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Energy Consumption

in Germany in 2019

Germany Exhibits Further Decrease in Energy Consumption in 2019

Contents

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Total Primary Energy Consumption

In 2019, the primary energy consumption in Germany amounted to a total of 12,832 petajoules (PJ) or 437.8 million tons of coal equivalents (Mtce); compared to the previous year, this equals a decrease of 2.1 % (please see Table 1).

Table 1

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Primary Energy Consumption in Germany in 2018 and 2019 [1)]

Energy Carrier	2018	2019	2018	2019	Changes in 2019 Compared to 2018			Proportions in %	
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	Mtce	%	2018	2019
Mineral Oil	4,443	4,530	151.6	154.6	87	3.0	2.0	33.9	35.3
Natural Gas	3,090	3,191	105.4	108.9	101	3.4	3.3	23.6	24.9
Hard Coal	1,427	1,134	48.7	38.7	-293	-10.0	-20.5	10.9	8.8
Lignite	1,464	1,167	50.0	39.8	-297	-10.1	-20.3	11.2	9.1
Nuclear Energy	829	820	28.3	28.0	-9	-0.3	-1.1	6.3	6.4
Renewable Energy	1,802	1,896	61.5	64.7	94	3.2	5.2	13.8	14.8
Electricity Exchange Balance	-175	-118	-6.0	-4.0	58	2.0	-	-1.3	-0.9
Other	222	212	7.6	7.2	-10	-0.3	-4.5	1.7	1.7
Total	**13,102**	**12,832**	**447.0**	**437.8**	**-269**	**-9.2**	**-2.1**	**100.0**	**100.0**

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

Sources: Working Group on Energy Balances (AGEB); AGEE-Stat

The level of energy consumption as well as its composition (energy mix) are also influenced by political and regulatory aspects. Significant for the medium-term to long-term development are the gradual phase-out from nuclear energy until the end of 2022, the termination of domestic hard coal mining (at the end of 2018), the scheduled exit from coal fired power generation (by 2038) as well as the continued promotion of expanding renewable energy. Relevant at a European level are, for example, the reduction of the maximum quantity of emissions during the 3rd trading period between 2013 and 2020 within the EU-ETS as well as the objectives pursued for climate protection in the non-ETS sector, energy efficiency, and the expansion of renewable energy.

In 2019 as well, the most important energy carrier in Germany continued to be mineral oil with a share of 35.3 %. It was followed by natural gas with a slightly increased share of 24.9 % (2018: 23.6 %). Renewables were able to expand their position at third place to 14.8 %; in 2018, their contribution had still been 13.8 %. The primary energy consumption of hard coal and lignite in 2019 fell noticeably by more than 20 % each in such a way that lignite still covered approximately 9.1 % and hard coal 8.8 % of the 2019 demand for primary energy. Compared to the previous year, nuclear energy's contribution to primary energy consumption dropped by 1.1 % in 2019 which is why, in light of the even more significant decline in the total consumption, this energy carrier was able to slightly increase its share to 6.4 %. The surplus obtained from the flow of electric power to foreign countries continued to decline in 2019. Consequently, the balance in the electricity exchange had a consumption-reducing effect (by 0.9 percentage points) on primary energy consumption also in 2019.

The development of primary energy consumption is influenced by many factors. As already mentioned above, this includes the general political and regulatory

framework as well as the macroeconomic and sectoral development (structural change), demographic factors, energy prices, and the weather conditions.
A closer look at select factors which played a specific role in the decline in primary energy consumption during the years 2018/2019 will be taken below.

Temperature and Weather Influence

The temperature conditions play, to a large extent, a vital role in the non-industrial energy consumption because most of the energy consumed in these sectors is designated for the heating or air conditioning of privately and commercially used rooms. The temperature influence is usually measured by means of degree day figures; this index states the

Figure 1

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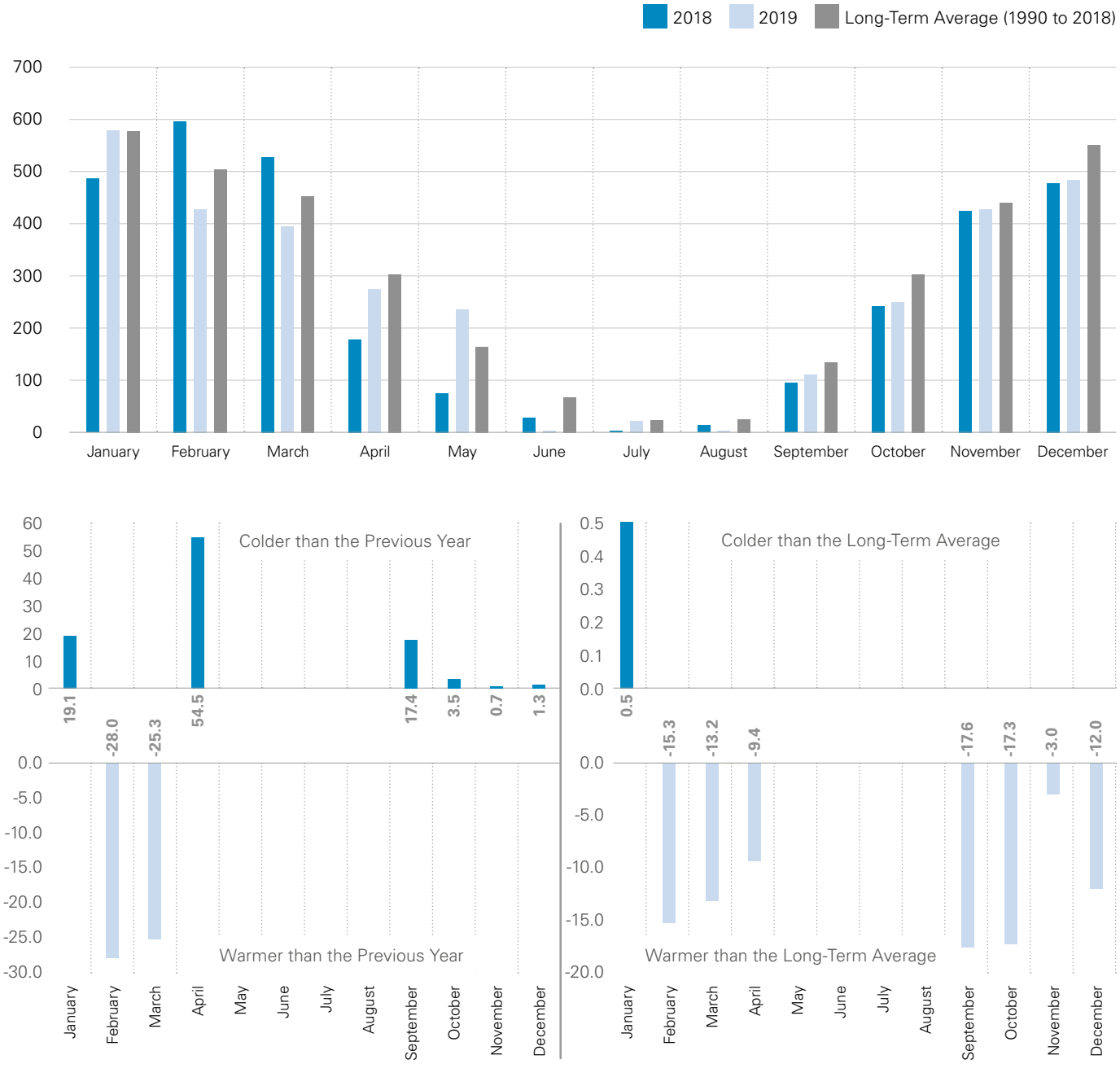
Monthly Degree Day Figures in Germany in 2019 (16 Measurement Stations)

Changes in 2019 compared to the previous year and to the long-term average (1990-2018) in %.
Due to their limited informative value, the months of July and August are not included.



Source: Germany's National Meteorological Service (DWD)

cumulative number of the specific days on which the average temperature falls below a certain level (heating threshold temperature; here: 15 degrees Celsius).

In 2019, the number of degree days was significantly below the long-term average. The small number of days with heating threshold temperatures of less than 15° C points towards a higher average temperature level (+ 9.7 %) and a drop in the energy demand for heating purposes. Compared to the previous year, however, the number of degree days increased slightly in 2019 because it was somewhat cooler in 2019 than it had been in 2018. Against this backdrop, the energy used for heating purposes ought to have increased slightly in 2019 when compared to the previous year.[1]

When considering the development of the degree day figures during the individual months, it becomes apparent that the year 2019, particularly during the months of January, April, and May, was significantly cooler than the previous year. In contrast, and as measured by the degree day figures, the temperatures in February and March significantly exceeded those of 2018 (please see Figure 1).

The impact of short-term temperature changes on the development of primary energy consumption is eliminated in that temperatures are assumed as indicated in the long-term average and that inventory-adjusted data are taken into account for mineral oil consumption.[2] When taking these assumptions as a basis, primary energy consumption would not have declined by 2.1 %; instead, the decrease would have been 2.4 %. The adjustment effect has a different impact on the individual energy carriers which is dependent upon their use for space heating purposes (please see Figure 2).

Figure 2

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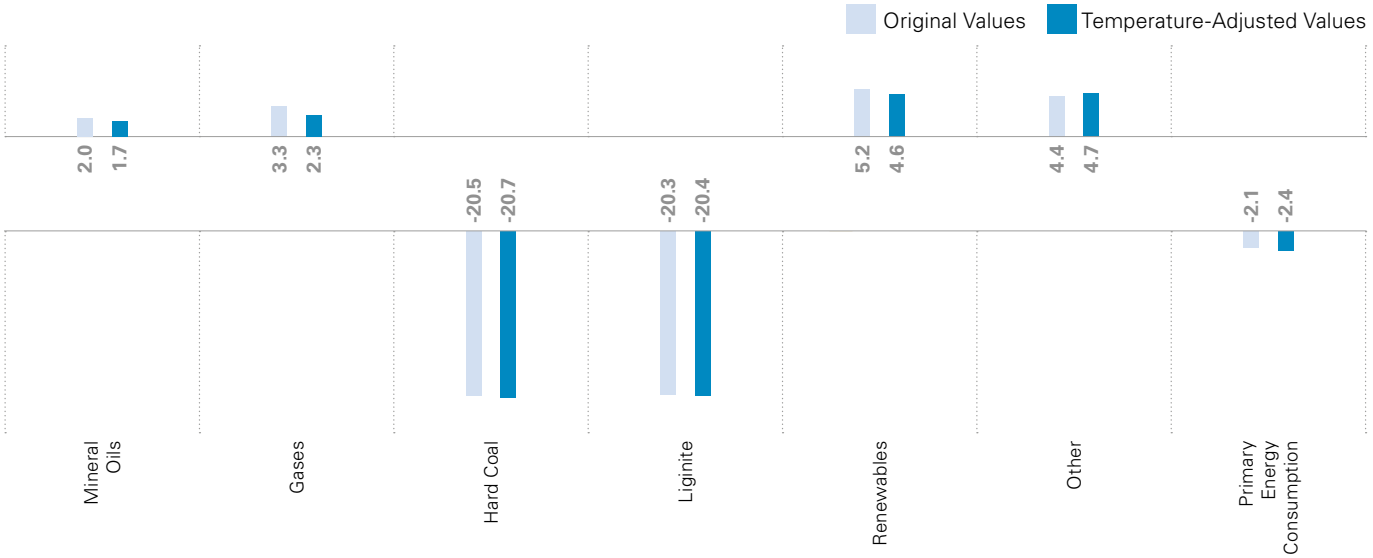
Primary Energy Consumption in Germany According to Energy Sources

Changes between 2019 and 2018 in %



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

1 *When compared to the long-term average (average number of degree day figures between 1990 and 2018), though, the year 2019 was extraordinarily warm; consequently, the mild winter caused the heating period to be relatively short. On an annual average (as measured by the degree days, and as a mean value taken from 16 measurement stations), the temperatures were 9.7 % higher than the long-term average. If against this backdrop one were to shift one's considerations towards a long-term perspective, then primary energy consumption would have been above the level observed both in 2018 and 2019 provided that the weather conditions during these years had equaled those of the long-term average.*

2 *The information on mineral oil consumption provided in the energy balance (particularly when it comes to light fuel oil) includes, in part, only sales figures. Hence, the actual consumption of this energy carrier may deviate from the indicated sales volumes by the respective changes in stockpiling. Yet official statistics actually record these inventory changes only for the energy sector and the manufacturing industry which means that the requisite figures can only be incorporated into the consumption calculations of these two sectors. No original statistical data are available on the changes in fuel oil stocks for private households and for the trade, commerce, and service sector. In order to close the described gap, the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group) has been using for quite some time now an econometrically based method which is designed to empirically determine the inventory changes for these sectors and which permits complete and comprehensive consumption calculations also for mineral oils. For more details on this procedure, please see "Implementing a Procedure for the Periodic and Current Ascertainment of the Energy Consumption in Areas Not Recorded by Official Statistics" (2016), a survey conducted by the AG Energiebilanzen on behalf of the German Federal Ministry for Economic Affairs and Energy (BMWI), pp. 82ff.*
(Internet: https://www.bmwi.de/Redaktion/DE/Downloads/Studien/umsetzung-verfahren-ermittlung-energieverbrauch-nicht-amtliche-statisik-langfassung.pdf?__blob=publicationFile&v=7 (download date: 2020-02-13; currently only available in German).

