil (Mtce)		155.3	159.5	2.7

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)

With less than one percent, the consumption of aviation fuels increased in comparison only slightly. The most significant oil product continued to be diesel fuel which climbed to a new record high of 38.7 million tons, followed by gasoline with 18.6 million tons, naphtha with 17 million tons, and light fuel oil with 16.1 million tons. All told, the demand for fuels, which accounted for a share of approximately 60 % in Germany's total oil consumption, went up by 1.8 %.

Unlike the total oil consumption, refinery production decreased slightly (-0.5 %); at the same time, crude oil with its dominating share went down by 1.8 % while the volume of product usage continued to increase by a substantial 11 %. With 90.6 % in 2017, the refining capacity of 102.1 million tons, which remained unchanged when compared to 2016, was utilized to a slightly lower degree than in the previous year (92.3 %).

In 2017, the foreign trade in mineral oil products changed once again in favor of imports. On balance, the imports were predominant; with about 43 million tons, they topped the exports of around 24 million tons by almost 20 million tons in 2017; this was almost a quarter more than in the previous year (15.9 million tons).

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 0.5 % with 90.7 million tons in 2017. In 2017, the three most important countries supplying crude oil to German refineries continued to be Russia (with a share of 36.9 %), Norway (11.4 %), and the United Kingdom (9.4 %); these countries contributed almost 58 % (2016: Around 62 %) to German crude oil imports in 2017 (please see Table 6). Important supplier countries continued to be Kazakhstan, Libya, Nigeria, Iraq as well as Azerbaijan, Algeria, and Egypt.

Divided into individual oil producing areas, the countries of the former Soviet Union (CIS states) were considerably ahead of all supplier countries; however, their share of German crude oil imports, which had amounted to 54.5 % in 2016, decreased significantly to 48.6 % in 2017. In contrast, the OPEC states recorded a substantial increase in their import shares from 15.8 % in 2016 to 23.7 % in 2017. Import shares from the North Sea zone, though, changed only slightly. While imports from Libya, Nigeria, and Iraq increased significantly, supplies from other major oil exporting countries dropped noticeably (please see Table 6).

In 2016/2017 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 5). 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-$/bbl; 1 barrel = 159 liters) in 2012 (the monthly peak had been about 133 US-$/bbl in July 2008), 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. Until mid-2017, prices continued to decrease to 46.37 US-$/bbl in June, followed by a new increase to slightly more than 64 US-$/bbl in December 2017.

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 fell noticeably below last year's low level. Starting in May 2017, the exchange rate remained once again at a comparably high level; ultimately reaching 1.1836 US dollars in December 2017. Hence, German crude oil import prices actually increased slower than the global market prices for crude oil between December 2016 and December 2017.

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 to almost € 356 /t in December 2016, an annual average of about € 286 /t had to be paid. In 2017, the import prices dropped initially to about € 315 /t in June; however, during the second half

Table 6

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Germany's Crude Oil Imports in 2016 and 2017 According to Countries of Origin

Important Supplier Countries/ Production Regions	2016	2017 [1]	2016	2017 [1]	Changes 2017/2016
	in Million Tons		Proportions in %		in %
Russia	36.0	33.5	39.5	36.9	-7.0
Norway	11.2	10.3	12.3	11.4	-7.9
United Kingdom	9.2	8.6	10.1	9.4	-7.1
Kazakhstan	8.4	8.1	9.2	8.9	-3.1
Libya	1.8	6.9	1.9	7.6	288.7
Nigeria	3.8	4.9	4.2	5.4	29.0
Iraq	3.1	4.7	3.4	5.2	48.6
Azerbaijan	5.1	2.5	5.6	2.7	-52.2
Algeria	3.3	2.0	3.6	2.2	-40.0
Egypt	1.7	1.7	1.9	1.9	-0.2
Other Countries	7.5	7.6	8.3	8.4	0.7
Total	91.2	90.7	100.0	100.0	-0.5
OPEC	14.4	21.5	15.8	23.7	49.4
North Sea [2] (excld. FRG)	21.7	20.5	23.8	22.6	-5.7
Former CIS	49.6	44.1	54.5	48.6	-11.3
Other	5.4	4.7	5.9	5.2	-13.5
Total	**91.2**	**90.7**	**100.0**	**100.0**	**-0.5**

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 2017

of the year, the price trend reversed and increased to almost € 414 /t in December. All told and on an annual average, the crude oil import prices in 2017 were a quarter higher than in 2016. While the import volumes for crude oil remained virtually unchanged, the expenditures for crude oil imports increased from 26.1 billion euros to 32.5 billion euros.

Prices for oil products in Germany followed primarily the changes in crude oil costs and in international product quotations; albeit at different rates (please see Figure 6). 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 %. However, an increasing trend became once again apparent over the course of the year 2016 so that the prices were noticeably higher in December than in the comparable month of the previous year. An upward trend also occurred in 2017; however, it stayed within a narrow margin. In December 2017, for example, the prices for premium gasoline were not even one percent higher than in December 2016; for diesel fuel, it was a plus of 2.2 % and for light fuel oil a plus of 4 %.

As measured by the producer price index, the prices for mineral oil products in Germany were on an annual average and in total almost 9 % higher in 2017 than in 2016 (but still somewhat lower than in 2015). The increases for light fuel oil between 2016 and 2017 amounted to approximately 16 %, for diesel fuel almost 8 %, and for gasoline 5.5 %. However, for all three products, it can be said that the prices in 2017 were still below those of 2015.

Figure 5

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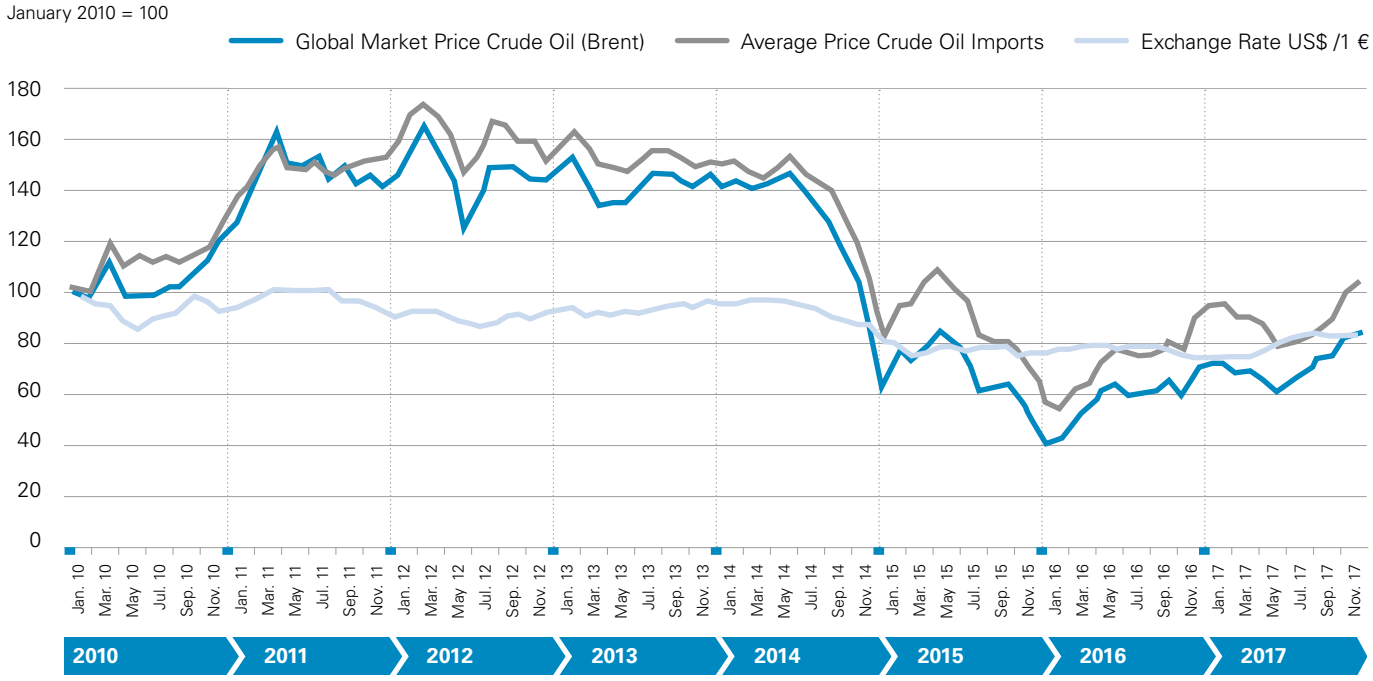
Global Market Prices for Crude Oil (Brent) [1], Border-Crossing Prices for German Crude Oil Imports [2], and Exchange Rates between January 2010 and December 2017



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 6

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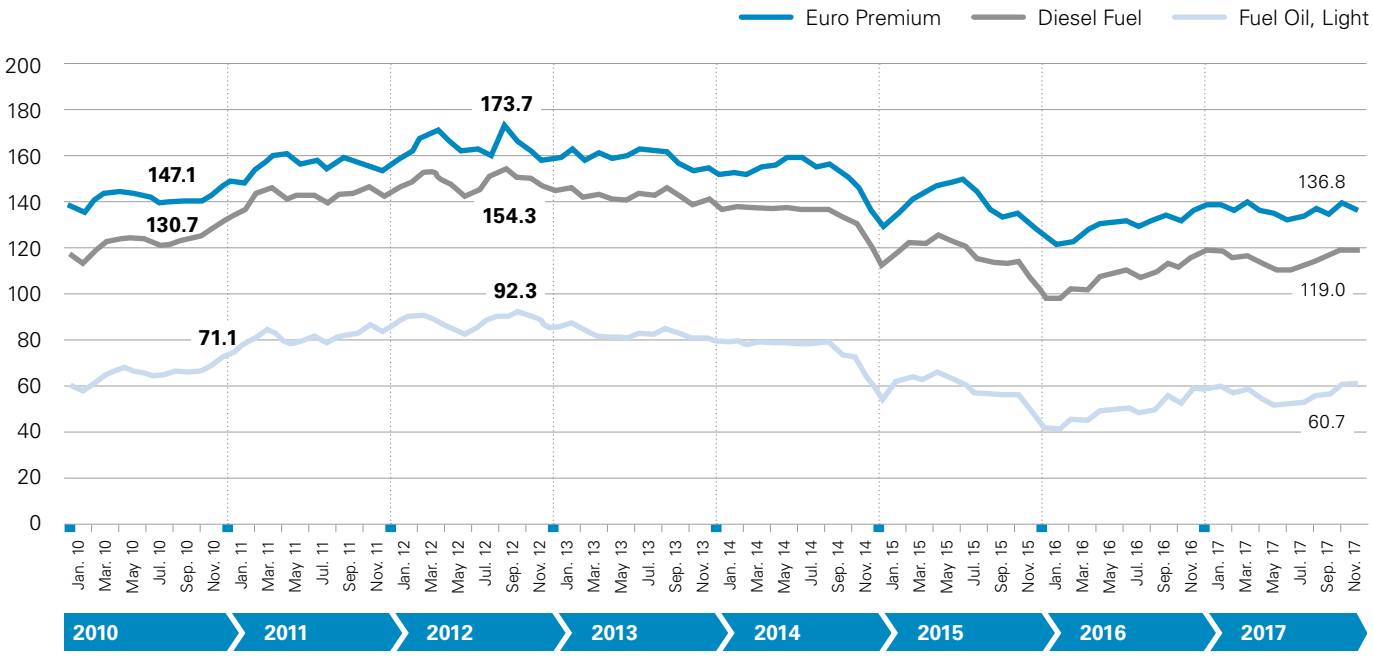
Prices for Fuels and Light Fuel Oil in Germany between 2010 and 2017



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

Natural Gas

In 2017, natural gas consumption in Germany increased by an estimated rate of more than 6 % to 3,231 PJ (this equals 995 billion kWh). This growth was influenced by diverse factors: The primary reason was the additional use of natural gas in the power plants of utility companies for the generation of electric power and heat. The price spread of natural gas compared to other energy carriers, which improved in favor of natural gas, as well as the high degree of efficiency of natural gas used for the combined production of heat and electricity caused the utilization of natural gas in the electric power and thermal energy industries to increase for the second year in a row. The proportion of electricity generated from natural gas with regard to gross electricity production in Germany increased by almost one percentage point to 13.2 %. This equals an increase of 6.4 % compared to the previous year's value. Larger volumes of natural gas were also used for the generation of heat in heating and thermal power stations in 2017. Industry as well used more natural gas in its own power plants for the combined generation of electricity and heat.

In addition, comparably cooler temperatures during individual months of the year 2017 also resulted in a higher demand for heating energy. The average temperature in 2017 amounted to 9.6 °C, which exceeded the previous year's value (9.5 °C); however, above all the temperatures in the months of April and September, which are on the brink of the heating period, fell significantly below their previous year's values. In turn, the last heating-intensive quarter was continuously warmer than the same quarter of the previous year and the long-term average.

Another aspect which caused natural gas consumption to rise and which 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 302,700 new homes were granted in 2017. 39.7 % of them will get their heat from a gas-powered heating system; 24.8 % of them will be connected to the district heating grid. Every year, existing dwellings which are converted from other heating systems into natural gas powered and district heating systems must be added to this figure.

When it comes to the use of natural gas in the individual consumption sectors, the following trends have been identified for 2017 so far (please see Table 7):

- After a sharp decline in 2014, the space heating market recorded an increase in sales for the third year in a row now. The natural gas consumed by private households as well as by commercial and service enterprises increased by an estimated 5.2 %. The number of natural gas heating systems continued to increase. By the end of 2017, a total of about 20.6 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 by 4.2 %.