When it comes to the influence of the weather, it is generally accepted that temperature-adjusted changes in energy consumption in comparably warmer years are more substantial than changes in the original values; accordingly, in colder years the increases in temperature-adjusted values are generally lower than those in the original values. This becomes also apparent from the different spreads of the energy carriers depicted in Figure 2.

Macroeconomic and Sectoral Factors

An export-oriented economy, which imports a substantial share of its demand for energy carriers and raw materials, as is characteristic for Germany, depends to a large extent on global developments. According to estimates of the International Monetary Fund (IMF) and in light of numerous crises and an increasing number of trade barriers, the global economy grew by about 2.9 % in 2019. For comparison: In 2018, the global economy had still expanded by 3.6 %.

The price-adjusted gross domestic product (GDP) in Germany grew by 0.6 % in 2019 (this was the lowest growth rate since 2013: 0.4 %). In the preceding year, the gross domestic product had still grown by 1.5 %; the increase had, thus, been significantly stronger. In 2019, growth impulses came primarily from consumption (private consumption expenditure +1.6 %, governmental consumption expenditure +2.5 %), and construction investments (+3.8 %). In contrast, exports of goods and services recorded a plus of 0.9 % in 2019; even though this represented an increase, they lost considerable momentum when compared to the previous year (+2.1 %).

The economic downturn affected primarily the industrial production sectors in the economy. All told, the production industry shrank by 3.9 % in 2019 (2018: +0.9 %); in the manufacturing industry, the production (also measured by the production index) even decreased by 5 % in 2019 (2018: +1.2 %).

Figure 3

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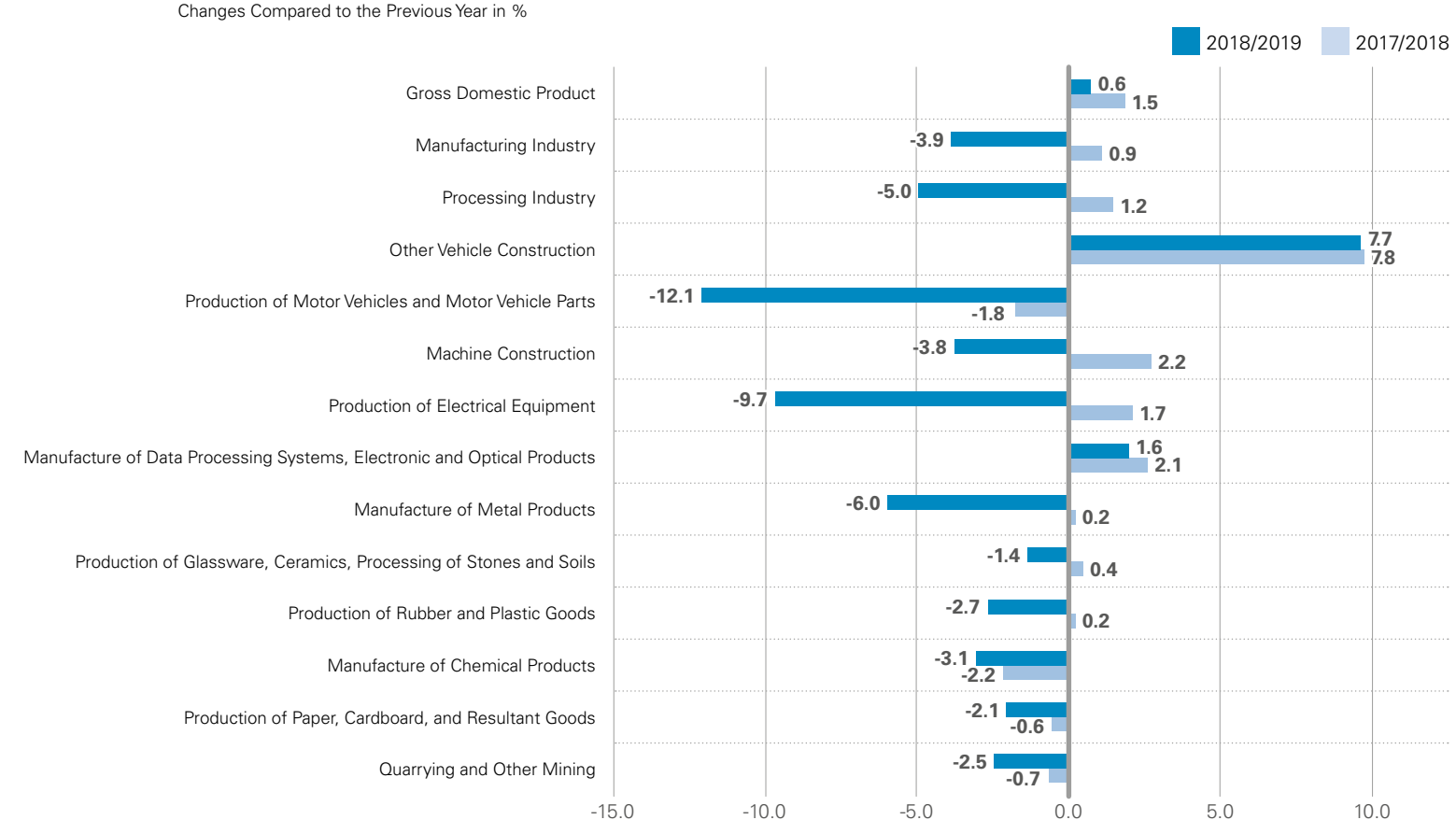
Production Index in Germany's Manufacturing Industry between 2018 and 2019

Changes Compared to the Previous Year in %



Source: Federal Statistical Office (Destatis)

The divergences ascertained for the macroeconomic utilization aggregates were directly reflected by the sectoral production, and they also exerted a decisive impact on the changes in the energy consumption during the period under review: Economic branches which either directly sell a significant proportion of their production abroad or act as prepaid suppliers for export-dependent sectors were affected by the decline in exports to an above average extent. Economic branches which produce consumer goods and consumables as well as economic branches which provide preliminary work to the construction industry were less affected by the economic downturn.

Against this backdrop, Figure 3 provides an overview of the annual rates of change in the production indices for 11 key economic branches (aggregated at the two-digit level of the economic branch classification WZ) of the manufacturing industry between 2017 and 2019:

- In 2019, only 2 economic branches were able to attain increases in production. These included the sectors manufacture of other transport equipment (+7.7 %) and manufacture of computers, electronic and optical products (+1.6 %), whereby the production growth in both economic branches did not reach the previous year's level.

- All other branches of the manufacturing industry recorded declines in production.

- Compared to the manufacturing industry as a whole, significantly above average growth slumps were reflected by production decreases in the sectors manufacture of motor vehicles, trailers, and semi-trailers (-12.1 %), manufacture of electrical equipment (-9.7 %) as well as the exceptionally energy-intensive sector manufacture of basic metals (-6.0 %).

- Compared to the development in the manufacturing industry, the overall declines in production in the remaining energy-intensive branches were below average. In 2019, the manufacture of chemicals and chemical products dropped by 3.1 %, the manufacture of paper and paper products by 3.1 %, and the manufacture of other non-metallic mineral products (which not only includes the production of glassware and ceramics as well as the processing of stones and soils, but also such energy-intensive processes as, for example, the burning of cement, lime, or bricks) by 1.4 %.

As a result of the described production decreases in virtually all branches of the manufacturing industry, a consumption-reducing impulse can generally be expected for the use of energy in the reporting year 2019; even though it must be kept in mind that part of the consumption that decreased due to the economic situation was presumably compensated again thanks to low capacity utilization.[3]

Demographic Factors

Between 2018 and 2019, the population in Germany grew from 82.9 million people to around 83.1 million people; this equals an increase in population of 0.2 %. Under these premises, the number of households is likely to increase further as well. In 2018, about 41.4 million households existed in Germany, of which almost 42 % were single-person households.

The increase in the number of households is not only due to the demographic development, but also due to the continuing trend of living in smaller households. Currently, an average of 2.0 persons live in one household.

The demographic development in 2019 is likely to have had a consumption-enhancing impact on energy consumption even though its influence on energy consumption might have only played a minor role in this.

Energy Prices

In addition, the energy prices also have an impact on the consumption behavior, efficiency improvements, and substitution processes. Generally speaking, the

3 *Low capacity utilization rates due to an economic downturn typically lead to increases in the specific demand for energy due to the fact that the energetic losses of many production facilities (dryers, kilns, etc.) remain virtually unchanged. In times of underutilization due to macroeconomic constraints, continuously working tunnel kilns in the brick industry, for example, are operated with so-called "empty loads" in order to keep the production running; this means, on the one hand, that the absolute energy consumption remains virtually constant or decreases only marginally and, on the other hand, that the (specific) energy consumption per ton of bricks actually increases.*

higher the prices for individual energy carriers are, the sooner efficiency improvements and substitutions occur.

On average, the import prices for crude oil, natural gas, and hard coals dropped between 2.3 % and 20.6 % in 2019 after price increases had been observed in particular for crude oil and natural gas in the previous year (please see Table 2). The import prices based on dollars decreased even more substantially. The development of the exchange rate (devaluation of the Euro against the US Dollar) partially offset the decline in prices on the global market for consumers in Germany.

The prices for domestic consumers deviate to some extent noticeably from the development of import prices because these prices, in addition to governmental taxes as well as statutory charges and levies, also include such components as transport and distribution costs as well as other distribution expenses. The consumer price trend for specific customer groups and/or end users will be highlighted in more detail in the respective sections referring to the individual energy carriers.

Table 2

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Prices of Selected Energy Sources

Changes 2019 to 2018 in %

	2018	2019				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average
		Import Prices				
Mineral Oil	24.6	3.4	1.7	-11.4	-1.9	-2.3
Natural Gas	18.1	6.8	-18.0	-34.2	-32.1	-20.6
Hard Coal	2.0	2.2	-11.3	-17.6	-25.0	-13.3
		Consumer Prices				
Fuel Oil, Light	21.8	11.6	3.1	-5.6	-15.1	-2.5
Natural Gas	-1.3	2.4	3.6	4.5	5.2	3.9
Electricity	1.3	2.7	3.2	3.8	3.9	3.4

Source: Federal Statistical Office (Destatis)

Dependence on Energy Imports

When it comes to the German economy's vulnerability to energy crises, a vital role is assigned to the availability of energy resources and the associated possibility of their domestic production and utilization. On the one hand, higher domestic production volumes generally reduce the dependence on imports and, thus, lower the risk of disturbances or disruptions in the overall supply as well as the commodity price risk for the domestic economy. On the other hand, however, Germany is considered to be more or less a resource-poor country at a global comparison.

Against this backdrop, a glance at Germany's foreign trade balance for energy carriers is of particular interest. When it comes to fossil fuels (hard coals, mineral oil, natural gas), Germany is a considerable or even a complete net importer. In 2018, domestic primary energy consumption had been covered by imports which amounted to 88 % for hard coal, 99 % for mineral oil, and 97 % for natural gas. In contrast, 100 % of the lignite had been made available from indigenous resources, and renewables had also come almost entirely from domestic production. All told, nearly 71 % of the German energy supply had been dependent on imports in 2018.

This situation remained basically unchanged in 2019 as well. The dependence on imports of hard coal increased (due to the complete discontinuation of the domestic production at the end of 2018) to 100 % in 2019. At the same time, the domestic production decreased by 21 % for lignite and increased by 6 % for renewables. The export surplus for electrical energy remained virtually unchanged in 2019; compared to the previous year, however, it declined by 58 PJ (more than 16 billion kWh respectively). According to first rough calculations, the changes outlined above were reflected by a slight increase in the import quota; nonetheless, the dependence on imports ought to still amount to almost 71 % also in 2019.

The import prices for fossil fuels changed significantly. As a result, the decrease in import prices caused the import calculation for coal, oil, and gas to drop substantially from about 65 billion euros in 2018 by 4.1 billion euros and/or by 6.3% to almost 61 billion euros in 2019.

A glance at the individual energy carriers reveals the following picture: The value of oil imports decreased by 2.8 %, the value of natural gas imports by 12.7 %. The value-based import balance for coals even decreased by more than 18 %. When it comes to electric power, the export surplus decreased by approximately 16 % (please see Table 3).