- The use of natural gas in power plants and heating stations supplying the general public had increased significantly since the second half of 2016. This was not only due to the price spreads to other energy carriers, which improved in favor of natural gas, but also due to the fact that the preservation of existing plants, which had been introduced by virtue of the Act on the Preservation, Modernization, and Expansion of Combined Heat and Power Plants (KWKG) in 2016, made it possible for combined heat and power plants based on natural gas to once again achieve more hours of full utilization. When it comes to the use of natural gas in the power plants of the electricity and heat suppliers, though, downturns have once again been visible since the 2nd half of 2017. The above mentioned cooler temperatures on the brink of the heating period and the rising number 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 more than 8 %. The use of natural gas in smaller, decentralized plants (CHP) and industrial plants also continued to grow.

Table 7

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Volume and Use of Natural Gas in Germany in 2016 and 2017

	Unit	2016 [1]	2017 [1]	Change in %
Domestic Production	Billion kWh	77.4	70.9	-8.4
Imports	Billion kWh	1,107.1	1,294.7	16.9
Total Volume of Natural Gas	Billion kWh	1,184.5	1,365.6	15.3
Storage Balance [2]	Billion kWh	1.6	4.4	-
Exports	Billion kWh	249.8	375.4	50.3
Primary Energy Consumption of Natural Gas	Billion kWh	936.3	994.6	6.2
	Petajoules (H_u)	3,042	3,231	-
	Mtce (H_u)	103.8	110.2	-
Structure of Natural Gas Volume According to Countries of Origin				
Domestic Production	%	6.5	5.2	
Import Ratio [3]	%	93.5	94.8	
Structure of Natural Gas Consumption According to Consumer Groups				
Private Households and Small Trade	Billion kWh	415	437	5.2
Industry (Including Industrial Power Plants)	Billion kWh	370	385	4.2
Power Plants, Thermal Power and Heating Stations Supplying the General Public	Billion kWh	142	153	8.1
Self-Consumption and Statistical Differences	Billion kWh	10	20	-
Primary Energy Consumption	Billion kWh	936.3	994.6	6.2
	PJ	3,042	3,231	

1) Preliminary data; some figures are estimates
2) Minus = storage
3) For reasons of data protection in 2016, the values are only cumulative; in 2015, Russia had a share of 35 %
Discrepancies in the totals are due to rounding off

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

Compared to 2016, the proportion of natural gas in the total primary energy consumption increased by one percentage point to 23.8 % in 2017.

While sales of natural gas in 2017 exceeded the previous year's level by 6.2 %, Germany's natural gas volume (domestic production plus imports) increased by 15.3 % to 1,366 billion kWh when compared to the previous year. More than 5 % of the natural gas volume in Germany came from domestic production, almost 95 % were imported. Domestic production decreased by 8.4 % to 71 billion kWh. Germany's natural gas imports increased by nearly 17 %. Germany's natural gas exports also increased significantly by 45.5 %. These volumes also include substantial transit volumes. Imports and exports of natural gas can hardly be distinguished by their countries of origin and destination anymore. All told, about 7 % of Germany's natural gas consumption was procured from domestic sources of natural gas.

On balance, almost 4.4 billion kWh of natural gas were taken from storage facilities in 2017; in the previous year, 1.6 billion kWh were withdrawn on balance.

According to initial figures, 9.3 billion kWh of biogas upgraded to natural gas quality were fed into the German natural gas grid during the year under review.

In 2016, the feeding volume had amounted to 9.2 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 0.6 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 2016, there were 1,238 enterprises; at the end of 2017, there were 1,247. A closer look reveals that seven of these enterprises were active as natural gas producers, 25 as natural gas storage operators, 68 as mere wholesalers, 16 as long-distance gas grid operators, 718 as gas distribution grid operators, and 964 as distribution companies in the end customer business.[3] With 36,500 persons employed at the end of 2017, the number of employees in the gas industry remained more or less stable.

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 7. The price trend for oil no longer plays any role in the development of procurement costs for gas today.

After having reached their highest level to date at the end of 2008, the import prices for natural gas first dropped considerably until August 2009, with an all-time low in July 2009, and then increased once again almost continuously until the end of 2012. 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.

Figure 7

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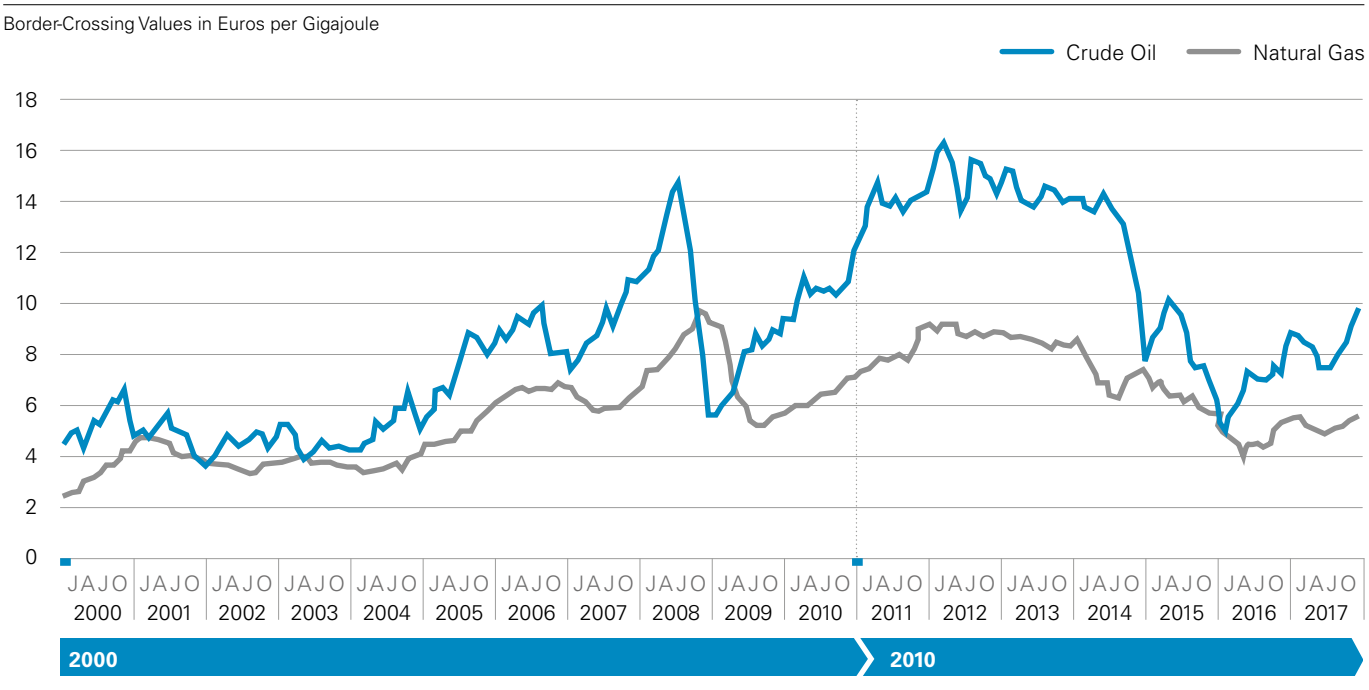
Monthly Border-Crossing Values for Crude Oil and Natural Gas between 2000 and 2017



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

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.*

Over the course of the year 2017, the import prices remained almost at the same level as during the 4th quarter of 2016; however, on an annual average for 2017, they exceeded the level of 2016 by almost 11 %.

The development of import prices has different effects on domestic sales prices (please see Figure 8). 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 increased by more than 21 % at the energy exchange while the sales prices to power plants went up by 4 %. For large industrial clients (annual supply: More than 500 GWh), the prices increased by 10 % compared to the previous year because natural gas had to be procured at shorter notice; for small industrial gas consumers (supply: 11.63 GWh/a), the purchase price for natural gas remained virtually unchanged. Due to early procurement, the gas prices for the trade, commerce, and service sector went down by 3.7 % and those for private households by 3.2 %.

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 course 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 8

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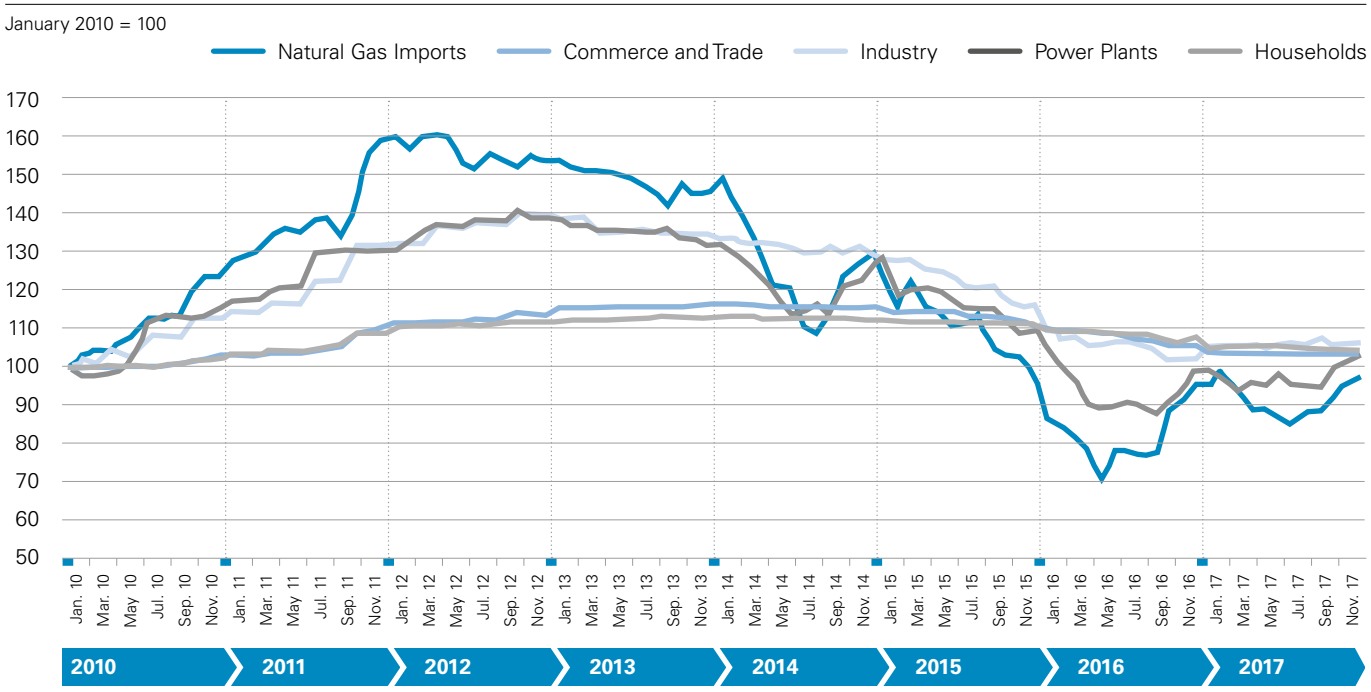
Prices for Natural Gas Imports and Natural Gas Sales in Germany between 2010 and 2017



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 initial and, thus, still preliminary estimates and compared to the previous year, Germany's hard coal consumption decreased significantly by more than 11 % to 50.3 Mtce (1,474 PJ) in 2017. This accounted for the lowest annual consumption of hard coal in post-war Germany so far. Thus, the downward trend on the German hard coal market, which had persisted since 2013, still continued. This was essentially due to economic, seasonal, and structural developments as well as due to the impact of the energy turnaround. Last year, though, the development outlined above accelerated even further because the considerably higher availability of renewable energy carriers as well as natural gas increasingly displaced hard coal from the medium load in electricity production.

Quantitatively, the once more declining heating market (foundries, district heating plants, small businesses, and private households) is of minor significance. The hard coal used in the steel industry in the form of coking coal and coke, however, accounted for a slight increase with an estimated +1 % last year. But this increase is also based on quite uncertain assumptions because the steel industry had not yet published any reliable figures for last year's crude steel and crude iron production before the editorial deadline of this report. In contrast, the generation of electricity in hard coal fired power plants declined by 17 % when compared to the previous year. With 89 TWh, the power plants supplying the general public, thus, produced about 18 % less electricity which was based on hard coal. The volume of heat and electricity provided by the power industry's hard coal fired combined heat and power plants decreased significantly as well. These developments were caused by displacement effects which were due to the fact that more electricity was fed into the grid from renewable energy sources and more electricity was produced in natural gas fired combined heat and power plants throughout the year. Another reason was the shutdown of several hard coal fired units which had a total net nominal capacity of 2.5 GW. This also included the four remaining units of the hard coal fired power plant Voerde in March 2017, Germany's largest facility of its kind so far.

The so-called clean dark spreads relate the power plant coal price, the electricity price, and the price for EU emissions certificates (EU allowances) to one another and, thus, permit statements on the gross margin of a coal fired power plant. For example, power plant coals benefited for a long time from the comparably low coal prices and low CO_2 certificate prices (EEX, secondary market) which increased, however, once again by 9 % to an average of € 5.83 /t CO_2 in 2017. During the last third of 2017, the CO_2 prices finally surpassed the threshold of € 7 /t CO_2, and by mid-January 2018, they climbed to more than € 8 /t CO_2. The fuel costs increased significantly as well. Compared to the previous year, for example, the average prices for power plant coals free at Northwest European ports increased by more than 40 % by the end of 2017. Last year's BAFA price (BAFA = Federal Office of Economics and Export Control) for power plant coal imports from non-EU countries free to the German border is not yet available in its final form. During the third quarter of 2017, the BAFA price amounted to € 88.07 /tce which was almost 2 % higher when compared to the previous quarter. Against this backdrop, the gross margins achieved by the hard coal fired power plants were quite inadequate for the operators, which ultimately contributed to the decommissioning decisions.

When it comes to the volume side, domestic hard coal mining was at a slightly lower level than in the previous year. No other pits were decommissioned after the shutdown of the Auguste Victoria mine in Marl (AV) as per January 1, 2016. The two finally remaining mines Prosper Haniel in Bottrop and Ibbenbüren in the Tecklenburg region continue their operations according to plan until the end of 2018. This is scheduled by the adjustment and phase-out process which is to be implemented in German 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 (please see Table 8).

Table 8

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Volume and Use of Hard Coal in Germany in 2016 and 2017

	2016 [1]		2017 [1]		Change
	PJ	Mtce	PJ	Mtce	in %
Primary Energy Consumption	1,662	56.7	1,474	50.3	-11.3
Power Plants and Thermal Power Stations	1,093	37.3	906	30.9	-17.2
Steel Industry	531	18.1	533	18.2	0.6
Heating Market	38	1.3	35	1.2	-7.7
Import of Hard Coal and Coke [2]	1,571	53.6	1,422	48.4	-9.5
Hard Coal Production	114	3.9	106	3.6	-7.7

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

Source: German Hard Coal Association (GVSt), The German Coal Industry's Statistical Office, German Coal Importers Association

According to initial estimates based on preliminary data derived from foreign trade statistics for the first eleven months and compared to the previous year, Germany's hard coal imports decreased by 9.5 % to approximately 48.5 Mtce in 2017. Russia was able to expand its already dominating position even further. The Russian share in total hard coal imports increased to 35 %, after 30 % in the previous year. The United States benefited from the once again somewhat elevated coal price level in Northwest Europe and were able to increase their hard coal exports to Germany slightly. This stabilized their position as the second most important supplier country. German hard coal imports from other major countries of origin, though, declined significantly; above all, imports from Columbia (-41 %), South Africa (-13 %), and Australia (-10 %) (please see Table 9). In the combined market segments power plant coals, anthracite coals, and briquettes, Russia attained a market share of 47 %, followed by the United States with 17 %, and Columbia with 16 %. When it comes to the utilization of coking coals, which are primarily used in steel production, Australia was the most relevant provider with a share of 47 %. Here, the United States reached second place with about 26 % while Russia and Canada shared third place with 12 % each. In contrast, 83 % of the German hard coal coke imports came from EU countries; above all, from Poland which just alone accounted for a share of about 63 %.

Unlike in Germany, and after a decline to 6.7 billion tons in 2016, global hard coal mining increased once again – according to first cautious estimates, by 2 % to currently 6.9 billion tons. While the degressive production course in 2016 had essentially been due to production cutbacks and even complete market exits particularly in the United States as well as to capacity adjustments decreed by China's Central Government, the absolute production growth in 2017, which amounted to approximately 140 million tons, was also primarily based on these two countries. For example, the People's Republic of China increased its production by 2 %, which equals an additional mining volume of about 80 million tons. Hard coal mining in the United States increased by 7 %, which translates into 48 million tons, of which a considerable portion accounted for exports. Thus, the USA once again became a "swing supplier."

Russia also expanded its production by about 23 million tons (+6 %), India increased it by 19 million tons (+3%), and Indonesia by 12 million tons (+3 %). On the other hand, Australia's hard coal production dropped by 28 million tons (-6 %) which was primarily due to a number of tropical storms that had seriously affected the entire coal supply chain throughout the year. A decline in production was also recorded by Columbia (-7 %) and the European Union (-3 %) while South Africa's production volume remained almost at

Table 9

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German Hard Coal Imports [1] According to Supplier Countries in 2016 and 2017

	2016	2017 [2]	2016	2017 [2]	Change
	in Million Tons		Proportions in %		in %
Russia	16.3	17.1	30.4	35.3	5.1
USA	9.2	8.9	17.2	18.4	-3.5
Australia	7.0	6.3	13.1	13.0	-10.2
Columbia	9.1	5.4	17.0	11.1	-40.9
Poland	3.6	2.6	6.7	5.4	-26.9
Canada	1.6	1.6	3.0	3.3	5.6
South Africa	1.6	1.4	3.0	2.9	-12.8
Czech Republic	0.5	0.4	0.9	0.8	-14.7
Other Third Countries	1.8	1.2	3.4	2.5	-31.9
Other EU Countries [3]	2.9	3.6	5.4	7.4	20.9
Total Imports	**53.6**	**48.5**	**100.0**	**100.0**	**-9.5**

1) Including coke imports; coke converted into coal.
2) Estimate based on the Federal Statistical Office's foreign trade statistics for the first eleven months.
3) Including transit volumes from third countries via Belgian and Dutch ports.
Discrepancies in the totals are due to rounding off

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

the previous year's level. Around 16 % of the global hard coal production in 2017 went into maritime trade which, thus, grew by 1.5 % to approximately 1.1 billion tons when compared to the previous year. This growth was entirely attributable to power plant coals (+2.8 %). In contrast, maritime trade of coking coals declined by 2.2 %. The most important winner were the United States whose seaward exports increased by 30 million tons (+60 %).

In contrast to mineral oil, the markets for hard coals were characterized by substantial price increases in 2017; for example, the price for power plant coals free at Northwest European ports based on weekly rates had increased from € 56.19 /tce at the beginning of 2016 by nearly 80 % before it peaked at € 100.42 /tce in December 2016. This high level remained virtually unchanged in 2017; on an annual average, power plant coals were, after all, almost 44 % more expensive in 2017 than in the previous year. Compared to the preceding year, considerably higher price increases were recorded for hard coal coke imports with almost 60 % as well as for coking coal imports with a substantial 90 %.

Figure 9 shows the long-term development of the global market prices for steam coal in comparison to crude oil.

Figure 10 conveys an indication of the price trend for energy imports in Germany for hard coal/ hard coal coke, natural gas, and crude oil.

Figure 9

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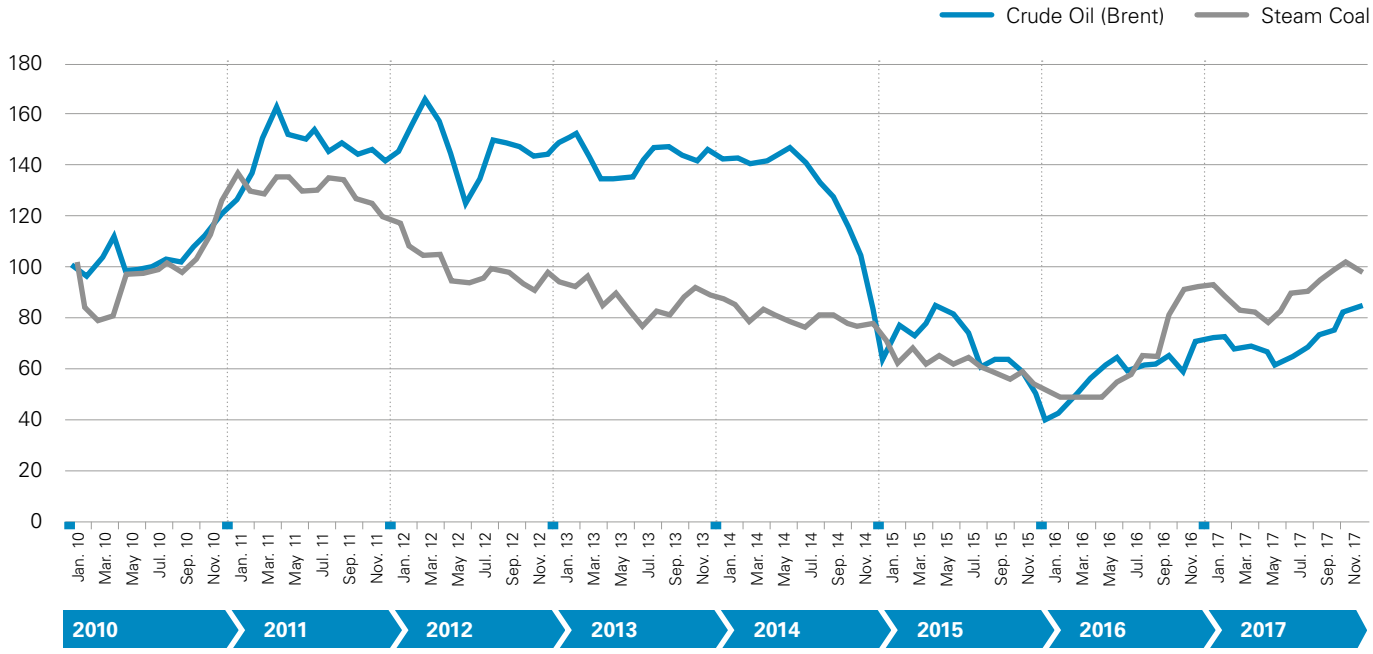
Global Market Prices for Crude Oil (Brent) and Steam Coal between January 2010 and December 2017

January 2010 = 100



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

Figure 10

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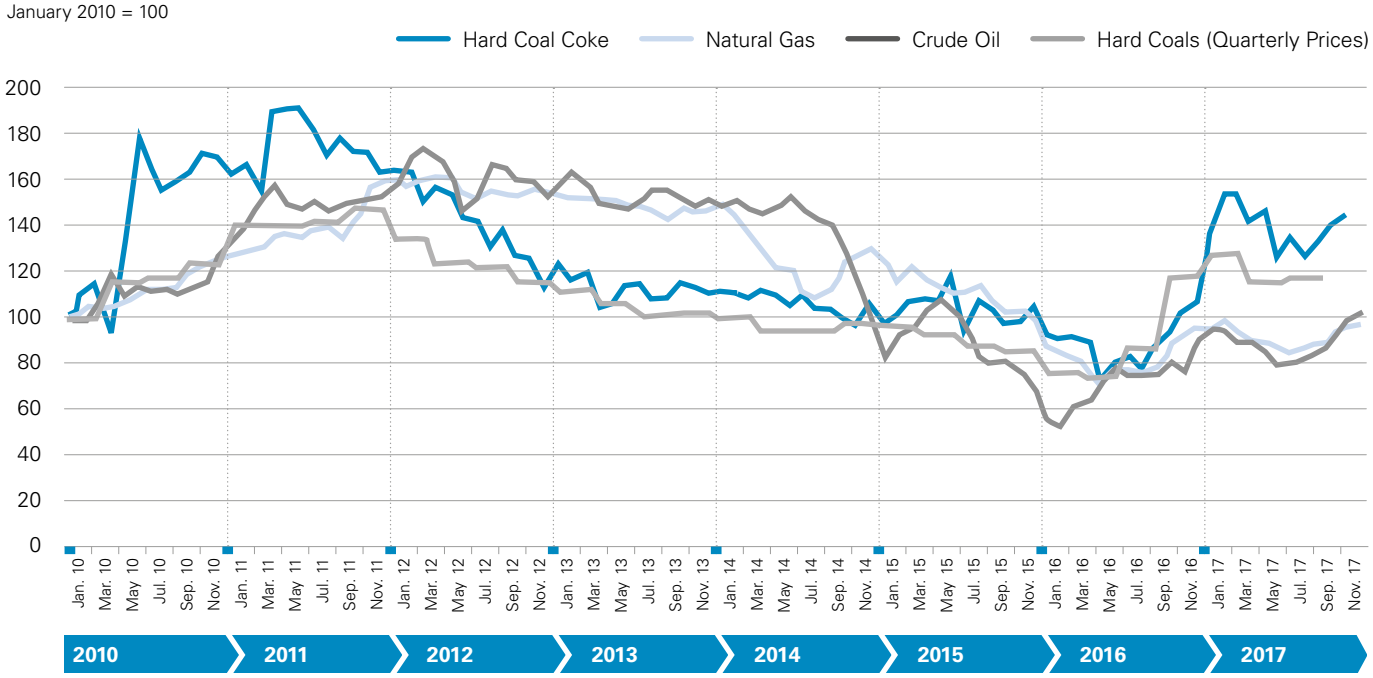
Development of Energy Import Prices between January 2010 and December 2017

January 2010 = 100



Sources: German Coal Importers Association; McCloskey's Coal Report; BAFA

Lignite

With about 171.3 million tons, lignite production in 2017 remained below the previous year's result for the fifth year in a row. However, the development in the individual mining districts varied: In Central Germany (+6.1 %) and the Rhineland area (+0.9 %), the extracted coal volume was higher due to the improved availability

Table 10

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Volume and Use of Lignite in Germany in 2016 and 2017

	Unit	2016	2017 [1]	Change
				in %
Domestic Raw Lignite Production According to Mining Districts				
Rhineland	Million Tons	90.5	91.2	0.9
Lusatia	Million Tons	62.3	61.2	-1.7
Central Germany	Million Tons	17.7	18.8	6.1
Helmstedt	Million Tons	1.1	0.0	-100.0
Total Lignite Production	**Million Tons**	**171.6**	**171.3**	**-0.2**
	Mtce	**52.7**	**52.6**	**-0.2**
	PJ	**1,545**	**1,542**	**-0.2**
Use of Indigenous Lignite				
Total Sales	**Million Tons**	**156.0**	**154.0**	**-1.3**
to Power Plants Supplying the General Public	Million Tons	155.2	153.2	-1.3
to Other Customers	Million Tons	0.8	0.8	1.6
Use for Refinement	Million Tons	14.2	14.7	3.8
Use in Lignite Mining Power Plants	Million Tons	1.7	2.4	42.7
Change in Stocks	Million Tons	-0.3	0.0	-
Total Volume of Refined Products from Domestic Production	**1,000 tons**	**6,418**	**6,705**	**4.5**
Foreign Trade				
Total Imports	1,000 tce	31	22	-28.5
Total Exports	1,000 tce	1,019	1,093	7.2
Foreign Trade Balance	1,000 tce	-987	-1,070	-
Primary Energy Consumption of Lignite	Mtce	51.8	51.5	-0.6
	PJ	1,519	1,510	-0.6
Electricity Production from Lignite [1]				
Power Plants Supplying the General Public	Billion kWh	146.2	144.2	-1.4
Industrial Power Plants	Billion kWh	3.4	3.3	-1.6
Total	Billion kWh	149.5	147.5	-1.4

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

Source: The German Coal Industry's Statistical Office

of power plants. In Lusatia, however, it fell below the previous year's result (-1.7 %). Coal mining in the Helmstedt District ended in the autumn of 2016.