Table 3

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Balance of Foreign Trade with Energy Carriers in Germany between 2010 and 2019

	2010	2012	2015	2016	2017	2018	2019	2019 ./. 2018	
	Foreign Trade Balance (Imports ./. Exports) in Billion Euros							Billion Euros	%
Coal, Coke, and Briquettes	4.4	5.1	4.0	3.5	5.2	5.0	4.0	-0.9	-18.3
Petroleum, Petroleum Products, and Related Goods	49.4	68.0	38.0	29.0	36.1	43.8	42.6	-1.2	-2.8
Gas [1]	20.7	30.5	20.5	16.1	15.0	18.0	15.7	-2.3	-12.7
Total Fossil Fuels	**74.6**	**103.6**	**62.5**	**48.6**	**56.3**	**66.8**	**62.4**	**-4.4**	**-6.6**
Electric Power	-1.0	-1.4	-2.1	-1.7	-1.8	-1.9	-1.6	0.3	-15.9
Total	**73.5**	**102.2**	**60.4**	**46.9**	**54.5**	**64.9**	**60.8**	**-4.1**	**-6.3**

1) Including transit volumes

Source: Federal Statistical Office (Destatis), Special Series 2 Series 1 (values according to sections of the Standard International Trade Classification, SITC-Rev. 4); Source since 2017: Special Series 7, Series 1 (summary overviews of foreign trade, Table 7.2 (Imports) and 7.1 (Exports))

Primary Energy Production in Germany

Except for renewables, domestic energy production decreased for all other energy carriers in 2019 which resulted in an overall decline of approximately 8 % to 3,582 PJ or 122.2 Mtce (please see Table 4). The strongest decline was recorded for lignite with a quantitative minus of about 316 PJ (-21 %) and for hard coal with -79 PJ (-100 %). At the same time, the domestic production of petroleum and natural gas also dropped over the past few years which was due to the increasing depletion of old fields and deposits. This trend continued during the reporting year 2019: Compared to the previous year, natural gas production and petroleum gas production decreased by 4 % (8 PJ) and domestic petroleum production by almost 7 % (6 PJ) in 2019.[4]

Renewable energy carriers managed to significantly expand their position as the most important indigenous energy source ahead of the traditionally strong lignite; their proportion of the total domestic production now amounted to well above 53 %, followed by lignite which accounted for approximately one third of the domestic energy production. Both continued to rank far ahead of natural gas and petroleum.

When taking primary energy consumption in 2019 into account, the proportion of domestic production decreased; namely, from 29.7 % in 2018 to now almost 28 % (please see Table 4).

Table 4

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Primary Energy Production in Germany in 2018 and 2019

	Production				Changes in 2019 Compared to 2018		Proportions	
	2018	2019	2018	2019			2018	2019
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	%	%	
Mineral Oil	88	82	3.0	2.8	-6	-6.9	2.3	2.3
Natural Gas, Petroleum Gas	200	192	6.8	6.6	-8	-4.0	5.1	5.4
Hard Coal	79	0	2.7	0.0	-79	-100.0	2.0	0.0
Lignite	1,506	1,190	51.4	40.6	-316	-21.0	38.7	33.2
Renewable Energy	1,797	1,906	61.3	65.0	109	6.1	46.2	53.2
Other Energy Carriers	222	212	7.6	7.2	-10	-4.5	5.7	5.9
Total	**3,892**	**3,582**	**132.8**	**122.2**	**-310**	**-8.0**	**100.0**	**100.0**
For information purposes: Proportion of Primary Energy Consumption	-	-	-	-	-	-	29.7	27.9

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

Sources: German Association of Energy and Water Industries (BDEW); German Brown Coal Industry Association (DEBRIV); German Hard Coal Association (GVSt); Federal Association for Natural Gas, Crude Oil, and Geoenergy (BVEG); Association of the German Petroleum Industry (MWV)

4 It needs to be noted in this context that the production of natural gas and petroleum not only depends on geophysical-technical factors, but also on economic constraints. Increasing oil and gas prices usually generate a particular impulse to reinforce the exploration efforts. Also worth mentioning here is that in times of high energy prices, the recommissioning of old fields and the use of new production technologies can perhaps be economically viable as well.

Mineral Oil

Compared to the previous year, the primary energy consumption of mineral oil in Germany was 2.0 % higher with 4,530 PJ (154.6 Mtce) in 2019.

Except for naphtha and heavy fuel oil, all products (domestic sales) recorded a plus. At the same time, consumption of the most important mineral oil products developed very differently from one another (please see Table 5): Compared to the previous year, the consumption of diesel fuels increased by 1.5 % to 38 million tons. But with 38 million tons, the consumption of diesel fuels continued to be more than twice as

Table 5

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Consumption and Volume of Mineral Oil in Germany in 2018 and 2019

		2018	2019 [1]	Change
		in Million Tons	in Million Tons	in %
Total Consumption		**103.9**	**105.9**	**2.0**
Self-Consumption and Losses [2]		5.7	5.6	-2.4
Domestic Consumption		98.2	100.3	2.2
Proportion of:	Gasoline	17.8	18.0	0.7
	Diesel Fuel	37.5	38.0	1.5
	Aviation Fuels	10.2	10.3	0.9
	Fuel Oil, Light	13.3	15.3	15.5
	Fuel Oil, Heavy [3]	1.8	1.8	-1.1
	Naphtha	11.4	11.0	-3.5
	Liquid Gas	3.6	3.9	8.2
	Lubricants	1.0	1.1	4.8
	Other Products	10.3	10.5	2.5
	Recycling (to be deducted)	-5.5	-6.3	14.6
	Biofuels [4] (to be deducted)	-3.4	-3.4	0.4
Total Volume		**98.1**	**100.3**	**2.2**
Domestic Production		2.1	2.0	-4.3
Refinery Production		99.0	98.7	-0.3
Generated from:	Input of Crude Oil	87.7	87.0	-0.8
	Input of Products	11.4	11.7	2.8
Foreign Trade Products (Balance)		17.7	20.3	-
	Imports	40.3	42.4	5.0
	Exports	22.6	22.0	-2.7
Compensation [Balance (Bunker, Differences)]		-12.9	-13.1	-
Refining Capacity		102.7	102.7	-
Utilization of Refining Capacity in %		0.9	0.8	-
Primary Energy Consumption of Mineral Oil (Mtce)		**4,443**	**4,530**	**2.0**

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)

high as that of gasoline whose demand grew by 0.7 % in 2019. The consumption of aviation fuels increased by only 0.9 % during the reporting year; thus, growth dynamics continued to slow down (2018: +2.3 %; 2017: +8.6 %). All told, the demand for fuels (2019: More than 66 million tons), which accounted for a share of almost 63 % in Germany's total oil consumption, was 1.2 % higher in 2019 than it had been in 2018.

With an increase of 15.5 %, sales of light fuel oil experienced a strong upward trend. In light of the weather, which once again was only slightly cooler in 2019 when compared to the previous year, marginally reduced prices, and continuing efficiency improvements due to the use of modern oil condensing heating systems, and finally, due to substituting oil fired heating systems, for example, with heat pumps or natural gas condensing systems, this upswing was probably caused to a lesser extent by "real" consumption increases rather than, above all, the replenishment of fuel oil stocks on part of private households.

At least the prices for light fuel oil decreased at an annual average between 2018 and 2019 from 68.9 c/liter to 67.3 c/liter, which equals a decline of approximately 2.3 %. Due to the price reductions in conjunction with the mild weather, the stock volumes were likely to have been increased by almost 1 million tons (which translates into 41 PJ). If this were indeed the case, then the actual consumption would most likely be correspondingly lower than the volume of fuel oil sold in 2019.

With 0.3 %, refinery production decreased slightly in 2019. Towards this end, refinery production from crude oil, which accounted for a share of about 88 %, decreased by 0.8 % whereas the processing of products increased by 2.8 %. In light of the declining production, the refining capacity of 103 million tons, which remained unchanged in 2019, was actually utilized at 84.8 % in 2019; in 2018, the degree of utilization had still amounted to 85.4 %.

All told, foreign trade in mineral oil products changed only slightly. On balance, imports predominated in 2019; with 42.4 million tons, they topped the exports of 22 million tons by more than 20 million tons.

Due to its very limited domestic petroleum resources, Germany is primarily dependent on crude oil imports which exceeded the previous year's level by 0.9 % with 86 million tons in 2019. In 2019, the three by far most important supplier countries for crude oil continued to be Russia (with a share of 31.5 %), Norway (11.3 %), and the United Kingdom (11.9 %); altogether, these countries contributed 54.7 % to German crude oil imports. Other important supplier countries in 2019 were Kazakhstan, Azerbaijan, Nigeria as well as the USA, whereby imports from the USA increased by 37 % when compared to the previous year (please see Table 6). Split into individual oil producing regions, the proportion of crude oil imports from the countries of the former Soviet Union (CIS states) experienced a noticeable decline; it decreased from 47.9 % in 2018 to 42.3 % in 2019. In contrast, the OPEC states (2018: 22.6 %) and the countries bordering the North Sea (2018: About 21 %) recorded increases in their shares.

In 2019 as well, international oil prices and the Euro/US Dollar exchange rate exhibited a volatile development; in other words, they experienced considerable short-term fluctuations (please see Figure 4).

While crude oil grade Brent UK, which is important for Europe, had reached the highest level since 2016 with an annual average of about 71 US dollars per barrel (US $/bbl; 1 barrel = 159 liters) in 2018 (whereby this price level is still far from the peak levels of about US-$ 112/bbl which had been attained in 2011/2012), the average price in 2019 dropped to nearly US-$ 64/bbl. The development in 2019 did not show a clear trend yet: The crude oil price went up at the beginning of the year, reached its monthly peak in May (more than US-$ 71/bbl), dropped to its annual low (US-$ 59/bbl) by August, and increased again to a level of more than US-$ 67/bbl by December 2019.

German crude oil import prices developed to a large extent parallel to the global market prices. Differences are essentially influenced by fluctuations in the exchange rate of the Euro (to the US Dollar). Since early 2018, the Euro exchange rate had continued to deteriorate. Compared to January 2018, the exchange rate had dropped by more than 6 % from US $ 1.22 per Euro to US $ 1.1416 by January 2019. This trend continued in 2019. Until the end of 2019, the Euro continued to lose value against the US Dollar; the exchange rate decreased (subject to monthly fluctuations) by 2.6 % to about US-$ 1.11 per Euro by December 2019. The devaluation of the Euro against the US Dollar partially compensated the decline

Table 6

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Germany's Crude Oil Imports in 2018 and 2019 According to Countries of Origin

Important Supplier Countries/ Production Regions	2018	2019	Changes 2018/2019	2018	2019
	in Million Tons		in %	Proportions in %	
Russia	31.0	27.1	-12.5	36.3	31.5
Norway	10.0	9.7	-3.2	11.8	11.3
Libya	7.2	8.3	15.6	8.5	9.7
Kazakhstan	6.8	6.3	-7.3	8.0	7.4
United Kingdom	6.7	10.2	52.8	7.8	11.9
Nigeria	5.5	5.2	-4.1	6.4	6.1
USA	3.9	5.3	37.0	4.6	6.2
Azerbaijan	3.1	2.5	-20.0	3.6	2.8
Iraq	3.0	2.0	-35.4	3.6	2.3
Saudi Arabia	1.4	1.7	21.9	1.7	2.0
Other Countries	6.6	7.6	15.0	7.8	8.8
Total	**85.2**	**86.0**	**0.9**	**100.0**	**100.0**
OPEC	19.2	20.4	6.1	22.6	23.7
North Sea [1] (excld. FRG)	17.8	20.8	17.2	20.8	24.2
Former CIS	40.9	36.4	-10.9	47.9	42.3
Other	7.4	8.4	13.9	8.7	9.8
Total	**85.2**	**86.0**	**0.9**	**100.0**	**100.0**

1) Including other EU countries

Discrepancies in the totals are due to rounding off

Sources: Federal Office of Economics and Export Control (BAFA); RohölINFO [Information on Crude Oil], December 2019

in crude oil prices on the global market for German consumers. All told, German crude oil import prices (on an annual basis and calculated in Euro/bbl) dropped at a slower rate (-5.3 %) than the global market prices for crude oil (-10.2 %) between 2018 and 2019.

This resulted in a reduction of German crude oil import prices from an annual average of 452 euros per ton (Euro/t) in 2018 to 428 Euro/t in 2019. Considering the import volumes, which increased by almost 1 % in 2019 when compared to the previous year while the crude oil prices for German consumers decreased by 5.3 % over the same period of time, the overall costs for crude oil imports went down by approximately 4.4 % from 38.5 billion euros to 36.8 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 5). While the prices for premium gasoline, diesel fuel, and light fuel oil had increased noticeably at an annual average between 2017 and 2018, they experienced a slight decline in 2019 when compared to 2018: On average, the annual prices for premium gasoline decreased by 1.7 %, for diesel fuel by 1.6 %, and for light fuel oil by 2.3 %.

Yet over the course of the year 2019, an increasing trend became initially apparent once again for all three products so that in May 2019, all prices exceeded the level which had still been observed in May of the previous year. Until the end of the year, the prices for all products under review here decreased once again; by the end of the year, however, they still marginally exceeded the low point that had been reached in January. As measured by the producer price index, the prices for mineral oil products in Germany were at an annual average and in total 2.4 % lower in 2019 than in 2018.