These changes generally correspond to the respective development of deliveries to power plants supplying the general public (153.2 million tons; -1.3 %) which receive around 90 % of the production. The transfer into a standby mode for backup purposes, which was concluded between the Federal Government and the requisite companies, has been in effect for the Buschhaus power plant since October 1, 2016, and for the power plant units in Frimmersdorf since October 1, 2017. Additional power plants will follow in 2018 and 2019. With the lignite fired power plants being in the standby mode for backup purposes, the volume of lignite used for electricity production will decline by a total of approximately 15 % by 2020. CO_2 emissions from electricity production in Germany's lignite fired power plants will, thus, decrease by more than 21 million tons.

With 52.6 Mtce (1,542 PJ), the energy content of the lignite extracted in 2017 fell 0.2 % short of the previous year's result. Once again, lignite's contribution to domestic energy production amounted to nearly 40 %. Lignite, thus, continues to be an important domestic energy carrier.

With 147.5 TWh, power generation from lignite was once again more than 1 % lower than in the previous year. Lignite's share in power generation decreased to 22.5 % (previous year: 23.0 %). Thus, virtually every fourth kilowatt hour of the electricity used in Germany is sourced from lignite.

Table 11

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Lignite Balance for Germany in 2016 and 2017
in 1,000 tce

		2016	2017 [1]	Change
				in %
Domestic Production		52,698	52,605	-0.2
+	Imports	31	23	-0.2
=	Volume	52,729	52,628	-25.8
+/–	Change in Stocks (Reduction: +, Replenishment: -)	129	3	-
–	Exports	1,019	1,092	7.2
=	Primary Energy Consumption	51,839	51,539	-0.6
–	Use in Power Plants	48,246	47,805	-0.9
–	Other Conversion Input	4,661	4,849	4.0
+	Conversion Output	4,735	4,932	4.2
–	Consumption during Production and Conversion as well as Non-Energetic Consumption	752	748	-0.5
=	Final Energy Consumption	2,915	3,069	5.3
	Industry	2,446	2,580	5.5
	Households, Trade, Commerce, Services, Concessionary Coal	469	455	-3.0

1) Preliminary data; some figures are estimates

Source: The German Coal Industry's Statistical Office

The manufacture of refined products based on lignite increased in total by 4.5 % to about 6.7 million tons. Increases were reported for briquette production (+9 %) and the production of pulverized coal (+5 %). The production of fluidized bed coal (-8 %) and coke production (-3 %), however, remained below the previous year's result.

With 51.5 Mtce (1,510 PJ), lignite-based primary energy consumption was 0.6 % lower than in the previous year. Lignite, thus, met more than 11 % of the entire domestic demand for energy.

With a total consumption of about 3.1 Mtce in 2017, the final energy sectors used in total more lignite and lignite products than in the previous year (+5 %). When it comes to industry, the use of lignite increased by more than 5 % while sales to private households also reported an increase (+4 %) after significant declines in the previous years.

At the end of 2017, the number of employees working in the German lignite industry amounted to about 20,900 people. This figure includes more than 1,300 apprentices and almost 5,000 employees who work in the lignite companies' power plants supplying the general public. The employment statistics listed 9,739 employees in the Rhineland area, 8,639 in Lusatia, and 2,367 in Central Germany. After the end of coal mining, only about 150 employees worked on behalf of the lignite industry in the Helmstedt District. If one takes the employment multiplier (3.5) 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, as a basis, a total of more than 70,000 jobs in Germany can be attributed either directly or indirectly to lignite mining and power generation from lignite[4].

4 *Source: EEFA. Die Rolle der Braunkohlenindustrie für die Produktion und Beschäftigung in Deutschland. (https://braunkohle.de/61-0-EEFA-Studie-Beschaeftigungseffekte-2011.html)*

The Electric Power Industry

In 2017, gross electricity production in Germany amounted to 654.8 billion kWh. The production of electric power, thus, increased by 0.6 % compared to the previous year's figure. The contributions of the individual energy carriers to the production of electric power developed differently: Declines in power generation from nuclear energy, lignite, and hard coal as well as hydropower were to some extent contrasted by substantial increases for wind energy, natural gas, photovoltaics, and biomass. According to the available figures, gross electricity consumption increased by 0.5 % to 599.8 billion kWh (please see Table 12).

The electricity produced by lignite fired power plants amounted to 147.5 billion kWh in 2017. This equals a decline of more than 1 % when compared to the previous year's value. According to preliminary data, a net capacity of about 21,000 MW was installed at the end of the year, of which 1,214 MW were already in the standby mode of lignite for backup purposes and, thus, no longer on the market. The contribution of lignite fired power plants to the gross electricity production amounted to 22.5 %. Lignite, thus, continued to be the most important energy carrier in the German electricity mix right after the group of renewables last year as well.

In 2017, hard coal fired power plants delivered significantly less electricity than in the previous year. They produced 92.6 billion kWh; this equals a decline of 17.5 % when compared to the previous year. Numerous shutdowns in 2017 resulted in the fact that a capacity of 25,341 MW (net) was installed by the end of the year whereas the previous year's capacity had still amounted to 27,711 MW. This equals a decline of 2,370 MW, which translates into almost 9 % of the installed capacity in 2016. Hard coal's share in the mix of energy sources supplying Germany with electric power amounted to 14.1 %.

During the reporting year, the nuclear power plants in Germany generated 76.3 billion kWh of electricity; this equals a share of 11.7 % in Germany's gross electricity production. By the end of 2017, the installed capacity of nuclear power plants remained unchanged at 10,799 MW which is why this figure is included in the calculations for the calendar year 2017. As per December 31, 2017, and as stipulated by § 7 of the Atomic Energy Act (AtG), Unit B of the nuclear power plant Gundremmingen went out of service so that the installed capacity of nuclear power plants decreased by 1,284 MW to 9,515 MW at the beginning of the year 2018.

The use of natural gas as a fuel in power plants and thermal power stations designed to supply electricity continued to increase in 2017. An estimated total of 86.5 billion kWh of electric power was produced from natural gas; this equals a plus of 6.4 % when compared to 2016. After the production of electric power from natural gas had experienced a continuous decline between 2008 and late 2016, it increased considerably once again in 2017 which was, for example, due to the price spread which was actually more favorable for natural gas compared to other energy carriers. Additional power plant capacities in 2016 also generated further growth in 2017 because these facilities were connected to the grid all year round for the first time ever in 2017. Compared to the previous year, though, the installed capacity (net) in 2017 increased only slightly to 29,645 MW. According to initial calculations, natural gas accounted for a 13.2 % share in Germany's gross electricity production in 2017.

In 2017, 15.0 % more electricity was generated from renewable energy than was the case in the preceding year. Due to outstandingly favorable wind conditions which exceeded the average, onshore wind turbines generated considerably more electric power than in 2016 (+31 %); namely, 88.7 billion kWh. With 17.9 billion kWh, offshore wind turbines also supplied more electricity than in the previous year (+46 %) which is due to the installation of additional capacities during the year under review. In 2017, the installed capacity of onshore wind turbines increased by almost 4,900 MW to currently 50,251 MW while nearly 1,300 MW were newly connected to the grid off shore – this is the second largest additionally installed capacity after 2015, the record year to date. Thus, the offshore wind capacity installed in Germany now amounts to more than 5,400 MW. All told, wind energy accounted for a share of 16.3 % in the German electricity production mix in 2017.

In the reporting year, 45.5 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 1.1 % when compared to the previous year. Power plants generating electricity from biomass accounted for a share of 6.9 % in electricity production. In addition to the proportional power generation in waste fueled power plants (from biogenic waste), 51.4 billion kWh of electricity were produced from biogenic energy sources in Germany in 2017. Their total contribution to the German electricity producers' mix of energy sources, thus, amounted to 7.9 %.

Table 12

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Gross Electricity Production, Electricity Exchange, and Gross Electricity Consumption in Germany between 1990 and 2017 According to Energy Carriers

	1990	2000	2005	2010	2015	2016	2017 [1]	2016 to 2017	1990 to 2000	2000 to 2017	1990 to 2017
	in Billion kWh							Average Annual Change in %			
Lignite	170.9	148.3	154.1	145.9	154.5	149.5	147.5	-1.4	-1.4	0.0	-0.5
Nuclear Energy	152.5	169.6	163.0	140.6	91.8	84.6	76.3	-9.8	1.1	-4.6	-2.5
Hard Coal	140.8	143.1	134.1	117.0	117.7	112.2	92.6	-17.5	0.2	-2.5	-1.5
Natural Gas	35.9	49.2	72.7	89.3	62.0	81.3	86.5	6.4	3.2	3.4	3.3
Mineral Oil	10.8	5.9	12.0	8.7	6.2	5.8	5.9	0.9	-5.9	0.0	-2.2
Renewables	19.7	37.9	63.1	105.2	188.6	189.8	218.3	15.0	6.8	10.8	9.3
Other	19.3	22.6	24.1	26.8	27.3	27.3	27.7	1.5	1.6	1.2	1.3
Gross Electricity Production	**549.9**	**576.6**	**623.2**	**633.5**	**648.1**	**650.6**	**654.8**	**0.6**	**0.5**	**0.8**	**0.6**
Electricity Flows from Foreign Countries	31.9	45.1	53.4	42.2	33.6	27.0	28.4	4.9	3.5	-2.7	-0.4
Electricity Flows into Foreign Countries	31.1	42.1	61.9	59.9	85.4	80.7	83.3	3.2	3.1	4.1	3.7
Foreign Electricity Exchange Balance	0.8	3.0	-8.5	-17.7	-51.8	-53.7	-55.0	-	-	-	-
Gross Electricity Consumption	**550.7**	**579.6**	**614.7**	**615.8**	**596.3**	**596.9**	**599.8**	**0.5**	**0.5**	**0.2**	**0.3**
Change versus Previous Year in %	-	4.0	0.7	5.8	0.7	0.1	0.5				
	Structure of Gross Electricity Production in %										
Lignite	31.1	25.7	24.7	23.0	23.8	23.0	22.5				
Nuclear Energy	27.7	29.4	26.2	22.2	14.2	13.0	11.7				
Hard Coal	25.6	24.8	21.5	18.5	18.2	17.2	14.1				
Natural Gas	6.5	8.5	11.7	14.1	9.6	12.5	13.2				
Mineral Oil	2.0	1.0	1.9	1.4	1.0	0.9	0.9				
Renewables	3.6	6.6	10.1	16.6	29.1	29.2	33.3				
Other	3.5	3.9	3.9	4.2	4.2	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 39.9 billion kWh, photovoltaic systems also supplied more electricity than had been the case in 2016 (38.1 billion kWh). Compared to 2016, this equaled a plus of 4.7 %. This amount of electricity includes not only the electric power fed into the German power distribution network, but also the plants' own in-house consumption on site – irrespective of whether the latter is reimbursed pursuant to the German Renewable Energies Act (EEG) or not. According to preliminary estimates, an additional photovoltaic capacity of more than 2,000 MWp was installed in 2017; thus, a total capacity of approximately 43,300 MWp was installed at the end of the year. The contribution of solar energy to the German electricity mix in the reporting year amounted to 6.1 %.

A slight minus was recorded by power generation in run-of-the-river and hydroelectric storage plants which, with 20.2 billion kWh, delivered 1.7 % less electricity than in the previous year. The contribution of run-of-the-river and hydroelectric storage plants to the electricity mix, thus, amounted to 3.1 %.

In total, 218.3 billion kWh of electricity were generated from renewable energy in the reporting year; this equals an increase of 15.0 %. According to initial figures, renewable energy's contribution to meeting the gross domestic electricity consumption, thus, increased to about 36.4 % in 2017 (2016: 31.8 %).

A Brief Discourse on Onshore Wind Turbines' Own In-House Consumption

Onshore wind energy currently accounts for a share of more than 2 % in the total primary energy consumption and/or for a share of almost 14 % in the gross electricity production in Germany.

In the past, the amounts of electricity fed into the grid and reimbursed in accordance with the German Renewable Energies Act (EEG), which were generated by wind turbines on shore, were captured in Germany's energy balance as "gross" electricity production. According to current knowledge, though, onshore wind turbines procure electric power from the grid only at times when favorable winds are unavailable. At other times, they ensure the energy supply of relevant consumers (for example, heating and cooling systems, yawing systems for wind direction alignment), which is required for the smooth operation of these plants, from their own in-house electricity production.

Consequently, the amounts of electricity fed into the grid from onshore wind turbines and billed pursuant to the EEG constitute the "net" electricity production. Yet the difference between the actual gross and the fed-in net electricity production, the plants' own in-house consumption, is not included in the statistics. That is why the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group) applies for the first time ever with this report a comprehensive procedure which helps close this statistical gap as of the reporting year 2003.

The starting point of the new method designed to determine the own in-house consumption of onshore wind turbines is the consideration that every plant's own in-house consumption typically exhibits a certain dependence on the plant's location. Information on specific locational conditions include the appropriate master data which are collected from the distribution and transmission grid operators within the scope of the EEG. In addition, average operating hours are ascertained for every known plant as a key component of any site-specific calculations. Furthermore, it was also possible to determine more precisely the plant-specific consumption of auxiliary systems on the basis of information obtained from diverse manufacturers such as, for example, Enercon, Nordex, or Vestas; these data are also incorporated into the calculations. And since the own in-house consumption of onshore wind turbines is subject to weather-related fluctuations, the new methodology also takes additional data regarding the air temperature (measured in more than 400 weather stations) into account.

The calculations made with the help of the new method aptly demonstrate that the proportion of the own in-house consumption in onshore wind turbines in relation to the gross electricity production had peaked at a rate of 2.17 % in 2016. According to first preliminary estimates, it can be assumed that the proportion of the plants' own in-house consumption declined slightly in 2017 and will amount to 1.95 %.