Figure 4

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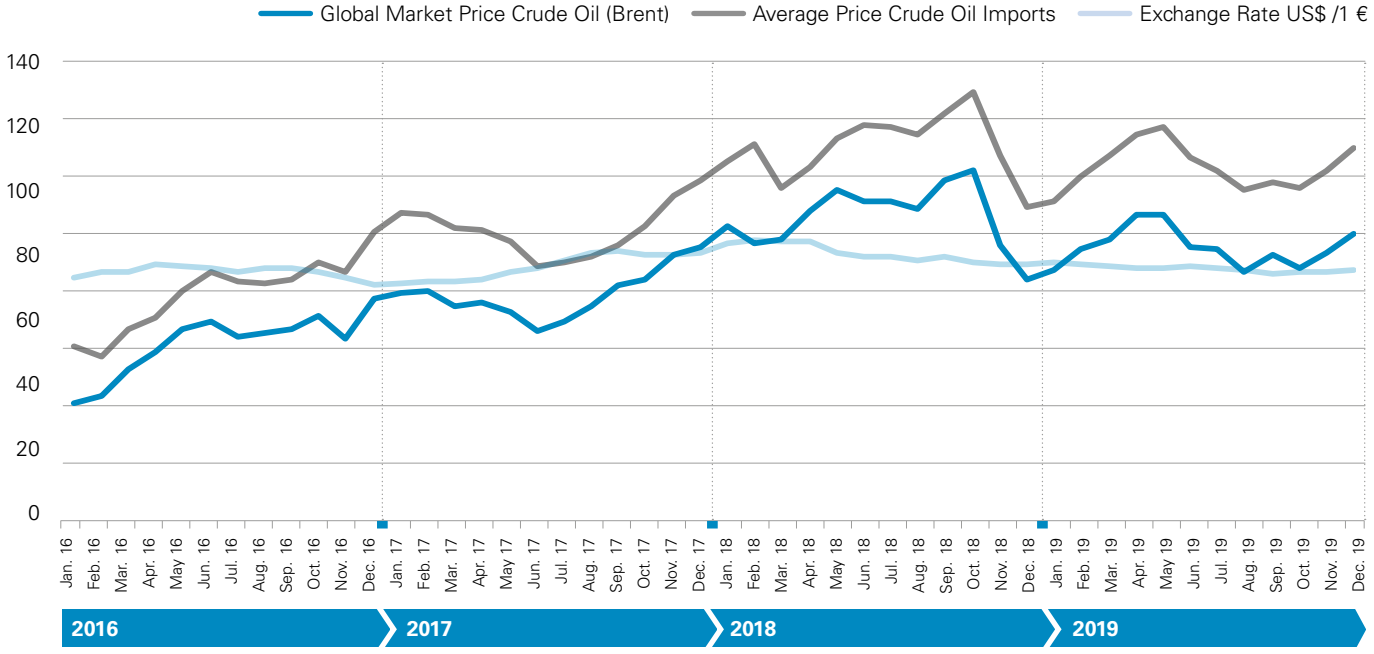
Global Market Prices for Crude Oil (Brent) [1], Border-Crossing Prices for German Crude Oil Imports [2] and Exchange Rates between 2016 and 2019

January 2010 = 100



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 5

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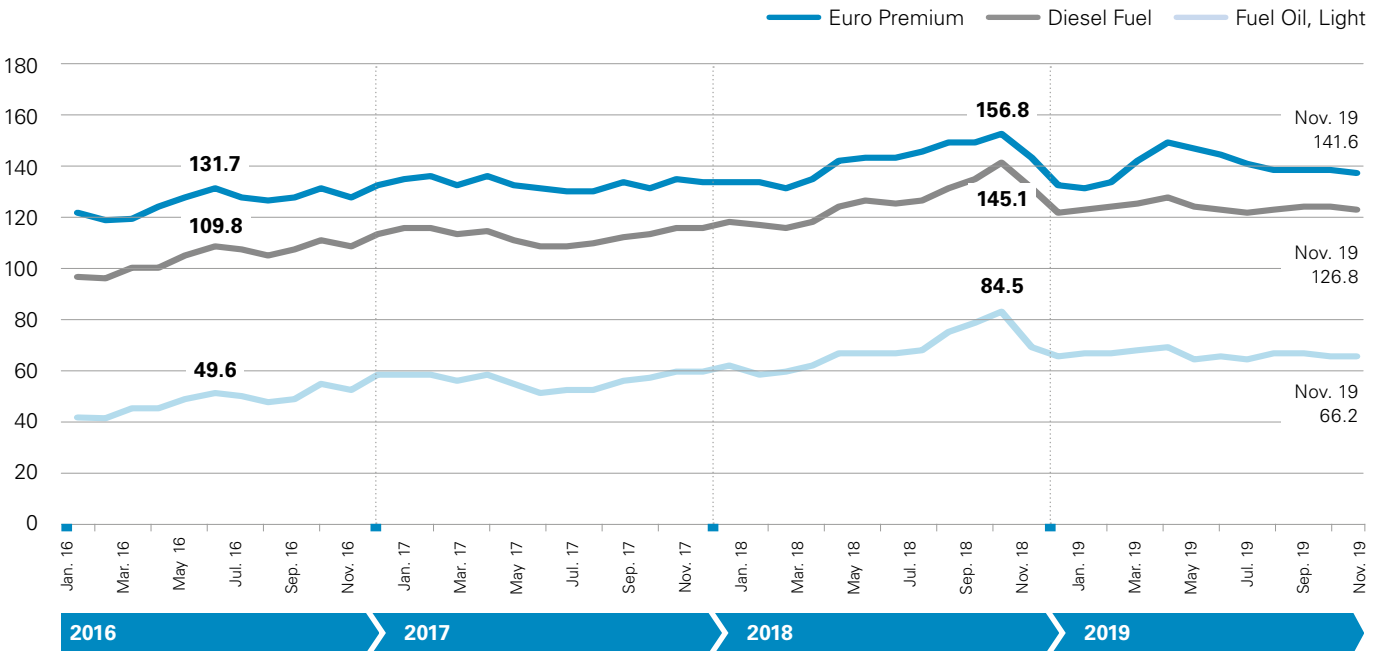
Prices for Fuels and Light Fuel Oil in Germany between 2016 and 2019

Eurocents per Liter



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

Natural Gas

According to preliminary data, natural gas consumption in Germany increased by more than 3 % to 982 billion kWh in 2019. This rise can be explained by several factors. In particular, the increased use of natural gas for the generation of electricity and heat in the power plants and the combined heat and power plants of the electricity suppliers accounted for a significant plus in consumption. The weather during the first half of 2019, which was sometimes significantly cooler than during the same period of the previous year, caused sales primarily to private households as well as to the trade, commerce, and service sector to increase. The continuous construction of new natural gas heated dwellings reinforced the increase in consumption even further. On the other hand, the economic slowdown resulted in a decline in the industrial demand for natural gas, which dampened the overall increase in consumption.

The proportion of electricity generated from natural gas in relation to the total gross electricity production in Germany increased by 2.1 percentage points to 15.1 %. However, the developments which produced this result were very inconsistent. Energy suppliers used considerably more natural gas in their power plants and combined heat and power plants. In contrast, the volume of natural gas used by industry for the combined production of heat and electricity in its own power plants decreased by more than 1 %.

Over 3 % more natural gas went into the generation of heat in the heating and thermal power stations of the energy suppliers. According to initial estimates, almost 47 % of the district heat produced in Germany in 2019 came from natural gas.

After the comparably cooler temperatures during the months of January, April, and May had initially resulted in a higher consumption of natural gas for the heating of residential and commercial properties, the warm temperatures caused the demand for heat to decrease as of June. The temperature effect was reinforced by the weather which was temporarily much too dry in some parts of Germany (the precipitation volume in the west was at an average level).

An aspect which causes 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 approximately 295,000 new homes (in new residential buildings) were granted in 2019. 37.0 % of them will get their heat from a gas-powered heating system; 25.5 % of them will be connected to the district heating grid. New homes in existing buildings as well as existing dwellings which are converted from other heating systems to natural gas powered heating and district heating systems must be added to this figure. All told, more than 20.9 million homes, which translates into 49.5 % of the existing homes, were equipped with a gas-powered heating system at the end of 2019.

In a nutshell, the use and utilization of natural gas developed quite differently in the individual consumption sectors in 2019 (please see Table 7):

- The construction of new homes that are heated with natural gas either directly or indirectly and, in addition, the use of natural gas in non-residential buildings as well as the cooler weather in early 2019 all resulted in a slight increase in sales in the space heating market. The proportion of natural gas consumed by private households, housing companies as well as commercial and service enterprises increased by an estimated 0.6 %.

- Starting already in the 3rd quarter of 2018, an economic downturn caused industry's demand for natural gas to decrease. Less natural gas than in the previous year was used for the production of process heat and electricity in power plants owned by industry and as a raw material in the chemical raw materials industry. All told, consumption in industry decreased by 0.7 %.

- The use of natural gas in power plants and heating stations supplying the general public had increased significantly since the beginning of 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 cogeneration plants based on natural gas to once again achieve more hours of full utilization. After a decline had been recorded here in 2018, a large number of factors finally led to a new upsurge: Price signals, shutdowns or transfers of coal fired power plants into the standby mode for backup purposes, and also the increasing number of district heating connections. All told, this resulted in a substantial plus of 12.7 % when it comes to the use of natural gas in the supply and provision of electric power and heat (including combined heat and power plants).

Table 7

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Volume and Use of Natural Gas in Germany in 2019 and 2018

	Unit	2018	2019 [1]	Change in %
Domestic Production	Billion kWh	62	59	-4.0
Imports [2]	Billion kWh	1,773	1,712	-3.4
Total Volume of Natural Gas	Billion kWh	1,835	1,771	-3.5
Storage Balance [3]	Billion kWh	-22	-53	140.3
Exports [2]	Billion kWh	862	737	-14.5
Self-Consumption and Statistical Differences	Billion kWh	16	25	57.1
Domestic Sales of Natural Gas	Billion kWh	**935**	**957**	**2.3**
Primary Energy Consumption of Natural Gas	**Billion kWh**	**951**	**982**	**3.3**
	Petajoules (H_u)	**3,090**	**3,191**	**3.3**
	Mtce (H_u)	**105**	**109**	**3.3**
Structure of Natural Gas Generation by Origin				
Domestic Production	%	3.4	3.3	
Import Quota	%	96.6	96.7	
Structure of Natural Gas Consumption According to Consumer Groups				
Industry (Including Industrial Power Plants)	Billion kWh	366	363	-0.7
Power Supply (Including CHP Plants)	Billion kWh	109	129	18.1
Provision of District Heating and Cooling (Including CHP Plants)	Billion kWh	63	66	3.3
Private Households	Billion kWh	283	285	0.7
Trade, Commerce, Services	Billion kWh	113	113	0.6
Transportation	Billion kWh	2	2	0.0
Total Sales of Natural Gas	**Billion kWh**	**935**	**957**	**2.3**
Self-Consumption and Statistical Differences	Billion kWh	16	25	57.1
Natural Gas Consumption	**Billion kWh**	**951**	**982**	**3.3**

1) Preliminary data; some figures are estimates
2) Import and export volumes including all transit volumes
3) Minus = storage; plus = withdrawal

Discrepancies in the totals are due to rounding off

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

Compared to 2018, the proportion of natural gas of the total primary energy consumption increased by 1.3 percentage points to 24.9 % in 2019.

Domestic natural gas production, which has continued to decline rapidly for many years now, amounted to more than 59 billion kWh in 2019. This accounted for 6.0 % of the domestic natural gas consumption. 94.0 % of the natural gas used in Germany were imported.

On balance, almost 53 billion kWh of natural gas were stored in 2019. Towards the end of 2019, 97 % of the natural gas storage facilities in Germany were filled. Such a high storage filling level at the end of a year is historically unique. According to initial figures, 9.8 billion kWh of biogas processed to natural gas quality were fed into the German natural gas grid during the reporting year. In 2018, this figure had amounted to 10.3 billion kWh. Almost 8 billion kWh of which went into combined power generation, around 0.5 billion kWh were used as a fuel, about 0.5 billion kWh were sold in the heating market (space heating, hot water). Another 1.0 billion kWh were used as materials, 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 2018, there had been 1,262 enterprises; at the end of 2019, there were 1,320. A closer look reveals that seven of these enterprises were active as natural gas producers, 31 as storage operators, 68 as mere wholesalers, 16 as long-distance gas grid operators, 704 as gas distribution grid operators, and 1,074 as distribution companies in the end customer business.[5] The number of employees in the gas industry increased slightly by 0.4 % and amounted to 39,180 persons at the end of the year 2019.

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 6.