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 2017. The largest amount of electric power flowed to Switzerland, followed by Austria and the Netherlands (Switzerland: 17.7 billion kWh, Austria: 15.4 billion kWh, Netherlands: 13.8 billion kWh). A portion of such physical flows of electric power from Germany to the Netherlands, however, actually moves farther in the direction of Belgium and the United Kingdom. Once again, the largest amounts of electric power came from France to Germany, followed by Denmark and the Czech Republic (France: 7.0 billion kWh, Denmark: 5.6 billion kWh, Czech Republic: 5.6 billion kWh). All told, 83.3 billion kWh of electricity flowed from German power grids to foreign countries (2016: 80.7 billion kWh) while Germany sourced 28.4 billion kWh from abroad (2016: 27.0 billion kWh). With an export surplus of 55.0 billion kWh, the balance for 2017 once again exceeded the previous year's level (2016: 53.7 billion kWh). It should be noted in this context that this report specifies the physical power flows; and that part of the exchange volumes include transit volumes and loop flows (please see Figure 11).

According to first estimates and based on the economic trend, industrial power consumption increased from 247.2 billion kWh in 2016 by 0.6 % to 248.6 billion kWh in the reporting year. Electricity-intensive industries, though, exhibited very diverse developments: Power consumption in the trade, commerce, and service sector increased by 0.7 %. The consumption of electric power in private households increased to a similar extent by 0.5 % from 128.2 billion kWh to 128.8 billion kWh. And the power consumption of public institutions increased a little less: It went up by 0.4 % to 52.8 billion kWh. Consumption in the transportation sector marginally exceeded the previous year's figure. In total, net electricity consumption increased by 0.5 % to 530.0 billion kWh.

Figure 11

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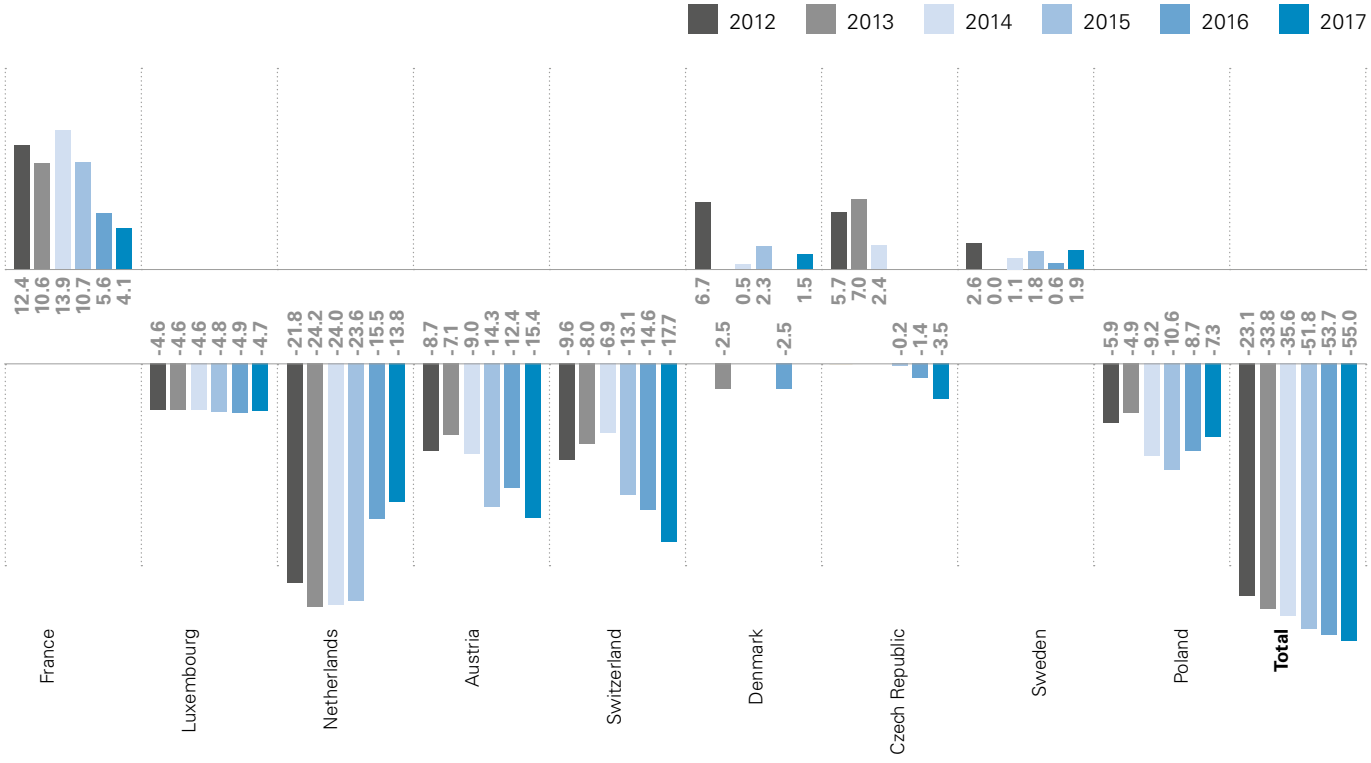
Germany's Electricity Exchange Balance with Neighboring Countries between 2012 and 2017

Electricity Flows in Billion kWh



Source: BDEW

Table 13

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Electricity Balance of Germany's Power Supply between 2000 and 2017

	2000	2008	2010	2014	2015	2016 [1]	2017 [1]	2016/ 2017	2008 to 2017
	Billion kWh							Change in %	
Gross Electricity Production	**576.6**	**641.5**	**633.5**	**627.8**	**648.1**	**650.6**	**654.8**	**0.6**	**2.1**
Self-Consumption in Power Plants	-38.1	-40.4	-39.0	-36.9	-37.7	-36.3	-34.2	-5.7	-15.4
Net Electricity Production	**538.5**	**601.1**	**594.5**	**590.9**	**610.4**	**614.3**	**620.5**	**1.0**	**1.2**
Electricity Flows from Foreign Countries	45.1	40.2	42.2	38.9	33.6	27.0	28.4	4.9	-29.5
Electricity Flows into Foreign Countries	42.1	62.7	59.9	74.5	85.4	80.7	83.3	3.2	32.9
Net Domestic Electricity Volume	**541.5**	**578.6**	**576.8**	**555.3**	**558.6**	**560.6**	**565.6**	**0.9**	**-2.3**
Pump Current Consumption	6.0	7.9	8.6	8.0	8.1	7.5	8.3	10.1	3.9
Grid Losses and Unrecorded Factors	34.1	32.3	27.6	23.3	26.0	26.0	27.3	5.2	-15.3
Net Electricity Consumption	**501.4**	**538.4**	**540.6**	**524.0**	**524.6**	**527.1**	**530.0**	**0.5**	**-1.6**
Proportion of:									
Mining and Manufacturing Industries	239.1	252.4	249.7	244.4	245.8	247.2	248.6	0.6	-1.5
Households	130.5	139.5	141.7	129.7	128.7	128.2	128.8	0.5	-7.7
Commerce and Trade, Public Institutions	118.6	135.4	135.4	135.4	135.4	135.4	135.4	0.0	0.0
Transportation	13.1	11.1	12.1	11.5	11.1	11.7	11.8	0.5	6.3
Gross Domestic Electricity Consumption	**579.6**	**619.1**	**615.8**	**592.2**	**596.3**	**596.9**	**599.8**	**0.5**	**-3.1**

1) Some figures are preliminary and estimates

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

In 2017, 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 0.43 kg CO_2/kWh net, which represents a significant decrease of 7.5 % when compared to the previous year. The downward trend for specific emissions is primarily due to the substantially increased production of electricity from renewables and the higher utilization of gas fired power plants as well as the simultaneously decreasing production of electricity in hard coal fired power plants. Just related to the mix of fossil energy sources alone, the specific CO_2 emissions amounted to 0.88 kg CO_2/kWh net in the reporting year. They declined by 1.0 %.

Due to the significant economic growth which was accompanied by a moderate increase in electricity consumption, the macroeconomic production of electric power, when expressed as the ratio of the price-adjusted gross domestic product to gross electricity consumption, increased by 1.8 % in 2017 compared to the previous year. During the period between 1990 and 2017, the average annual increase in productivity amounted to 1.2 % (please see Table 2 and Figure 12). For the annual changes in gross electricity consumption and electricity productivity, please turn to Figure 13.

The influence of the different components on the changes in power consumption from 1990 and/ or 2015 to 2017 are shown in Figure 14. It indicates that the 2017 increase of 3 billion kWh in gross electricity consumption when compared to 2016 was primarily caused by the strong economic growth (+10.8 billion kWh) and, to a lesser degree, by the increasing population (+2.4 billion kWh). However, the associated increase in consumption was significantly reduced by the simultaneously increasing electricity productivity that amounted to 10.2 billion kWh. Similar relationships appear over the entire period between 1990 and 2017: The total increase of approximately 49 billion kWh was caused by higher consumption as a result of the economic (+210 billion kWh) and demographic (+23.2 billion kWh) development which, in turn, was reduced by the effects of enhanced electricity productivity (-184 billion kWh).

Figure 12

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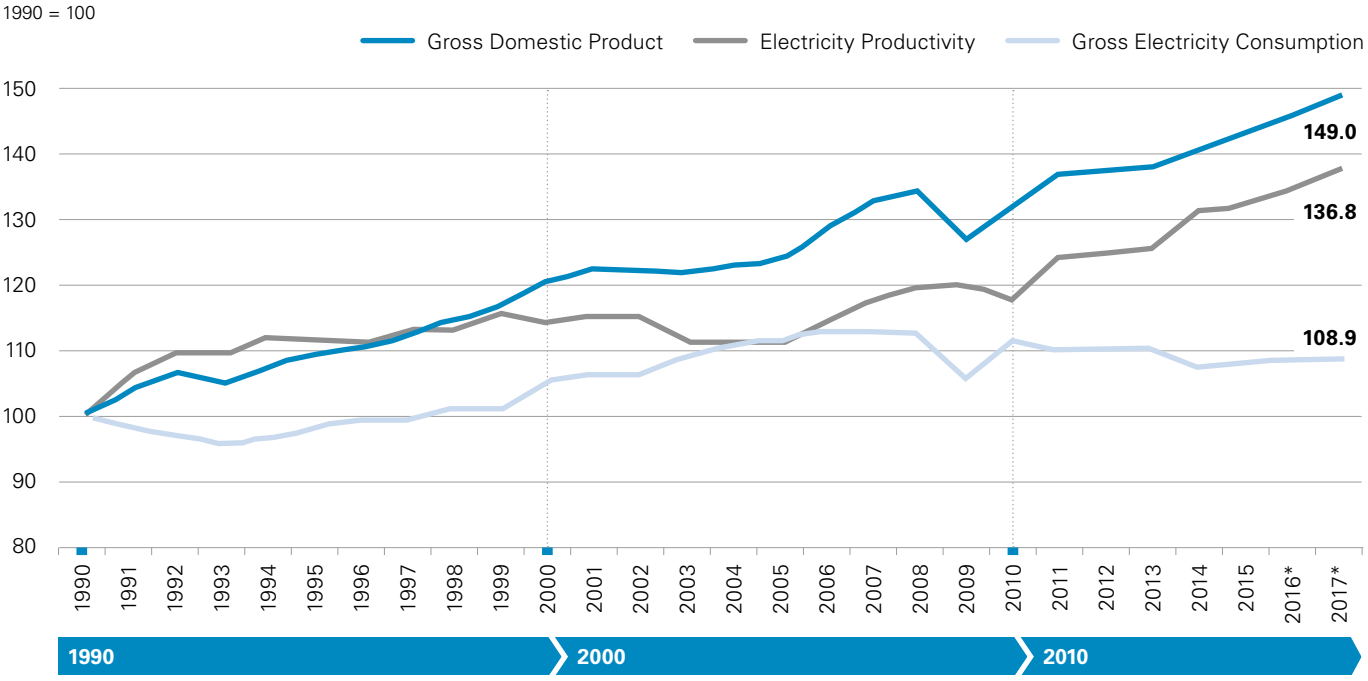
Gross Domestic Product [1], Gross Electricity Consumption, and Macroeconomic Electricity Productivity [2] in Germany between 1990 and 2017



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

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

Figure 13

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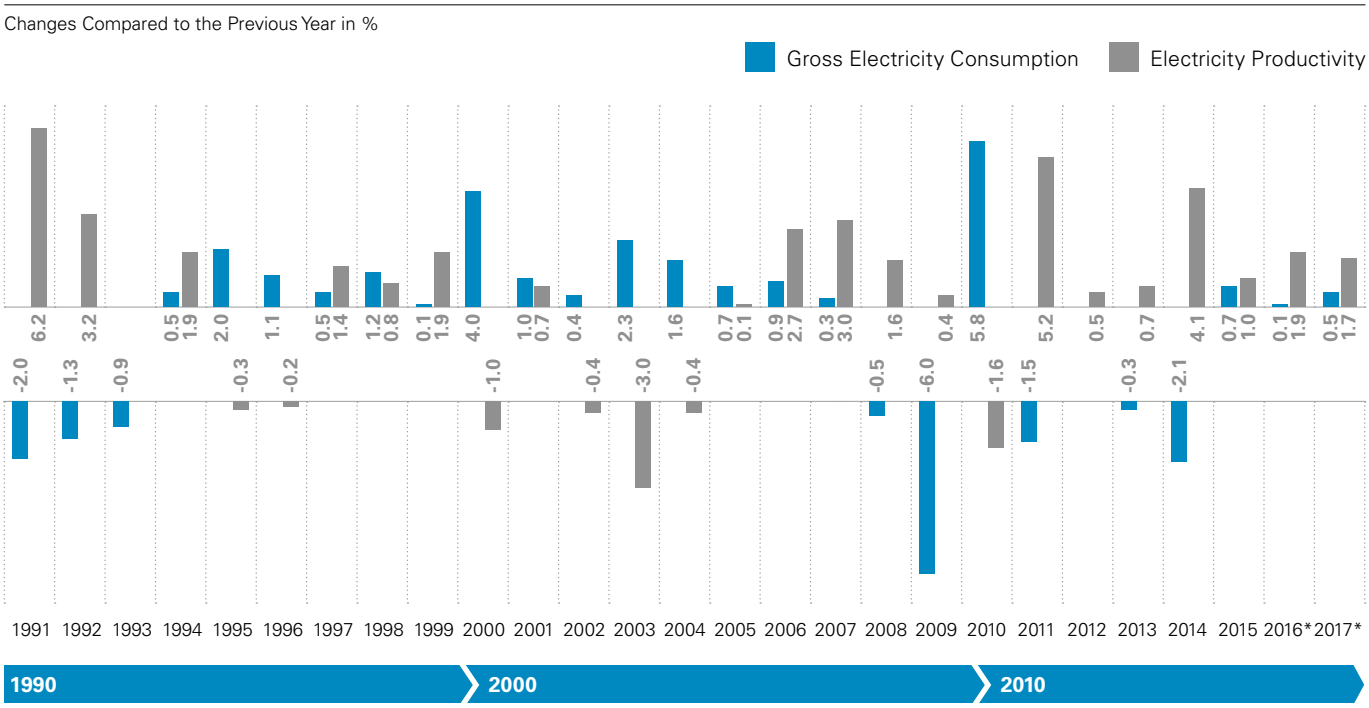
Changes in Gross Electricity Consumption and Electricity Productivity between 1991 and 2017



**) Preliminary*

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

Figure 14

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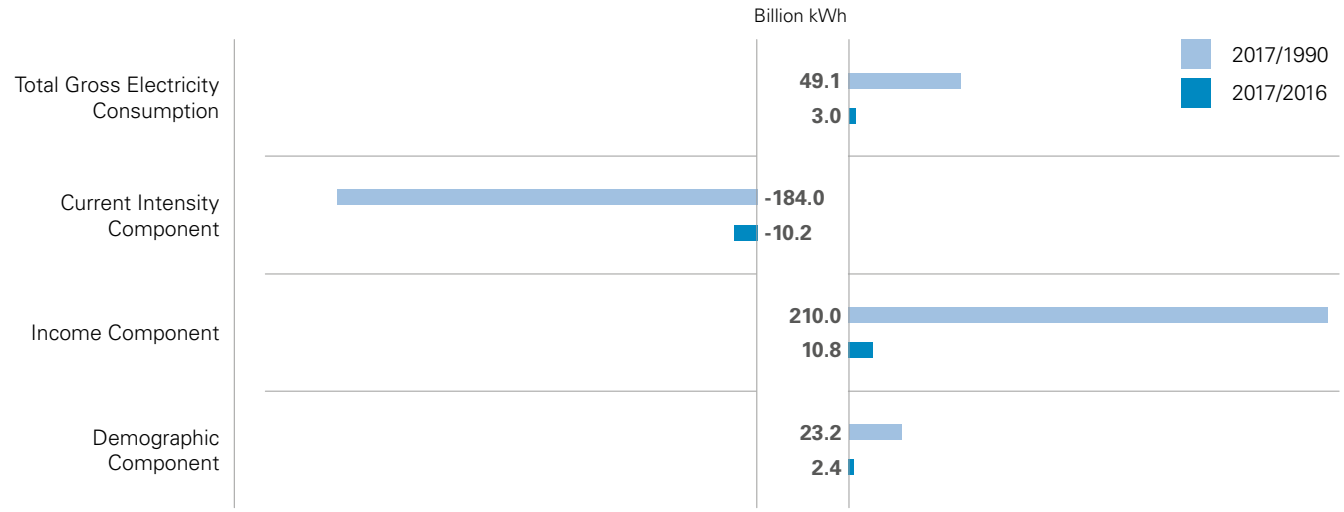
Contributions of Diverse Influencing Factors to the Changes in Gross Electricity Consumption in Germany

Changes in 2017 Compared to 2016 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 2016, there had been 1,747 companies; by the end of 2017, the number increased to 1,802. At closer examination, it is revealed that 80 of these companies were active as electricity producers with a power plant park larger than 100 MW, 917 of which worked as power distribution grid operators, four as transmission grid operators, 45 as electricity wholesalers, and 1,258 as distributors in the ultimate consumer business[5]. The number of employees working in the electric power industry increased in 2017. According to preliminary figures, there were 130,900 employees at the end of 2017 which was an increase of 1.3 % when compared to the end of 2016.

Electricity prices for industrial clients went up by 11 %, which was primarily due to the increases in taxes, duties, and levies, but also due to the increases in network charges and procurement costs. The proportion of governmental charges included in the electricity price for industrial clients, which had still amounted to 50 % in 2016, decreased to 48 % in 2017 (excluding the electricity tax).

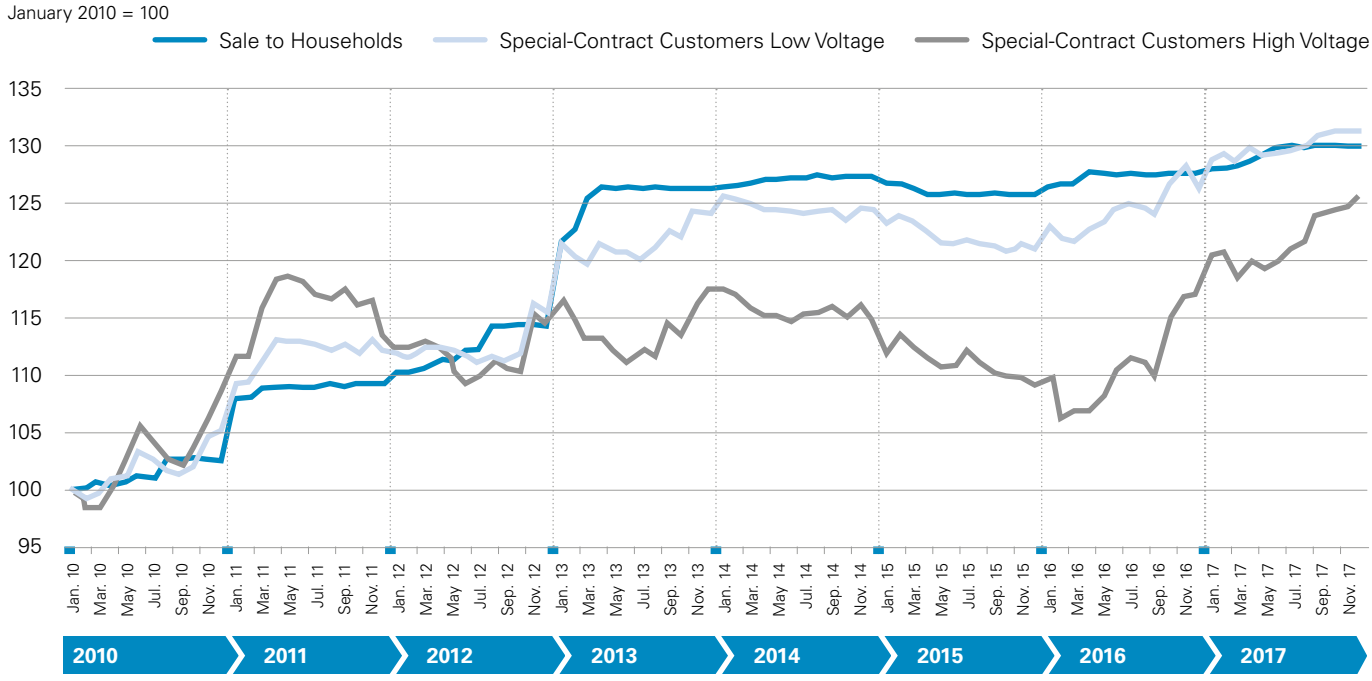
Electricity prices for households also increased by 1.7 %. This was caused by increases in taxes, duties, and levies as well as by increases in network charges. The proportion of taxes, duties, and levies included in the electricity price climbed to a record high of 55 % in 2017 compared to 54 % in the previous year. In 2018, the proportion of governmental charges included in the electricity price will decrease slightly by 0.09 ct/kWh which will, thus, keep the tax burden for consumers stable.

As measured by the producer price index, electricity prices developed quite differently in 2017 for each respective customer group: While there was an increase of 1.5 % for households and an increase of 1.6 % for commercial customers (previous year: +1.0 % and +0.6 % respectively), the prices for special-contract customers at the low voltage level now went up by 4.6 % which was different from the previous year's increase of 1.9 %. With 9.6%, the price increase for special-contract customers at the high voltage level was even higher; especially in light of the fact that there had been a slight decline of 0.2 % in the previous year (please see Figure 15). Particularly hefty was the price increase on the exchange; in 2017, the prices for electricity on the exchange were 21.8 % higher than in 2016 when they had exhibited a decrease of 13.4 %. The price for electricity on the exchange was 55.3 % lower in 2017 than in 2008; the year it reached its highest level to date.

5 *Here as well, 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 15

Electricity Producer Price Index for Special-Contract Customers and Sale to Households in Germany between 2010 and 2017



Source: Federal Statistical Office (Destatis)

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 16). However, the subsequent price upswing remained mostly below the limit of € 40 /MWh until the fall of 2017. Nonetheless after the turn of 2016/2017, there was considerable turmoil with price fluctuations of up to more than € 100 /MWh due to the long lasting cold spell in January 2017 and the unavailabilities of French nuclear power plants.

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 (please see Figure 17). 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 which is 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 over the course of the year 2014 was there a slight upward trend in the direction of € 7 /t CO_2 to € 9 /t CO_2 which lasted until late 2015 but came to a new standstill in 2016: In 2016, the prices ranged again between € 4 /t CO_2 and € 6 /t CO_2. Since mid-2017, the certificate prices had once again been increasing significantly and were approaching the limit of € 8 /t CO_2. In February 2018, they hovered around a level of nearly € 10 /t CO_2. To what extent this already represents the desired trend reversal in the direction of higher certificate prices will also depend on the efficiency and effectiveness of the intended structural reforms of European emissions trading. Apart from that, 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.

Figure 16

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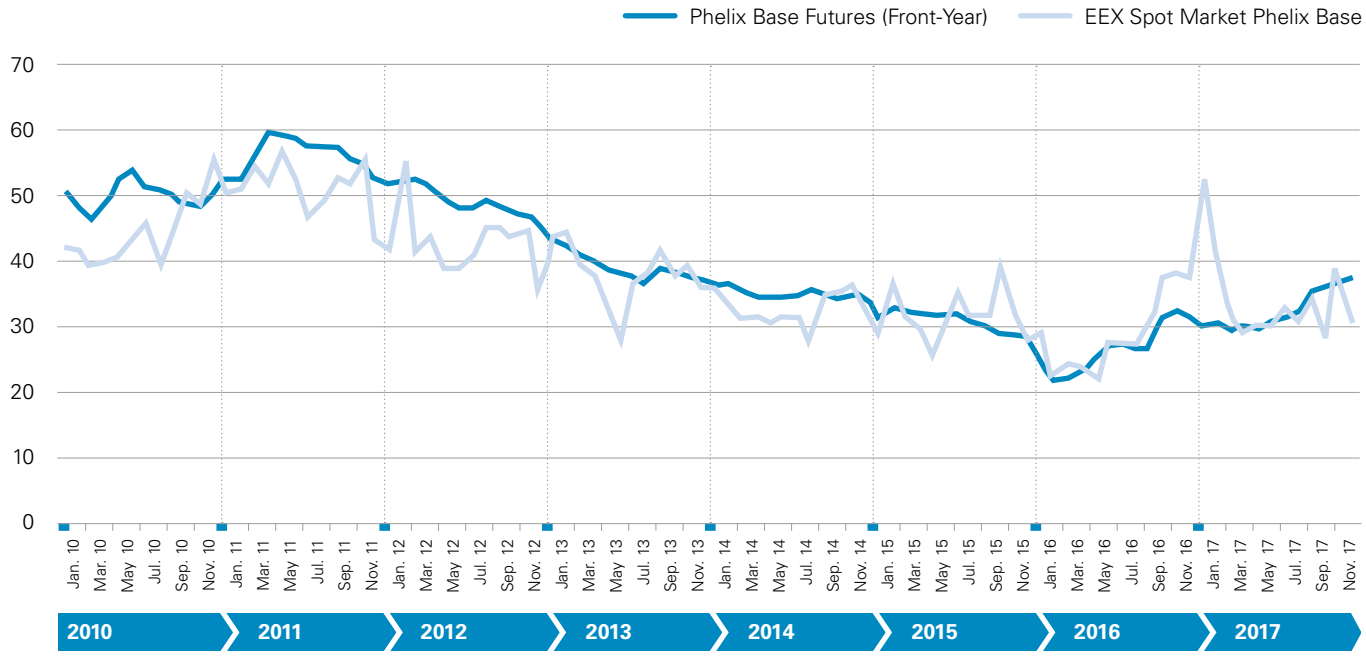
Development of Electricity Prices on the EEX Spot Market and Term Market (Front Year) between 2012 and 2017