Figure 6

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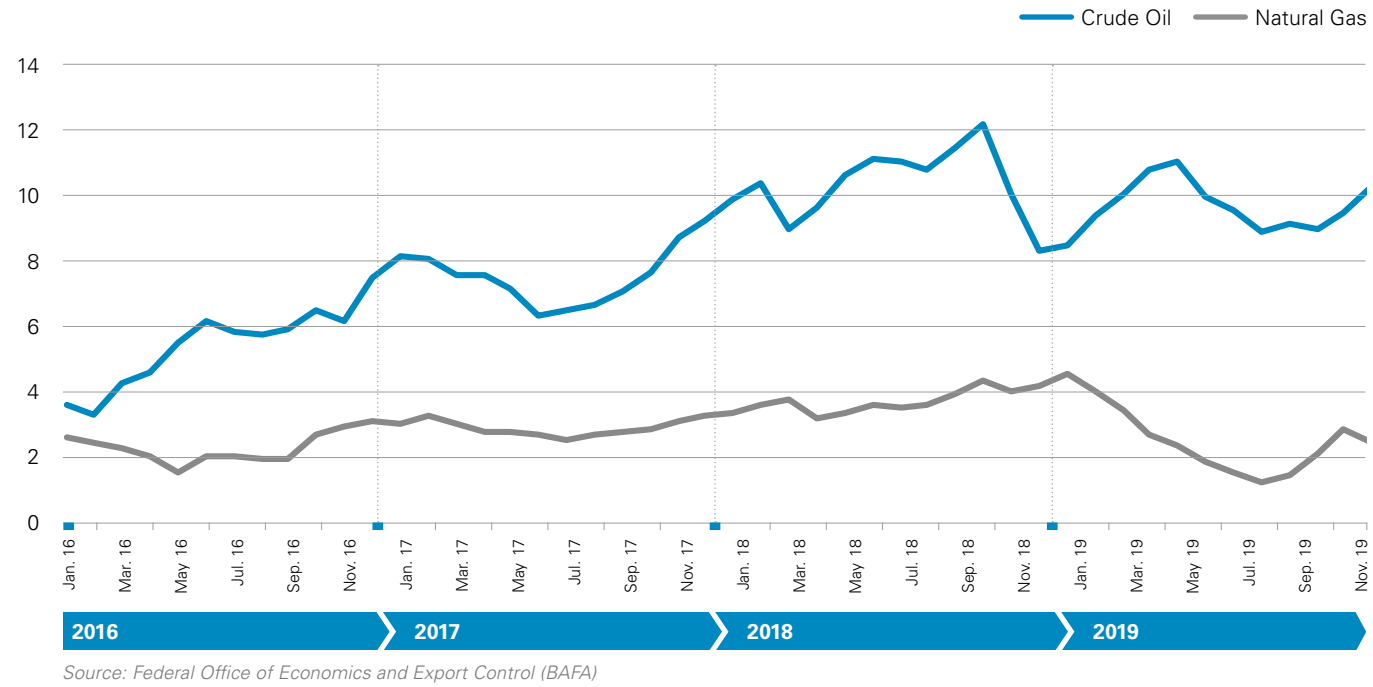
Monthly Border-Crossing Values for Crude Oil and Natural Gas between 2016 and 2019



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

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

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

Over the course of the year 2019, the import prices exhibited a significant decline. At an annual average, the border-crossing price amounted to 1.62 ct/kWh. This equals a decline of 16 % when compared to 2018. Towards the end of the year, however, a slight increase in prices became apparent once again. All told, the prices were still significantly below the level of 2012.

The development of import prices has different effects on domestic sales prices (please see Figure 7). 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 level for natural gas at the energy exchange decreased by 33 % while the sales prices to power plants went down by 10 %. For large industrial clients (annual supply of more than 500 GWh), the purchase prices decreased by 13 % compared to the previous year because natural gas had to be procured at shorter notice; small industrial gas consumers (supply of 11.63 GWh/a) had to pay 6 % less. Due to early procurement, the gas prices for the trade, commerce, and service sector as well as for private households increased by about 4 %.

The diverging development of the energy exchange and distribution prices for various customer groups is associated with the composition of end customer prices and the different contract periods. Procurement costs on the wholesale market actually reflect only a part of the end customer price. The latter 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.

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 7

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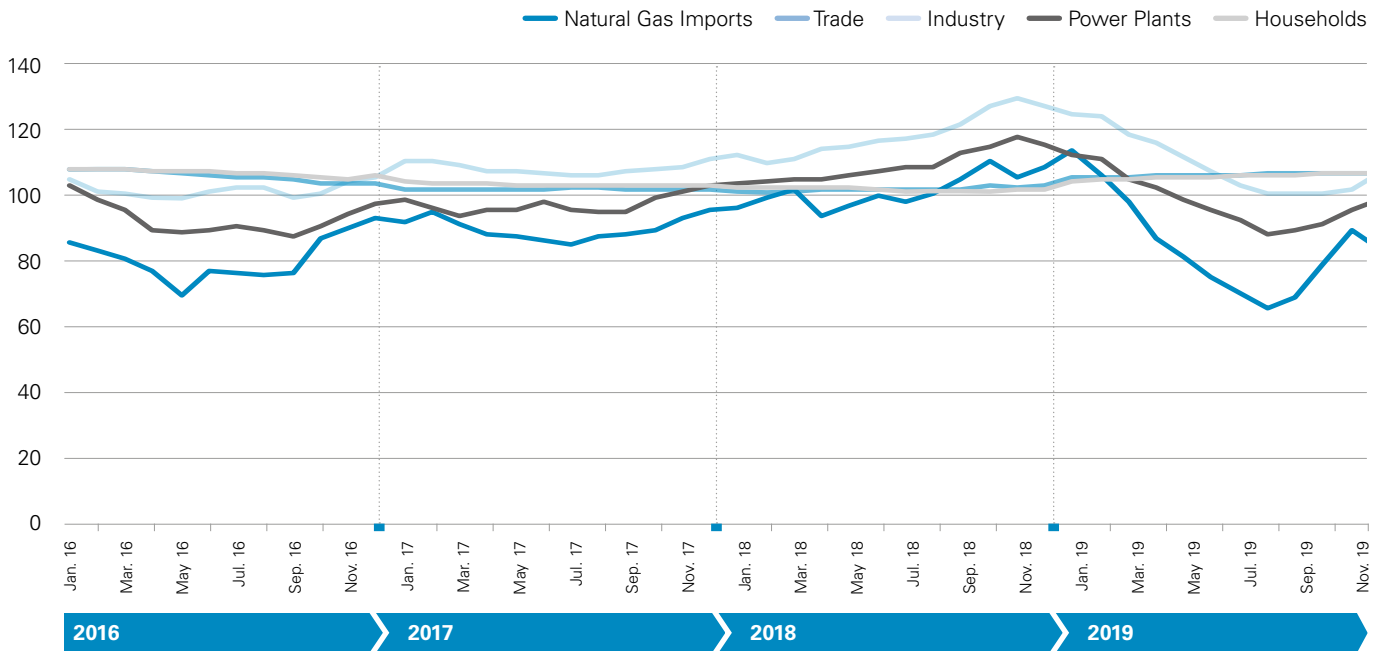
Prices for Natural Gas Imports and Natural Gas Sales in Germany between 2016 and 2019

January 2010 = 100 (Basis of Producer Price Indices 2015 = 100)



Sources: Federal Office of Economics and Export Control (BAFA); Federal Statistical Office (Destatis)

Hard Coal

According to preliminary estimates and compared to the previous year, Germany's hard coal consumption continued to decrease in 2019. The decline amounted to almost 21 %; hence, hard coal consumption dropped to its lowest level in the entire post-war period and actually amounted to 38.7 Mtce (1,134 PJ) in 2019 (please see Table 8). The continuous downward trend, which has persisted for a period of six years now, is above all due to the fact that, on the one hand, hard coal fired power plant capacities were withdrawn from the market and, on the other hand, renewables were tremendously expanded in the electricity sector. This was complemented by the CO_2 certificate price, which had been significantly higher over the past one and a half years, as well as low natural gas prices. In the course of these developments, hard coal was increasingly displaced from the medium load in electricity production.

All three sectors under review in which hard coal is used exhibited a downward trend last year: For example, the use of hard coal as a reducing agent in the steel industry (coking coal and coke) dropped by almost 4 % to 19.6 Mtce (574 PJ). This was essentially caused by a decline in crude iron production of about 4% to less than 26 million tons. Yet consumption in power plants that generate electricity and heat declined even more significantly. This figure dropped by approximately one third to 18.1 Mtce (531 PJ) when compared to the previous year.

For the first time ever in many years, the power plant sector was, thus, surpassed by the steel sector as the most important field of application for hard coal in Germany. The drastic decline in power plant usage was, above all, due to displacement effects coming from other energy carriers. Renewable energy carriers, particularly wind energy and photovoltaics, fed higher volumes of electricity into the grid than in the previous year. Moreover, natural gas has benefited in the merit order (price-dependent operational ranking of power plants) from lower natural gas prices and higher CO_2 prices. Another aspect is that according to the Federal Network Agency (BNetzA), operators of hard coal fired power plants reduced their capacities by about 1 GW in 2019. The heating market for hard coal, which within this definition includes foundries, district heating plants, and private households, remained relatively insignificant in terms of volumes and decreased by approximately 9 % to about 1 Mtce (29 PJ).

Table 8

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Volume and Use of Hard Coal in Germany in 2018 and 2019

	2018		2019 [1]		Change
	PJ	Mtce	PJ		in %
Primary Energy Consumption	**1,427**	**48.7**	**1,134**	**38.7**	**-20.5**
Power Plants and Thermal Power Stations	797	27.2	530	18.1	-33.5
Steel Industry	598	20.4	574	19.6	-3.9
Heating Market	32	1.1	29	1	-9.1
Import of Hard Coal and Coke [2]	1,301	44.4	1,111	37.9	-14.6
Hard Coal Production	**79**	**2.7**	**0**	**0**	**-100.0**

1) Preliminary data; some figures are estimates
2) Coke converted into coal

Discrepancies in the totals are due to rounding off

Sources: German Coal Importers Association; The German Coal Industry's Statistical Office; German Hard Coal Association (GVSt)

Table 9

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German Hard Coal Imports[1] According to Supplier Countries in 2018 and 2019 (January to November)

	2018	2019 [2]	Change	2018	2019
	in Million Tons		in %	Proportions in %	
Russia	17.6	17.6	0.0	41.5	45.1
USA	8.7	7.4	-14.9	20.5	19.0
Australia	4.6	4.4	-4.3	10.8	11.3
Columbia	3.6	1.9	-47.2	8.5	4.9
Poland	1.6	1.3	-18.8	3.8	3.3
Canada	1.4	1.2	-14.3	3.3	3.1
South Africa	0.9	0.7	-22.2	2.1	1.8
Czech Republic	0.3	0.3	0.0	0.7	0.8
Other Third Countries	1.1	1.7	54.5	2.6	4.4
Other EU Countries [3]	2.6	2.5	-3.8	6.1	6.4
Total Imports	**42.4**	**39**	**-8.0**	**100.0**	**100.0**
Total Year (Expansion) [4]	**44.4**	**37.94**	**-14.5**	**-**	**-**

1) Including coke imports; coke converted into coal
2) Preliminary
3) Including transit volumes from third countries via Belgian and Dutch ports
4) As-is values for 2018; projected values for 2019 based on imports accrued during the specific period of time

Discrepancies in the totals are due to rounding off

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

Except for the month of January and compared to the respective months of the previous year, the rates of change for the generation of electricity in hard coal fired power plants in 2019 were in the double-digit negative range across all months up to and including December. Starting in the summer, the situation deteriorated further. High availabilities of renewable energy carriers, the mild weather especially in the fourth quarter, only slightly higher electricity prices, persistently low natural gas prices, and high CO_2 certificate prices all interacted with one another. These market constellations taken together resulted in a weak demand particularly on the Northwest European market for power plant coal. Compared to the previous year, the prices for power plant coals dropped on average by more than one third to almost US $ 61.00/t free at Northwest European ports in 2019. In 2018, the average price had still amounted to US $ 91.93/t.

Since the termination of domestic hard coal mining at the end of 2018, Germany's hard coal volume has been sourced exclusively from imports and existing stocks.

According to preliminary data derived from the foreign trade statistics of the Federal Statistical Office for the first eleven months of the year 2019 and compared to the same period of the previous year, Germany's hard coal imports decreased by 8.0 % to approximately 39.0 million tons (please see Table 9). Of this figure, 26.1 million tons accounted for power plant coals,

10.3 million tons for coking coals, 0.9 million tons for anthracite coals and briquettes, and 1.7 million tons for coke. If one were to take into account state-specific calorific values derived from the data ascertained in accordance with the Energy Statistics Act, then it is possible to calculate hard coal imports amounting to 37.9 Mtce for the entire year 2019. When compared to the previous year, this would equal a decline of around 15 %. The significantly weaker decline in imports when compared to consumption can be attributed to a number of effects. Over the entire year 2018, there had still been production from domestic hard coal mining which stopped completely in the subsequent year. This decline was compensated by imports in 2019. Furthermore, a contango situation has been in place since 2019, which means that futures are going up so that it is worthwhile to increase stock levels.

During the period under review between January and November 2019, Russia once again dominated the field with a share of 45 % in the total imports. As measured by absolute figures, imports from Russia hovered around the previous year's level. The secondmost important supplier region continued to be the United States, which attained a proportion of 19 %. Compared to the same period of the previous year, US imports went down by nearly 15 %. A substantially stronger decline, namely by almost a half, was recorded for imports from Columbia. In a sectoral breakdown, Russia was the most important country of origin for power plant coal with a share of almost 60 %. When it comes to coking coal imports, Australia headed the field with a share of 42 %. Most of the coke imports, precisely 84 %, came from the EU, primarily from Poland which alone accounted for a share of 63 %.

In 2019, the changes in the German hard coal market were primarily accompanied by the discussion of the scheduled exit from coal fired power generation for climate protection reasons. Towards this end, the "Commission for Growth, Structural Change, and Employment" (commonly referred to as Coal Commission or WSB Commission), which had been appointed by the Federal Government specifically for this purpose, published its recommendations in the summer of 2019. These recommendations, which had been adopted with the broad approval of the diverse stakeholders, revolve around a plan for the gradual phase-out from coal fired power generation flanked by the appropriate energy-political and structural measures by no later than 2038. The Federal Government agreed "to rigorously implement the recommendations of the WSB Commission." In order to implement the section on structural politics, Germany's Federal Government presented its draft of the Structural Development Act for Coal Mining Regions in the summer of 2019. The energy-political section contained in the draft of the Coal Phase-Out Act, which consists of an act on the reduction and termination of coal fired power generation (Coal Fired Power Generation Termination Act [KVBG]) as well as additional accompanying measures to be amended to the Energy Industry Act (EnWG), the Renewable Energies Act (EEG), and the Act on the Preservation, Modernization, and Expansion of Combined Heat and Power Plants (KWKG), had been postponed several times which is why it was actually not adopted by the Federal Cabinet in 2019. This adoption did not take place until January 2020. The necessary parliamentary procedure for both draft legislations is to be completed ideally by the summer of 2020.