Electricity in EUR/MWh



Source: BMWi

Figure 17

AGEB
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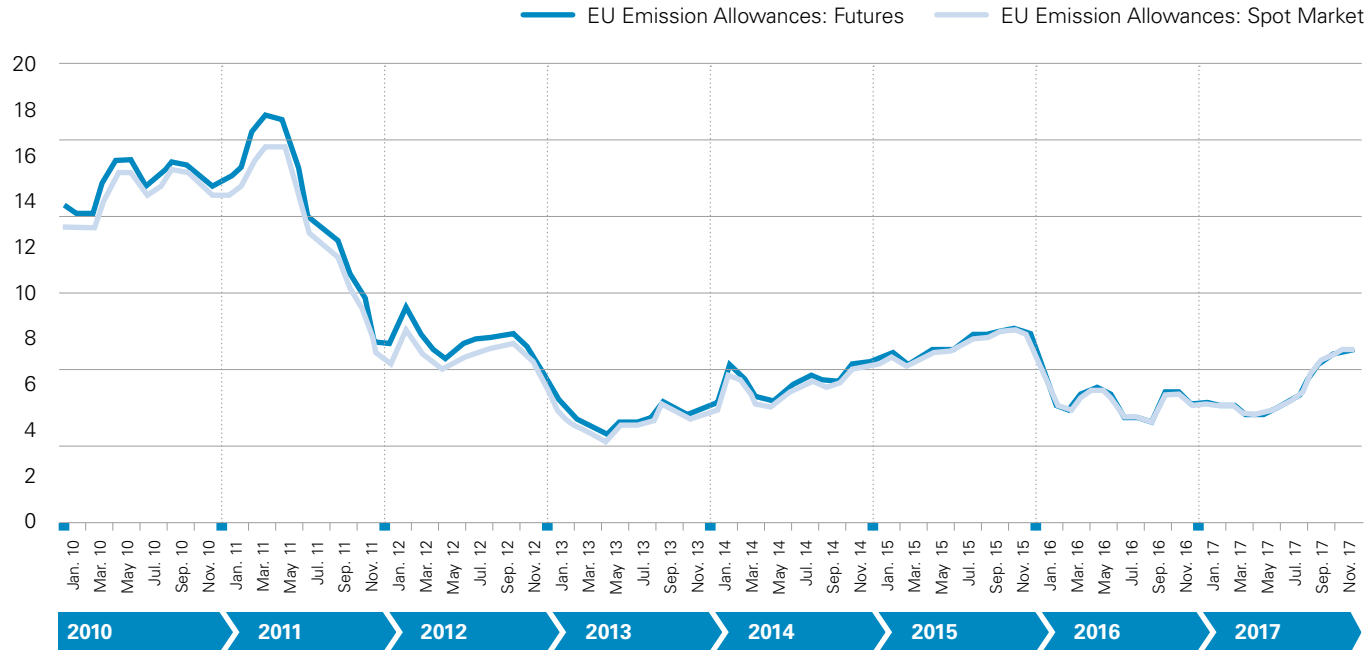
Development of the European Emission Allowances on the EEX Spot Market and Term Market between 2010 and 2017

Certificate Prices in /t Co_2



Source: BMWi

Provision of District Heating and Cooling

According to first estimates, district heating and district cooling suppliers produced 132 billion kWh of net heat[6] in 2017; an additional 8 billion kWh came from other producers of heat. A total of 140 billion kWh was fed into the heating/cooling grid. Compared to 2016, production increased by 0.7 %. 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 124.2 billion kWh (2016: 121.5 billion kWh). The increased consumption compared to the previous year is both due to the further expansion of district heating and due to cooler temperatures during individual months (please see Table 14).

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 a total of about 1.1 % from 147 billion kWh in 2016 to 148 billion kWh in 2017. When it comes to the use of fuel, natural gas once again experienced the highest increase; compared to 2016, its contribution improved by more than 5 billion kWh (this equals 8.8 %) to 63 billion kWh. Thus, natural gas had a share of over 42 % in the fuel which was used to supply district heating in 2017. According to initial estimates, the use of hard coal and lignite exhibited a downward trend (-12.8 % and -16.7 % respectively). Renewable energy (including the renewable proportion of residential waste) recorded a plus of almost 3 %. Renewables contributed more than 28 billion kWh, which translates into 19.0 %, as a fuel which was used in Germany's heating and thermal power stations.

Table 14

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Balance of Heating and Cooling Companies

	2015	2016 [1]	2017 [1]	Changes
		Billion kWh		in %
Net Production	**133.7**	**138.7**	**139.6**	**0.7**
Mains Losses and Operating Consumption; Stat. Differences	18.1	17.2	15.4	-10.4
Net Consumption District Heating/Cooling	**115.6**	**121.5**	**124.2**	**2.3**
Industry	47.1	47.7	49.3	3.4
Households	47.3	51.7	52.5	1.4
Other	21.2	22.0	22.4	1.9

1) Some figures are preliminary and estimates

Sources: Federal Statistical Office (Destatis); BDEW

6 Here: District heating always includes district cooling.

According to initial estimates, the heat consumed by private households and the heat supplied to residential buildings went up by 1.4 % to 52.5 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 scheduled for 24.8 % 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 49.3 billion kWh of thermal energy which was approximately 3.4 % more than in 2016. The consumption of heat by other customers in 2017 increased by 1.9 % to an anticipated amount of 22.4 billion kWh.

It is interesting to compare the development of the producer prices for supplying electricity, natural gas, and district heat to households (please see Figure 18). 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 reveals a slight upward trend.

Figure 18

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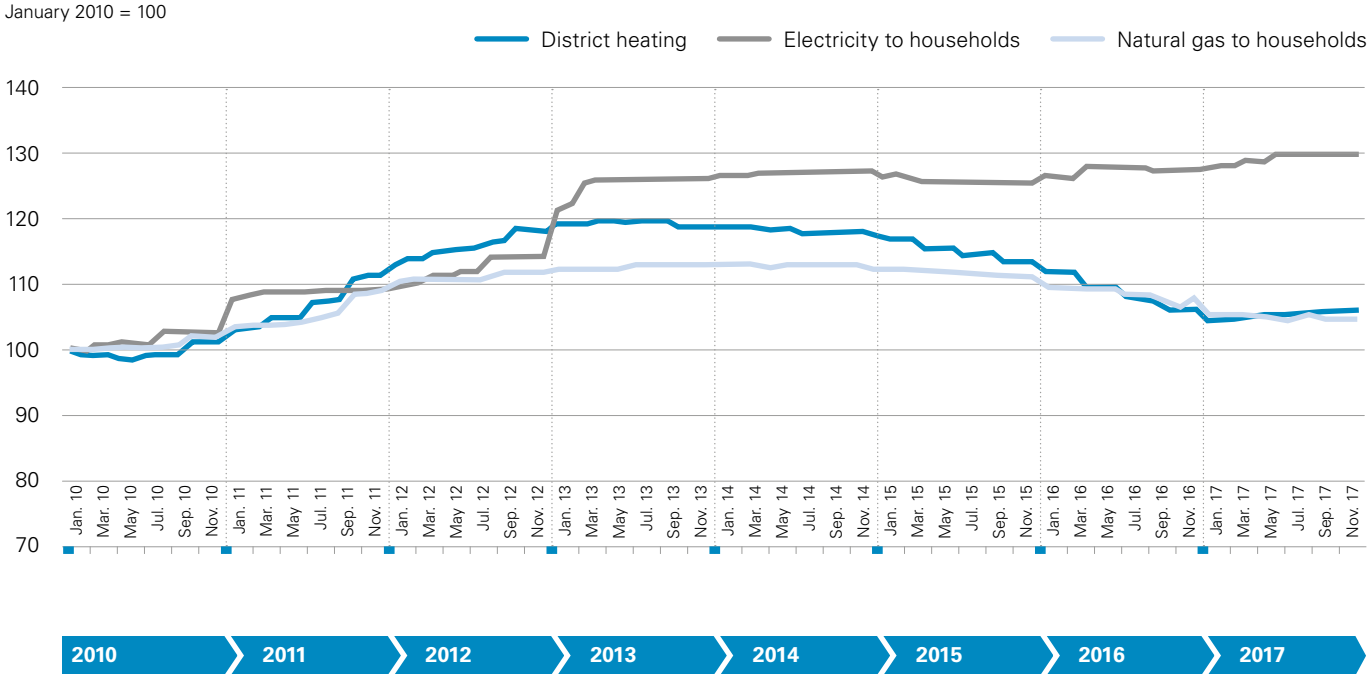
Producer Price Indices for District Heating, Electricity, and Natural Gas Charges to Households in Germany between January 2010 and December 2017



Source: Federal Statistical Office (Destatis)

Renewable Energy

In 2017, the use of renewable energy sources increased by 6.1 % from an initial 1,678 PJ (57.2 Mtce) to 1,780 PJ (60.7 Mtce). This development is essentially attributable to the climatic conditions – during individual months, the wind conditions were particularly favorable; and the number of sunshine hours was somewhat higher than in 2016 – as well as to the progressing expansion of capacities. As a result, renewables expanded their share in Germany's total primary energy consumption from 12.5 % to 13.1 % (please see Table 1). Their contribution to gross electricity production amounted to 29.2 % in 2016 and to 33.3 % in 2017 (please see Table 12).

A glance at the individual consumption sectors (please see Table 15 and Figure 19) reveals that renewables are used primarily in power plants for the production of electricity; amounting to a share of 57.2 % as measured by the total primary energy consumption of renewables (2016: 54.6 %). In contrast, only 5.5 % are used in power plants for the production of district heat. The increased decentralized use of renewables entails that 36.0 % of the energy used is attributable to end consumers (2016: 38.2 %). 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. If one analyzes the individual technologies and/ or energy carriers, then it becomes apparent that consumption actually exhibited different trends:

Hydropower, which had a share of 4.1 % in the primary energy consumption of renewables, experienced a slight decline over the entire year (-1.8 %). While about 74.0 PJ had been consumed in run-of-the-river and hydroelectric storage plants as well as in pumped storage plants with a natural influx into the upper reservoir and then used for electricity production in 2016, this figure amounted to only 72.7 PJ in 2017. Particularly during the first half of the year, Germany's hydroelectric power plants generated 18 % less electricity due to low precipitation and, in part, low water levels. The installed capacity of electric power is not a driving force in this development because it has been stagnating between 5 GW and 6 GW (currently 5.7 GW) for many years now.

The wind year developed quite differently. With a total of 383.8 PJ, the primary energy consumption of onshore and offshore wind energy attained another record result thanks to partially superb wind conditions; with a share of 21.6 % in the primary energy consumption of renewables, it consolidated its second position behind biomass. Compared to 2016 (288.2 PJ), this translates into an increase of 33.1 %. During ten out of twelve months, the result attained in the same month of the previous year was actually exceeded; in October and December, the results were even topped significantly (+123 % as well as +59 %). A disproportionate share was assued in an internal comparison by wind turbines on land (319.2 PJ, +30.8 % – wind turbines at sea 64.6 PJ, +46.2 %), whose installed capacity exceeded the margin of 50 GW in 2017. Just over the past twelve months alone, an additional capacity of 5.3 GW (gross) was installed on land – in absolute terms, the gross additional capacity on shore for a single year is, thus, almost on par with the installed capacity of all offshore wind farms taken together (5.4 GW). As per the end of the year, almost 30,000 wind turbines rotated on the mainland as well as in the German maritime regions of the North Sea and the Baltic Sea (coastal waters and exclusive economic zone).

In 2017, solar energy's primary energy consumption went up from an initial 165.2 PJ to currently 173.1 PJ and, thus, attained a 9.7 % share in the primary energy consumption of renewables. This equals an increase of 4.7 %, triggered by positive trends in the number of sunshine hours as well as the radiation intensity. A proportion of 143.6 PJ or about 83 % accounted for the use of solar energy in the production of electric power through photovoltaic cells, of which more than 90 % were fed into public power grids while around 10 % were produced and consumed directly on site. At the end of the year, more than 43 GW, which translates into nearly 1.6 million, rooftop and open space systems had been installed in Germany; and 1.6 GW of these new systems had gone into operation over the course of the year 2017. Unlike photovoltaics, solar thermal collectors supply thermal energy which is primarily used for space heating and drinking water heating. The contribution to the primary energy consumption of renewables in 2017 amounted to 29.5 PJ; compared to the previous year, this equals an increase of 4.9 %.

Table 15

Renewable Energy in Germany in 2016 and 2017 According to Its Use and Energy Sources

	Hydropower			Wind Energy (Onshore and Offshore)			Solar Energy			Geothermal Energy			Biomass			Waste			Total		
	2016	2017	Changes	2016	2017	Changes	2016	2017	Changes	2016	2017	Changes	2016	2017	Changes	2016	2017	Changes	2016	2017	Changes
	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%
Domestic Production	74.0	72.7	-1.8	288.2	383.8	33.1	165.2	173.1	4.7	53.8	57.9	7.7	990.4	987.3	-0.3	129.9	129.9	0.0	1,701	1,805	6.1
Foreign Trade Balance	-	-	-	-	-	-	-	-	-	-	-	-	-23.7	-24.6	-3.8	-	-	-	-24	-25	3.8
Primary Energy Consumption	**74.0**	**72.7**	**-1.8**	**288.2**	**383.8**	**33.1**	**165.2**	**173.1**	**4.7**	**53.8**	**57.9**	**7.7**	**966.7**	**962.7**	**-0.4**	**129.9**	**129.9**	**0.0**	**1,678**	**1,780**	**6.1**
Use in Power Plants (Electricity)	74.0	72.7	-1.8	288.2	383.8	33.1	137.2	143.6	4.7	6.3	6.7	6.1	346.8	347.6	0.2	64.1	63.9	-0.3	917	1,018	11.1
Use in Power Plants (Heat)	-	-	-	-	-	-	-	-	-	1.6	1.2	-23.7	45.6	45.6	-0.1	50.6	50.4	-0.3	98	97	-0.6
Consumption during Conversion, Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**23.4**	**23.7**	**1.4**	**0.0**	**0.0**	**0.0**	**23**	**24**	**1.4**
Final Energy Consumption	**-**	**-**	**-**	**-**	**-**	**-**	**28.1**	**29.5**	**4.9**	**45.9**	**50.0**	**9.0**	**550.9**	**545.9**	**-0.9**	**15.2**	**15.6**	**2.5**	**640**	**641**	**0.1**
Industry	-	-	-	-	-	-	-	-	-	-	-	-	100.9	102.5	1.5	15.2	15.6	2.5	116	118	1.7
Transportation	-	-	-	-	-	-	-	-	-	-	-	-	107.8	109.4	1.6	-	-	-	108	109	1.6
Households, Trade, Commerce, Services	-	-	-	-	-	-	28.1	29.5	4.9	45.9	50.0	9.0	342.2	334.0	-2.4	-	-	-	416	413	-0.6

All values for 2016 and 2017 are preliminary.