Figure 8 conveys an indication of the long-term price trend for power plant coals also in comparison to the changes experienced by crude oil. Figure 9 represents the import prices for hard coal coke and coal from third countries (power plants and steel producers). The overall picture reveals that the import prices for steam coals and power plant coals experienced a significant decline over the course of the year 2019 when compared to 2018. The import price for steam coals dropped from about € 108/tce (annual average 2018) to approximately € 72/tce in 2019. After a price level of around € 100/tce had still been noticed in January 2019, the import price for steam coals decreased to a value below € 65/tce by December 2019.

Figure 8

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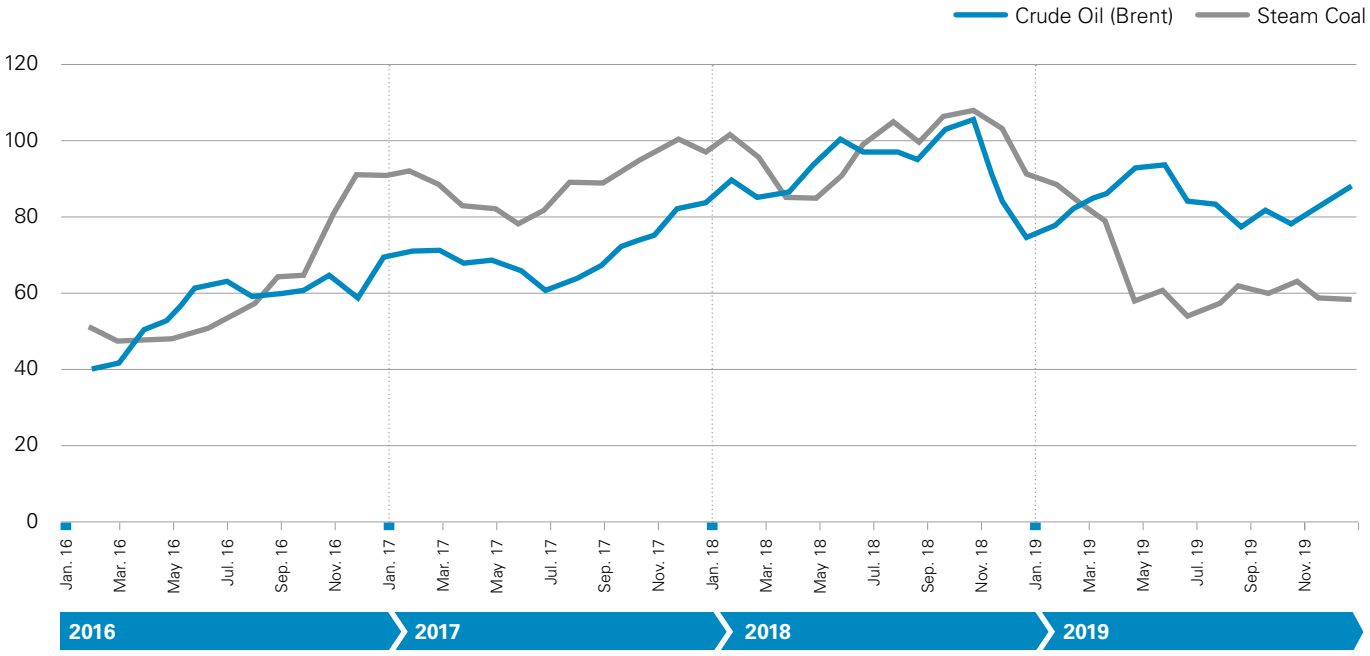
Global Market Prices for Crude Oil (Brent) and Steam Coal between January 2016 and December 2019

January 2010 = 100



Sources: German Coal Importers Association; Association of the German Petroleum Industry (MWV)

Figure 9

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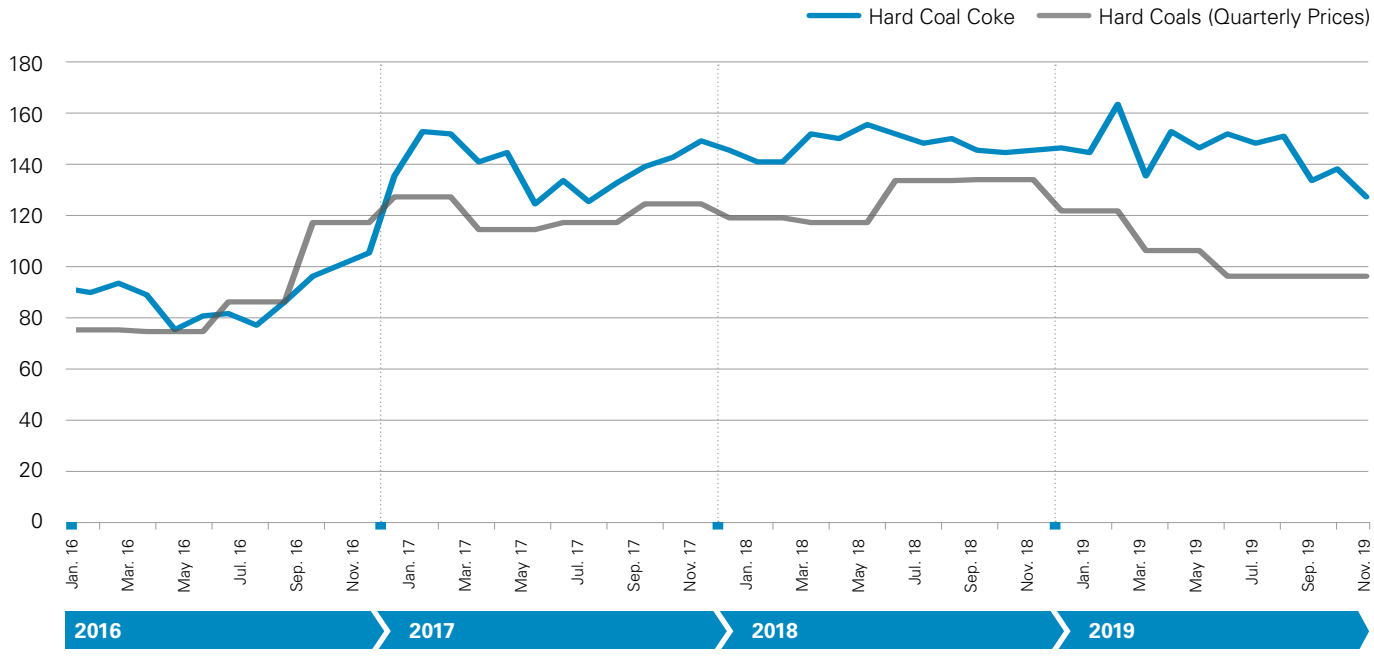
Development of Selected Hard Coal Import Prices between 2016 and 2019

January 2010 = 100



Sources: German Coal Importers Association; Federal Office of Economics and Export Control (BAFA)

Lignite

With about 131 million tons, lignite production in 2019 remained below the previous year's level for the seventh year in a row (-21 %). Yet the decline was quite different in the individual mining districts: Both the Rhineland area (-24.9 %) and Central Germany (-24.6 %) exhibited particularly high cutbacks; but also in Lusatia (-14.3%), the rate of change was in the double-digit negative range.

These changes generally correspond to the respective development of deliveries to power plants supplying the general public (115.0 million tons; -22.4 %) which receive around 90 % of the production. This development was caused by the transfer of additional power plants into the standby mode for backup purposes, the substantial increase in power generation from wind energy and natural gas, the production shortfall in the open-pit mine Hambach as a result of the respective court order of the Higher Administrative Court as well as a larger number of power plant overhauls when compared to the previous year. Since 2016, a total net capacity of 2,730 MW has been transferred into the standby mode for backup purposes; most recently, one unit of the Neurath power plant in the Rhineland area (almost 300 MW) as well as one unit of the Jänschwalde power plant in Lusatia (465 MW) went off the grid as of October 1, 2019.

With about 40.6 Mtce (1,190 PJ), the energy content of the extracted lignite fell about 21 % short of the previous year's result. The contribution of lignite to domestic energy production amounted to more than 33 %. Lignite, thus, continues to be an important domestic energy carrier.

With nearly 114 TWh, power generation from lignite was once again lower than in the previous year (-22 %). Lignite's share in power generation decreased to approximately 18.6 % (previous year: 22.6 %). Almost every fifth kilowatt hour of the electricity used in Germany is sourced from lignite (please see Table 10).

The manufacture of refined products based on lignite decreased in total by approximately 10 % to about 6 million tons. The declines amounted to -7.0 % for briquettes, -10.0 % for pulverized coals, and -22.9 % for fluidized bed coals. Coke production remained to a great extent at the previous year's level (-1.2 %).

With 39.8 Mtce (1,167 PJ), lignite-based primary energy consumption was 20.3 % lower than in the previous year. Lignite, thus, met more than 9 % of the entire domestic demand for energy.

With a total consumption of about 2.6 Mtce in 2019, the final energy sectors used in total less lignite and lignite products than in the previous year (-10 %) (please see Table 11). When it comes to industry, the use of lignite decreased by about 9 % while sales to private households were cut back even more significantly (-17 %).

At the end of 2019, the number of employees working in the German lignite industry amounted to 20,336 people. This figure includes nearly 1,300 apprentices and almost 4,800 employees who worked in the lignite companies' power plants supplying the general public. Employment statistics listed 9,785 employees in the Rhineland area, 8,116 in Lusatia, and 2,334 in Central Germany. After the end of coal mining, only 101 employees still worked on behalf of the lignite industry in the Helmstedt District. If one takes the results of the study Folgenabschätzung Klimaschutzplan und Strukturwandel in den Braunkohleregionen [Assessment of the Impact of the Climate Protection Plan and Structural Change in the Lignite Mining Regions], which was conducted by the Cologne Institute for Economic Research (IW Consult), as a basis, a total of more than 70,000 jobs in Germany are secured either directly or indirectly by lignite mining and power generation from lignite.[6]

6 *"Folgenabschätzung Klimaschutzplan und Strukturwandel in den Braunkohleregionen". IW, 10/2018. https://www.iwkoeln.de/studien/gutachten/beitrag/roman-bertenrath-cornelius-baehr-thilo-schaefer-strukturwandel-in-den-braunkohleregionen.html [only available in German].*

Table 10

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Volume and Use of Lignite in Germany in 2018 and 2019

	Unit	2018	2019 [1]	Change in %
1. Domestic Raw Lignite				
Total Lignite Production	**Million Tons**	**166.3**	**131.3**	**-21.0**
	Mtce	**51.4**	**40.6**	**-21.0**
	PJ	**1,506**	**1,190**	**-21.0**
2. Foreign Trade				
Total Imports	1,000 tce	23.9	25.5	6.5
Total Exports	1,000 tce	1,095.3	972.0	-11.2
Foreign Trade Balance	1,000 tce	-1,071.3	946.6	-
3. Primary Energy Consumption				
	Mtce	50.0	39.8	-20.3
	PJ	1,464	1,167	-20.3
4. Sales				
Total Sales	**Million Tons**	**149.1**	**115.7**	**-22.4**
to Power Plants Supplying the General Public	Million Tons	148.2	115.0	-22.4
to Other Customers	Million Tons	0.9	0.7	-14.4
Use for Refinement	Million Tons	14.6	13.2	-10.0
Use in Lignite Mining Power Plants	Million Tons	2.5	2.5	-2.5
Change in Stocks	Million Tons	0.0	-0.1	-
5. Electricity Production from Lignite				
Power Plants Supplying the General Public	Billion kWh	142.2	110.7	-22.1
Industrial Power Plants	Billion kWh	3.4	3.3	-3.6
Total Electricity Production from Lignite	**Billion kWh**	**145.6**	**114**	**-21.7**

1) Preliminary data; some figures are estimates

Discrepancies in the totals are due to rounding off

Source: The German Coal Industry's Statistical Office

Table 11

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Lignite Balance for Germany in 2018 and 2019

in 1,000 tce

		2018	2019 [1]	Change
				in %
Domestic Production		51,399	40,602	-21.0
+	Imports	24	25	4.2
=	**Volume**	**51,423**	**40,627**	**-21.0**
+/–	Change in Stocks (Reduction: +, Replenishment: -)	17	164	-
–	Exports	1,094	972	-11.2
=	**Primary Energy Consumption**	**50,346**	**39,819**	**-20.9**
–	Use in Power Plants	46,617	36,300	-22.1
–	Other Conversion Input	5,086	4,682	-7.9
+	Conversion Output	4,796	4,500	-6.2
–	Consumption during Production and Conversion as well as Non-Energetic Consumption	508	700	37.8
=	**Final Energy Consumption**	**2,931**	**2,637**	**-10.0**
	Industry	2,447	2,237	-8.6
	Households, Trade, Commerce, Services, Concessionary Coal	484	400	-17.4

1) Preliminary data; some figures are estimates

Source: The German Coal Industry's Statistical Office

The Electric Power Industry

According to preliminary figures, gross electricity production in Germany amounted to 612.4 billion kWh in 2019.[7] The production of electric power, thus, decreased by 4.8 % when compared to the previous year's figure. Power generation from the individual energy carriers developed differently. In 2019, significantly more electricity was generated from renewables as a whole as well as from natural gas than in the previous year. In contrast, electricity production in coal fired power plants experienced a sharp decline. The contribution of nuclear energy to power generation in Germany dropped slightly. According to preliminary estimates, gross electricity consumption decreased by 2.5 % to 579.7 billion kWh during the reporting year (2018: 594.8 billion kWh) (please see Table 12).

The electricity produced by lignite fired power plants amounted to about 114 billion kWh in 2019. This equals a decline of 21.7 % when compared to the previous year's value. According to preliminary data, a net power plant capacity of 20,928 MW was installed at the end of the year; however, 2,730 MW of which 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 decreased to 18.6 %.

After a slight decline in the previous year, the use of natural gas as a fuel in power plants and thermal power stations designed to supply electricity increased considerably again in 2019. An expected total of 91 billion kWh of electricity were generated in the power plants of electricity producers and industrial enterprises as well as in the combined heat and power plants of other electricity producers; this equals a plus of 10.3 % when compared to 2018. Never before has such an amount of electric power been produced from natural gas in Germany. Electricity production in gas fired power plants increased, in particular, because of the considerable decline in spot market prices for gas over the course of the year as well as the significantly higher price level for CO_2 certificates, which is why natural gas fired power plants were able to improve their competitive position against coal fired power plants. Compared to the previous year, the installed capacity (net) of 29,721 MW remained virtually unchanged. Commissionings of 346 MW were contrasted by shutdowns amounting to 392 MW. 3,009 MW of the installed capacity of 29,721 MW are currently in the grid reserve. According to initial calculations, natural gas accounted for a 15.1 % share in Germany's gross electricity production in 2019.

With more than 57 billion kWh in 2019, hard coal fired power plants once again delivered less electricity than in the previous year. With -30.6 %, this equals a decline of nearly one third when compared to the previous year. Additional power plant shutdowns in 2019 resulted in the fact that a capacity of 22,737 MW (net) was installed by the end of the year; in comparison: This figure had still amounted to 23,759 MW in 2018. This equals a decline of 1,022 MW, which translates into a drop of more than 4 % in the installed capacity when compared to the end of 2018. 2,308 MW of the installed capacity of 22,737 MW are currently in the grid reserve. Thus, hard coal's share in the mix of energy sources supplying electric power amounted to 9.4 %.

During the reporting year, Germany's nuclear power plants generated 75 billion kWh of electricity which was about 1.2 % less than in 2018; this equals a share of 12.3 % in gross electricity production. Due to the decommissioning of the nuclear power plant Philippsburg 2 as of December 31, 2019, the installed capacity went down by 1,402 MW to currently 8,114 MW at the end of 2019.

Wind energy on shore was able to expand its position as the most important renewable energy source even further in 2019. With more than 101 billion kWh, onshore wind turbines produced 11.9 % more electricity than in 2018. With almost 25 billion kWh, offshore wind turbines also supplied noticeably more electricity than in the previous year (+26.9 %) which was not only due to the above average wind year, but also to the continuously advancing expansion of wind turbines off shore.

7 This production figure includes the production volumes of pumped storage plants (pumping energy) as well as those of other storage facilities. For the methodological consequences of using pumped storage plants and other technologies for the interim storage of electricity at the level of gross electricity production and the associated gross electricity consumption, please see Hans Georg Buttermann, Tina Baten, and Thomas Nieder: "Methodische Konsequenzen der gegenwärtig praktizierten Behandlung von Stromspeichern in der Energiebilanz". Energiewirtschaftliche Tagesfragen, 70th year (2020), Booklet 1/2, pp. 84-89 [only available in German].

Table 12

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Gross Electricity Production, Electricity Exchange, and Gross Electricity Consumption in Germany between 1990 bis 2019 According to Energy Carriers

	1990	2000	2010	2015	2016	2017	2018 [1]	2019	2018 to 2019	1990 to 2019
	in Billion kWh								Average Annual Change in %	
Lignite	170.9	148.3	145.9	154.5	149.5	148.4	145.6	113.9	-21.8	-1.4
Nuclear Energy	152.5	169.6	140.6	91.8	84.6	76.3	76.0	75.1	-1.2	-2.4
Hard Coal	140.8	143.1	117.0	117.7	112.2	92.9	82.6	57.3	-30.6	-3.1
Natural Gas	35.9	49.2	89.3	62.0	81.3	86.7	82.5	91.0	10.3	3.3
Mineral Oil	10.8	5.9	8.7	6.2	5.8	5.6	5.2	5.1	-1.9	-2.6
Renewables	19.7	37.9	105.2	188.8	189.7	216.3	224.8	244.3	8.7	9.1
Other	19.3	22.6	26.6	27.3	27.3	27.5	26.8	25.7	-4.1	1.0
Gross Electricity Production	**549.9**	**576.6**	**633.3**	**648.3**	**650.5**	**653.7**	**643.5**	**612.4**	**-4.8**	**0.4**
Electricity Flows from Foreign Countries	31.9	45.1	43.0	37.0	28.3	27.7	31.7	39.8	25.6	0.8
Electricity Flows into Foreign Countries	31.1	42.1	57.9	85.3	78.9	80.3	80.5	72.5	-10.0	3.0
Foreign Electricity Exchange Balance	0.8	3.1	-15.0	-48.3	-50.5	-52.5	-48.7	-32.7	-32.9	-
Gross Electricity Consumption	**550.7**	**579.6**	**618.3**	**600.0**	**600.0**	**601.2**	**594.8**	**579.7**	**-2.5**	**0.2**
Change versus Previous Year in %		4.0	5.8	1.0	-0.0	0.2	-1.1	-2.5		
	Structure of Gross Electricity Production in %									
Lignite	31.1	25.7	23.0	23.8	23.0	22.7	22.6	18.6		
Nuclear Energy	27.7	29.4	22.2	14.2	13.0	11.7	11.8	12.3		
Hard Coal	25.6	24.8	18.5	18.2	17.2	14.2	12.8	9.4		
Natural Gas	6.5	8.5	14.1	9.6	12.5	13.3	12.8	14.9		
Mineral Oil	2.0	1.0	1.4	1.0	0.9	0.9	0.8	0.8		
Renewables	3.6	6.6	16.6	29.1	29.2	33.1	34.9	39.9		
Other	3.5	3.9	4.2	4.2	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**	**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); AGEE-Stat (for renewables)

In 2019, the installed capacity of onshore wind turbines increased by almost 900 MW to currently 53,515 MW while more than 1,100 MW were newly connected to the grid off shore. Thus, the offshore wind capacity installed in Germany now amounts to 7,503 MW. All told, wind energy accounted for a share of 20.9 % in the German electricity production mix in 2019.

According to preliminary figures, photovoltaic systems also supplied more electricity than had been the case in 2018 (45.8 billion kWh); namely, more than 47.5 billion kWh. Compared to the previous year, this equals a plus of 3.8 %. This amount of electricity includes not only the electric power fed into the grid supplying the general public, 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 the Federal Network Agency (BNetzA), an additional photovoltaic capacity of more than 3,900 MWp was installed in 2019; thus, 49,125 MWp were installed at the end of the year. The contribution of solar energy to the German electricity mix in the reporting year amounted to around 7.8 %.

In the reporting year, 44.6 billion kWh of electricity were produced from solid, liquid, and gaseous biomass (including landfill gas, sewage gas as well as sewage sludge). With a change of less than -0.2 % when compared to the previous year, the result remained more or less stable. Power plants generating electricity from biomass accounted for a share of 7.4 % in electricity production. In addition to the proportional power generation in waste fueled power plants (from biogenic waste), more than 50 billion kWh of electricity were produced from biogenic energy sources in Germany in 2019. Their total contribution to the German electricity producers' mix of energy sources, thus, amounted to 8.2 %.

After a year of drought in 2018, electricity production from hydropower was able to record increases once again in 2019. Due to persistently low precipitation primarily at the beginning of the year, however, it was only possible to attain a production plus during the second half of the year. According to initial figures, the electricity produced in Germany's run-of-the-river and hydroelectric storage plants amounted to 20 billion kWh in 2019. Compared to the previous year, this equals a plus of 12.3 %. The contribution of hydropower to the electricity mix amounted to approximately 3.3 %.

In total, about 244.3 billion kWh of electricity were generated from renewable energy in 2019; this equals an increase of 8.7 %. According to initial figures, renewable energy's contribution to meeting the gross domestic electricity consumption increased to about 39.9 % in 2019 (2018: 34.9 %).

In 2019, storage facilities collected 8.2 billion kWh of electric power and fed 6.0 billion kWh back into the grid again. So far, pumped storage plants assumed the largest proportion in this development. While the pumping capacity was 8.1 billion kWh, the backflow into the grid amounted to 5.9 billion kWh.

The trend of a continuously increasing negative balance in Germany's electricity exchange has been interrupted since 2018. With an export surplus of 34.9 billion kWh in 2019, the balance once again fell below the previous year's value (2018: 51.2 billion kWh) (please see Figure 10). The largest amount of electricity flowed in the direction of Austria, followed by Switzerland and the Netherlands (Austria: 16.7 billion kWh, Switzerland: 14.0 billion kWh, Netherlands: 11.1 billion kWh). The largest amounts of electricity in 2019 came from France to Germany, followed by Switzerland and the Netherlands (France: 15.2 billion kWh, Switzerland: 6.1 billion kWh, Netherlands: 5.4 billion kWh). All told, 74.5 billion kWh of electricity flowed from German power grids to foreign countries (2018: 82.7 billion kWh) while Germany sourced 39.6 billion kWh from abroad (2018: 31.5 billion kWh). It should be noted in this context that most of the cross-border electricity flows are not any contractually agreed upon deliveries, but rather transit volumes and loop flows. For example, a part of the electricity flows from Germany to the Netherlands actually moves farther in the direction of Belgium and the United Kingdom.

According to initial estimates and due to the economic situation, electricity consumption in the mining and manufacturing industries went down by 4.1 % from 226.1 billion kWh in the previous year to 216.8 billion kWh in 2019. Particularly when it comes to electricity-intensive industries, significant production declines were recorded almost for the entire year. For the private household sector as well, initial estimates revealed a decrease in consumption of 0.7 % to almost 126 billion kWh when compared to the previous year. For the trade, commerce, and service sector, however, initial figures indicated that consumption remained virtually unchanged (+0.1 %). Consumption in the transportation sector also exceeded the previous year's figure.

Figure 10

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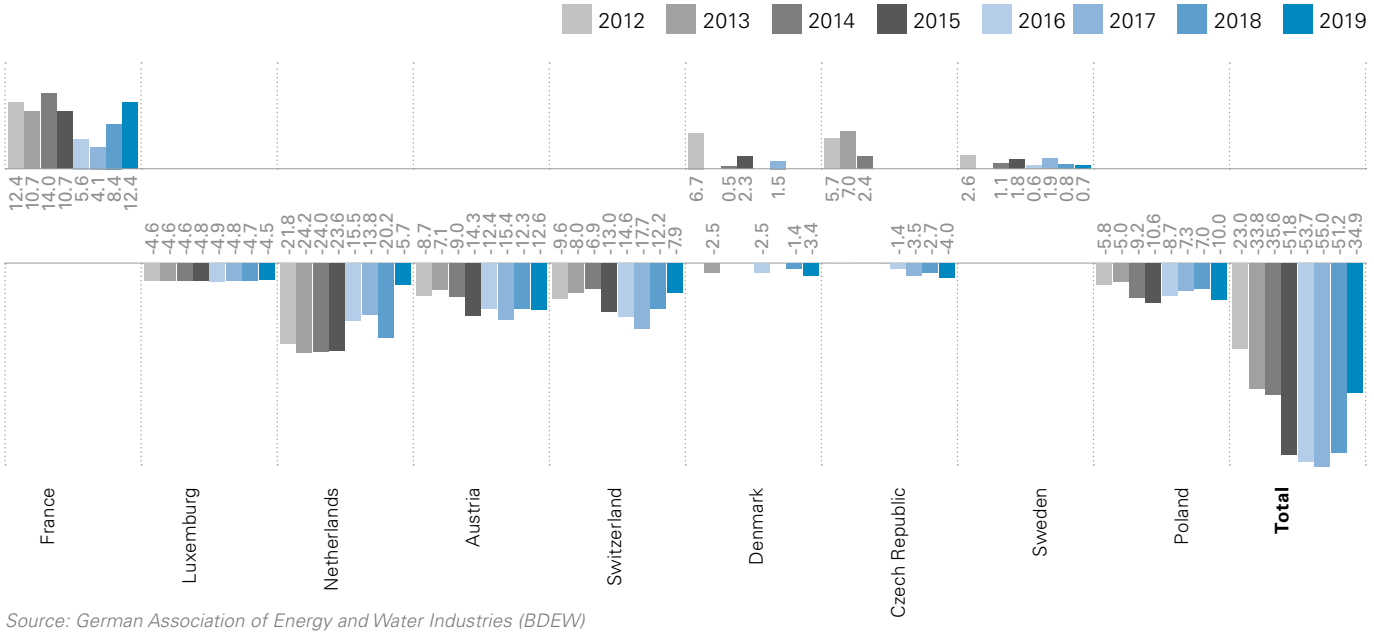
Germany's Electricity Exchange Balance with Neighboring Countries between 2012 and 2019