Sources: Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)

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With regard to renewables' primary energy consumption, geothermal energy continued to remain at a low level; its contribution of 57.9 PJ (2016: 53.8 PJ) just represented a mere proportion of 3.3 %. The current number of 33 deep geothermal energy facilities in Germany, which are used for the production of electricity and district heat, account for 11.5 PJ or about 20 % of geothermal energy's primary energy consumption. In contrast, heat pumps for heating systems and domestic hot water which are mostly installed in private households augmented their share to approximately 80 % or 46.4 PJ. This equals an increase of 9.2 % compared to the previous year. This development was due to the installation of 91,500 additional systems which increased the total number to now slightly above 1 million systems. The primary energy consumption of biomasses, which accounted for a 54.1 % share of the total primary energy consumption of renewables, consists of diverse solid, liquid, and gaseous fuels; whereby wood in the form of wood logs, wood chips, pellets, or briquettes continues to be the most important source (with a 52 % share in the primary energy consumption of biomass). Liquid fuels such as palm kernel oil or rapeseed oil as well as biofuels such as biodiesel and bioethanol with a proportion of 12 % actually assume only a secondary role.

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. Thus, gaseous biomasses contributed 36 % to the primary energy consumption of biomasses. Considering the overall situation, the primary energy consumption of biomasses, which amounted to 962.7 PJ, continued to remain at the previous year's level (966.7 PJ). Due to the slightly warmer winter months, the consumption of solid biomasses recorded a marginal decline (-2 %) whereas the use of biogas increased slightly (+1 %). Yet when it comes to biogas plants, the additional capacity of about 300 MW which was installed over the course of the year was almost exclusively designed to provide more flexibility for plants and systems (of which 21 MW accounted for new plants) and is, thus, only partially relevant for the consumption. Just like the year before, biogenic waste contributed 129.9 PJ to renewables' primary energy consumption; whereby only 50 % of the total energy used in waste incineration plants are classified as renewable fuels. Their proportion of renewables' primary energy consumption, thus, equals 7.3 %.

Figure 19

AGEB
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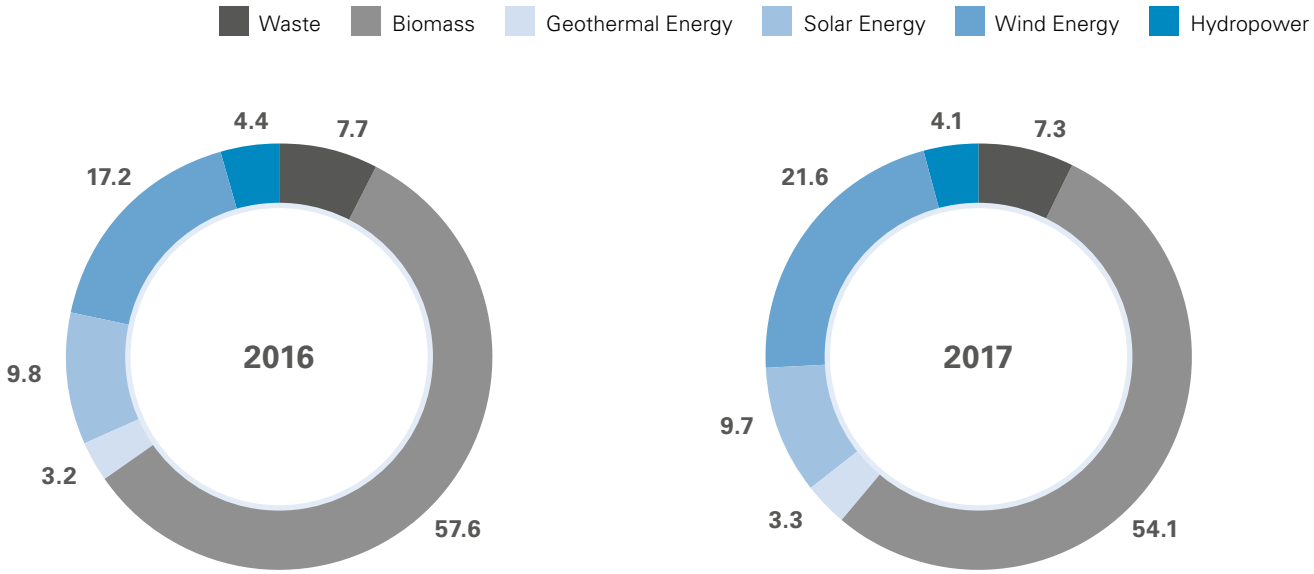
Structure of Renewable Energy Sources in Germany between 2016 and 2017

Shares in Total Renewable Energy in %



Source: Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)

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 0.43 kg CO_2/kWh net in 2017, which represented a significant decrease of 7.5 % compared to the previous year. The downward trend for specific emissions is primarily due to the considerable increase in the production of electric power from renewables and the higher utilization of gas fired power plants as well as the simultaneously decreased production of electric power in hard coal fired power plants. Just concerning the mix of fossil energy carriers, the specific CO_2 emissions in the reporting year amounted to 0.88 kg CO_2/kWh net, which was 1 percent below the previous year's figure.

In 2017, the structure of electricity production shifted considerably further (by 3.5 percentage points) 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 (-3.6 percentage points). Against this backdrop and in light of a gross electricity production that increased by only 0.6 %, a rough calculation indicates a significant decline in CO_2 emissions in the electric power and district heating supply sector by an estimated 6 % to 8 %, which translates into a ballpark figure of up to 20 million tons of CO_2. This would equal the strongest annual decline since German Reunification and the economic crisis of 2009.

If, for a first estimate of the total energy-related CO_2 emissions, the calculation were to be based on the changes in the original values of primary energy consumption (2017/2016: +0.9 %), and when taking the decreased energy intensity of primary energy consumption into account, then a more or less stagnating or, at best, even slightly declining emissions level could be anticipated. But this also means that the remaining sectors taken together must exhibit a respective increase in emissions at least to the same extent as exhibited by the decline in electricity production (please see above). This ought to be once again the case in the transportation sector, if one takes the increase in the consumption of gasoline and diesel fuels as a basis for comparison. Yet in light of the changes in the sale of natural gas to the household, small business, and light fuel oil sectors, increasing emissions ought to be anticipated also in the heating sector. And finally, emissions in industry with its very positive production trend in 2017 ought to have exceeded the previous year's level as well.

Irrespective of the sectoral development of emissions, it can be stated that the total emissions in Germany still continue to be a long way from achieving the objective of attaining a 40 % reduction in greenhouse gas emissions by 2020 when compared to 1990. If one were to assume for simplicity's sake that the trajectory follows essentially a linear course from the base year 1990 (1,252 million tons of CO_2 equivalents) all the way to the emission target for 2020 amounting to approximately 750 million tons of CO_2 equivalents, then a reduction to 818 million tons of CO_2 equivalents would have been necessary by 2016 and/or to only about 800 million tons of CO_2 equivalents by 2017 in order to achieve this national objective – in fact, the emissions in 2016 had amounted to approximately 909 million tons of CO_2 equivalents, and they ought to probably stagnate in 2017. Thus, the previous "underreduction" would have amounted to almost 110 million tons of CO_2 equivalents. In order to attain the objective of 750 million tons by 2020, an annual reduction of 53 million tons of CO_2 equivalents would be required for each of the remaining three years. This simplified calculation aptly demonstrates the enormous challenges that continue to be imposed on the requisite reduction measures which are necessary to reach the objective by 2020. From today's perspective, it does not seem possible that this objective is achieved. Hence, it will first and foremost be paramount to close the target gap for 2020 to the maximum possible extent and to turn all efforts towards achieving the objectives for 2030.

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 originate from domestic electricity production and 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 comparably positive economic trend, but also the expanding population were the primary reasons for the increased primary energy consumption in Germany. In addition, it needs to be pointed out that 2017 had one "energy consumption day" less than the leap year 2016. The development in consumption was further fostered by the still comparably low prices particularly for fossil fuels. As a result, primary energy consumption went up by 0.9 % in 2017. Unlike previous years and in light of the fact that the temperatures were comparable to the previous year, the temperature influence played a relatively minor role so that the temperature-adjusted primary energy consumption is hardly different from the original values. The macroeconomic energy productivity improved by 1.3 %; however, it continued to be below the long-term average of 1.8 % per year.

With a plus of 0.5 %, the increase in electricity consumption was weaker than the increase in primary energy consumption. Thus, the 1.7 % growth in macroeconomic electricity productivity was considerably stronger than the long-term average of only 1.1 % for the period between 1990 and 2016. Electricity consumption increased, above all, in industry, in households, and in transportation.

As measured by the producer price index, electricity prices developed quite differently in 2017 for each respective customer group: While there was an increase of 1.5 % for households and an increase of 1.6 % for commercial customers, the prices for special-contract customers at the low voltage level went up by 4.6 %. With 9.6 %, the prices for special-contract customers at the high voltage level climbed even higher. A particularly strong price increase was recorded at the exchange; here, the prices for electricity on the exchange were almost 22 % higher in 2017 than in 2016. However, the price for electricity on the exchange was still 55.3 % lower in 2017 than in 2008, the year it reached its highest level to date.

The prices for oil products and natural gas were also subject to great fluctuations. In 2017, the import prices for crude oil, which had initially reached their bottom level of about € 315 /t in June, started to increase again during the second half of the year before they finally peaked at almost € 414 /t in December. All told and on an annual average, the crude oil import prices in 2017 were a quarter higher than in 2016. Prices for oil products followed primarily the changes in crude oil costs and in international product quotations; albeit at different rates. All told, an upward trend became apparent in 2017, but it was quite moderate. For example, the prices for premium gasoline in December 2017 were not even one percent higher than in December 2016 while diesel fuel recorded a plus of 2.2 % and light fuel oil a plus of 4 %.

The import prices for natural gas, which have been decreasing for quite some time now, continued to drop in 2017; albeit to a limited extent. Over the course of the year 2017, the import prices remained virtually at the same level they had reached during the 4th quarter of 2016; on an annual average, however, they exceeded the level that had been reached over the course of the entire year 2016 by approximately 10 %. Due to different procurement periods for various customer groups, the development of import prices has different effects on domestic sales prices. Parallel to the import prices for natural gas, the price level for natural gas at the energy exchange increased by more than 21 % while the sales prices to power plants went up by 4 %. For large industrial clients, the prices increased by 10 % compared to the previous year because natural gas had to be procured at shorter notice; for small industrial gas consumers, the purchase price for natural gas remained virtually unchanged. Due to early procurement, the gas prices for the trade, commerce, and service sector went down by 3.7 % and those for private households by 3.2 %.

While the certificate prices in European emissions trading had fluctuated at a very low level between € 4 /t CO_2 and € 6 /t CO_2 in 2016, they have been increasing significantly again since mid-2017. Currently, they amount to a level of nearly € 10 /t CO_2. To what extent this already represents the desired trend reversal in the direction of higher certificate prices will also depend on the efficiency and effectiveness of the intended structural reforms in European emissions trading.

In light of the objectives pursued by the German Federal Government in conjunction with its energy concept, the first energy-related data for 2017 actually provide mixed results. For example, there are doubts as to whether the Federal Government's objective of reducing primary energy consumption by 20 % in 2020 when compared to 2008 will actually be attained; the more so as once again no such contribution was made in 2017. All told, the (unadjusted) primary energy consumption in 2017 was just around 6 % lower than in 2008, the target base year for primary energy consumption. In order to still reach the

objective for 2020, the reduction would have to be increased to nearly 15 % or to 5.3 % per year in the remaining three years, which means it would have to be increased more than sevenfold when compared to the annual average reduction achieved between 2008 and 2017 (-0.7 % per year). But it appears more than questionable whether the requisite measures which have been launched by the Federal Government so far (for example, within the scope of the National Action Plan on Energy Efficiency) will suffice within the short time remaining. Furthermore, it is also possible that opposing trends might impede the attainment of this objective; whether it be the increasing population figures, the positive economic development, or the energy prices and CO_2 certificate prices which continue to be low despite the fact that the price trends for some energy carriers are on the rise again and, thus, 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 would be necessary for electricity consumption to be further decreased in total by a substantial 7 % or by an annual average of 2.4 % when compared to 2017. As measured by the actual development between 2008 and 2017, when electricity consumption had declined by an annual average of only 0.3 %, this equals a reduction rate that is also about seven 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.

The Federal Government's objective of reducing greenhouse gas emissions by 40 % in 2020 when compared to 1990, which has been in effect so far, has meanwhile been adjusted considerably through the coalition agreement concluded between the CDU/CSU and SPD against the backdrop that achieving this objective is considered to be increasingly impossible; towards this end, the coalition agreement now states that measures must be undertaken "to implement the required action as quickly as possible so that the climate objective for 2020 can be reached."[7] The data actually show that the objective has become virtually unattainable because when taking the year 2017 as a basis for comparison, then the emissions would have to be reduced by 53 million tons every year – a goal which is above and beyond any political feasibility.

However, what really matters now is that the planned (and to be legally determined as proposed) objective of reducing emissions by 55 % in 2030 when compared to 1990 is backed by the appropriate efficient and effective measures. This constitutes another considerable challenge because the objective of achieving an emissions level of 563 million tons of CO_2 equivalents in 2030 implies a reduction of about 346 million tons to be realized during the period between 2017 and 2030. This scheduled reduction for the remaining 13 years virtually equals the reduction achieved during the 27 years between 1990 and 2017 (342 million tons). It means that the average annual decline in emissions must be about twice as high for the period between 2017 and 2030 when compared to the decline that was reached between 1990 and 2017. Attaining this objective will not be possible without substantially intensifying the requisite measures in conjunction with energy and climate protection policies.

All told, the development of the level and structure of energy consumption in Germany in 2017, 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. This also applies to the target to be achieved by 2030; the more so as the 2020 objective is meanwhile out of reach. Towards this end, the primary focus should not only be on the electricity sector since there is still a considerable need for action in the building sector and, above all, in the transportation sector where reduction tendencies are still not recognizable.

7 *Draft of the coalition agreement (last update: Feb. 7, 12:45 hrs.), p. 142.*

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