Electricity Flows in Billion kWh



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

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Table 13

Electricity Balance of Germany's Power Supply between 2017 and 2019

	2017	2018	2019 [1]	Changes 2018/2019
		Billion kWh		Change in %
Gross Electricity Production	**653.7**	**643.5**	**612.4**	**-4.8**
Self-Consumption in Power Plants	-34.6	-34.0	-30.2	-11.1
Net Electricity Production	**619.1**	**609.5**	**582.2**	**-4.5**
Electricity Flows from Foreign Countries	27.8	31.7	39.8	25.6
Electricity Flows into Foreign Countries	80.3	80.5	72.4	-10.0
Net Domestic Electricity Volume	**566.6**	**560.8**	**549.6**	**-2.0**
Pump Current Consumption	8.3	8.3	8	-3.9
Grid Losses and Unrecorded Factors	27.1	26.8	23.8	-11.2
Net Electricity Consumption	**531.3**	**525.6**	**517.8**	**-1.5**
Proportion of:				
Mining and Manufacturing Industries	228.1	226.1	216.8	-4.1
Households	128.2	126.6	125.7	-0.7
Commerce and Trade, Public Institutions	151.5	149.0	149.2	0.1
Transportation	11.2	11.7	11.9	1.8
Energy Consumption in the Conversion Sector (without Own Power Plant Consumption)	12.3	12.3	14.2	15.4
Gross Domestic Electricity Consumption	**601.3**	**594.7**	**579.8**	**-2.5**

1) Some figures are preliminary and estimates

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

Germany's net electricity consumption amounted to a total of 517.8 TWh in 2019. In the previous year, the net electricity consumption had still amounted to 525.6 TWh (this equals a minus of 1.5 %) (please see Table 13).

According to current estimates and as defined by the Climate Protection Plan, the greenhouse gas emissions of the energy industry decreased by 52 million tons of $CO_{2\ eq}$ to 221 million tons of CO_2. The decline in the diffuse emissions contained therein, which dropped by 1.5 million tons, was primarily due to the termination of hard coal mining at the end of 2018 (one-time effect). The power plants of the energy industry emitted 50 million tons of CO_2 less than in the previous year; industrial power plants reduced their CO_2 emissions by 2 million tons. The specific emission factor of the total mix amounted to 0.385 kg of CO_2/kWh net.

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 2018, 1,899 companies had worked as electricity suppliers; by the end of 2019, the number increased to 1,952. At closer examination, it is revealed that 90 of these companies were active as electricity producers with a power plant park larger than 100 MW, 903 of which worked as power distribution grid operators, four as transmission grid operators, 103 as operators of power storage facilities, 58 as electricity wholesalers, and 1,353 as distributors in the ultimate consumer business. (It is not possible to add up and combine the indicated numbers because many of the companies are active at multiple stages of the value creation chain and are, thus, recorded several times.) The number of employees in the companies of the electricity industry, which amounted to 138,000 persons, remained more or less stable in 2019 when compared to the previous year.

Electricity prices for industrial clients went up by almost 3 %, which was primarily due to the increase in procurement, distribution, and grid usage costs, whereas taxes, duties, and levies remained virtually unchanged in 2019. That is why the proportion of governmental charges included in the electricity price for industrial customers, which had still amounted to 45 % in 2018, decreased slightly to 44 % in 2019 (excluding the electricity tax).

Figure 11

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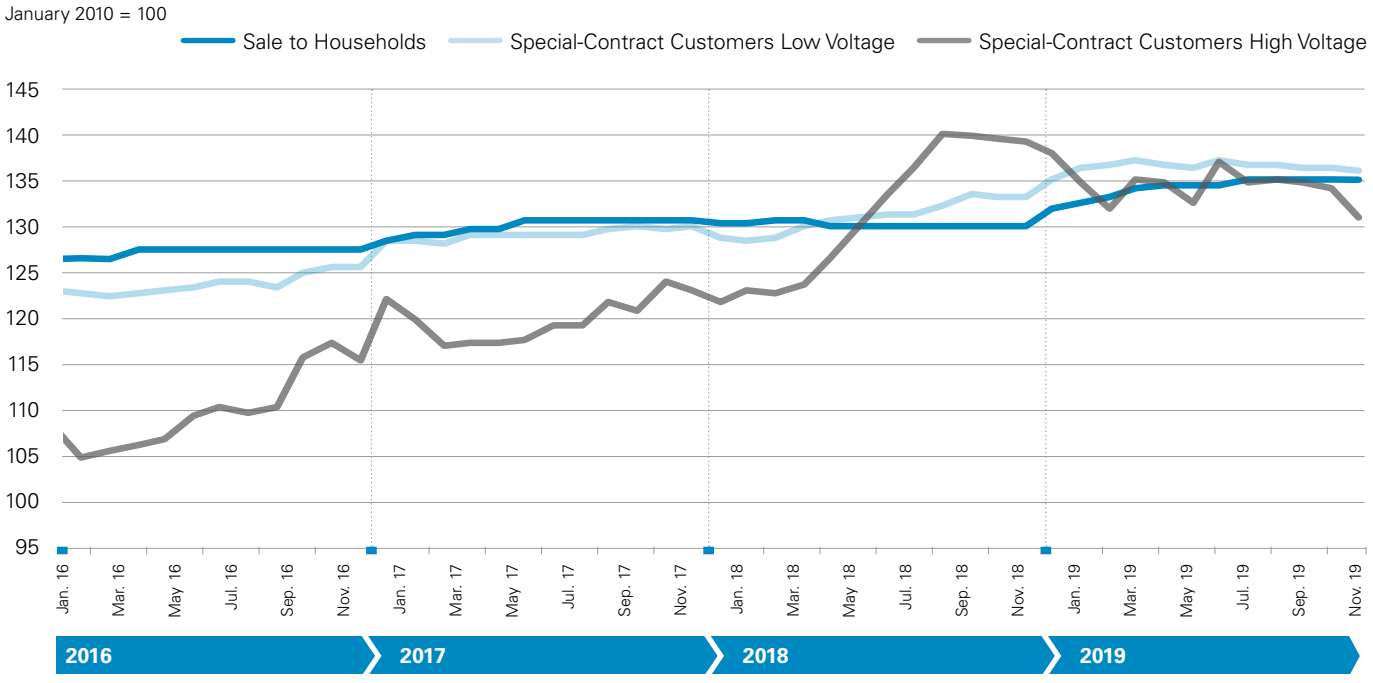
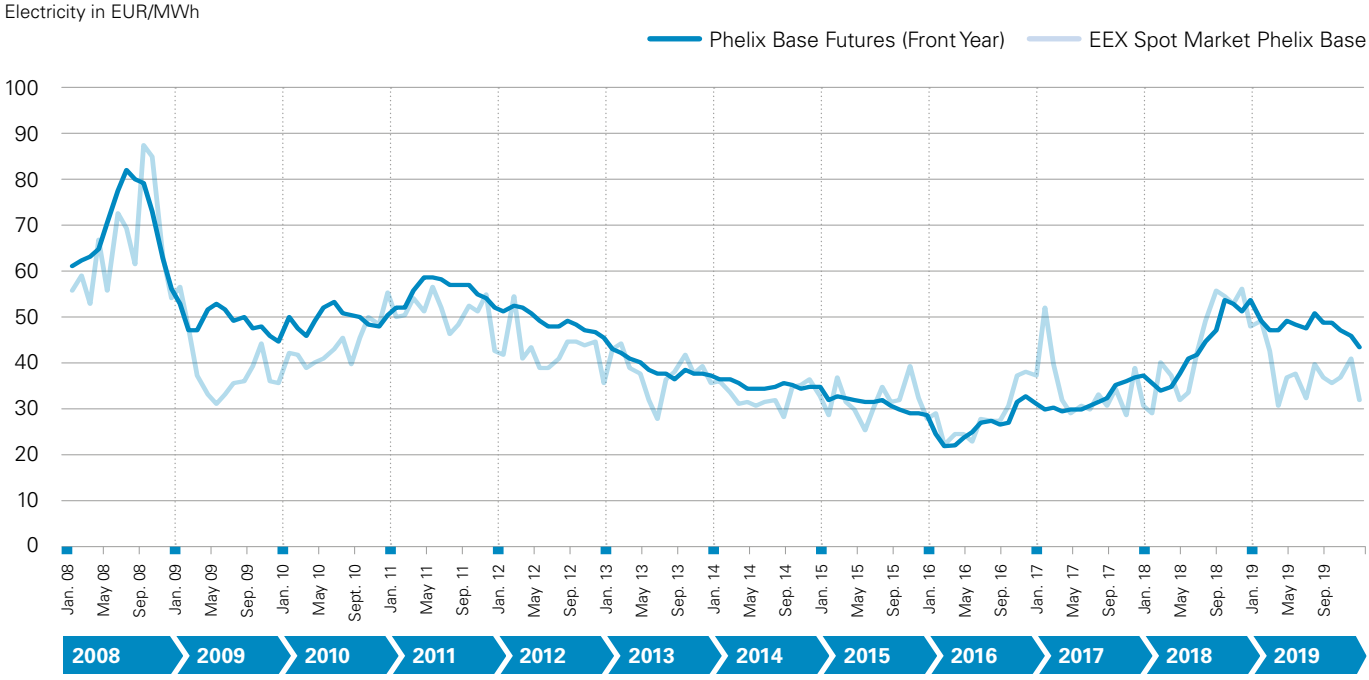
Electricity Producer Price Index for Special-Contract Customers and Sale to Households in Germany between 2016 and 2019



Sources: German Coal Importers Association; Federal Office of Economics and Export Control (BAFA)

Figure 12

Development of Electricity Prices on the EEX Spot Market and Futures Market (Front Year) between 2008 and 2019



Source: Data according to the Federal Ministry for Economic Affairs and Energy (BMWi)

Electricity prices for private households increased by 3.4 % in 2019. This was caused by increased procurement costs on the wholesale market as well as increased grid usage charges. Taxes, duties, and levies remained unchanged in 2019. Their proportion decreased to 53 % in 2019 compared to 54 % in the previous year. However, these were still the largest items on the customer bill. In 2020, governmental charges will go up, in particular, because the apportionment pursuant to the Renewable Energy Act (EEG) increased by 0.5 cents/kWh (please see Figure 11).

The monthly development of the prices for electricity on the exchange since 2008 initially exhibited, after a high in 2008, a strong decline which, after a temporary increase, was followed by a clear trend 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 12). However, the subsequent price € 40/MWh until the end of 2016. Nonetheless after the turn of 2016/2017, there were considerable price fluctuations of up to more than € 100/MWh. Since mid-2018, the exchange price generally exceeded the limit of € 50/MWh. In early 2019, the electricity price on the spot market decreased noticeably; it dropped from about € 49/MWh in January to almost € 31/MWh in March of that year. During the remaining three quarters, the electricity price fluctuated between a minimum of € 32/MWh (December 2019) and a maximum of € 41/MWh (November 2019).

For the electric power industry, which after all represents the by far largest group of emitters in Germany, the development of certificate prices for CO_2, which are determined within the scope of European emissions trading, plays a significant role. High CO_2 prices improve the competitiveness of modern, low-emission gas and steam power plants and, at the same time, force carbon-intensive and/or less efficient power plants out of production. A closed time series of CO_2 certificate prices is now available for the second trading period between 2008 and 2012 as well as for the first seven years of the third trading period between 2013 and 2020.

With the amendment to the Greenhouse Gas Emissions Trading Act (TEHG), which entered into force in April 2018, Germany implemented the new Emissions Trading Directive (which serves the purpose of revising and restructuring EU emissions trading for the fourth trading period starting in 2021). The most important elements of this revision include the establishment of a market stability reserve (which is designed to trigger adjustments of the annual volume to be auctioned if and when the circulating volume of certificates is outside the predefined range) and the emissions budget which will be reduced in the future even faster than it has been in the past (namely, by 2.2 % p.a. instead of 1.7 % p.a. as had been the case during the third trading period). Another revision gives member states the opportunity of cancelling those CO_2 certificates which are caused by power plant shutdowns so that the emission rights which are set free are not used elsewhere which, in turn, would nullify and undo emissions reductions.

After the aforementioned structural reform of emissions trading had been adopted in April 2018, the price for emissions certificates initially tripled from an average of 5 euros per ton of CO_2 in 2017 to 15 euros in 2018. At the beginning of the year 2019, the price increased even further; it ranged between 20 euros and 26 euros per ton of CO_2. Subject to fluctuations, the CO_2 price continued to be at this comparably high level until the end of 2019 (with more than 28 euros per ton of CO_2 in July 2019, the CO_2 price reached its highest level that year) (please see Figure 13).

Figure 13

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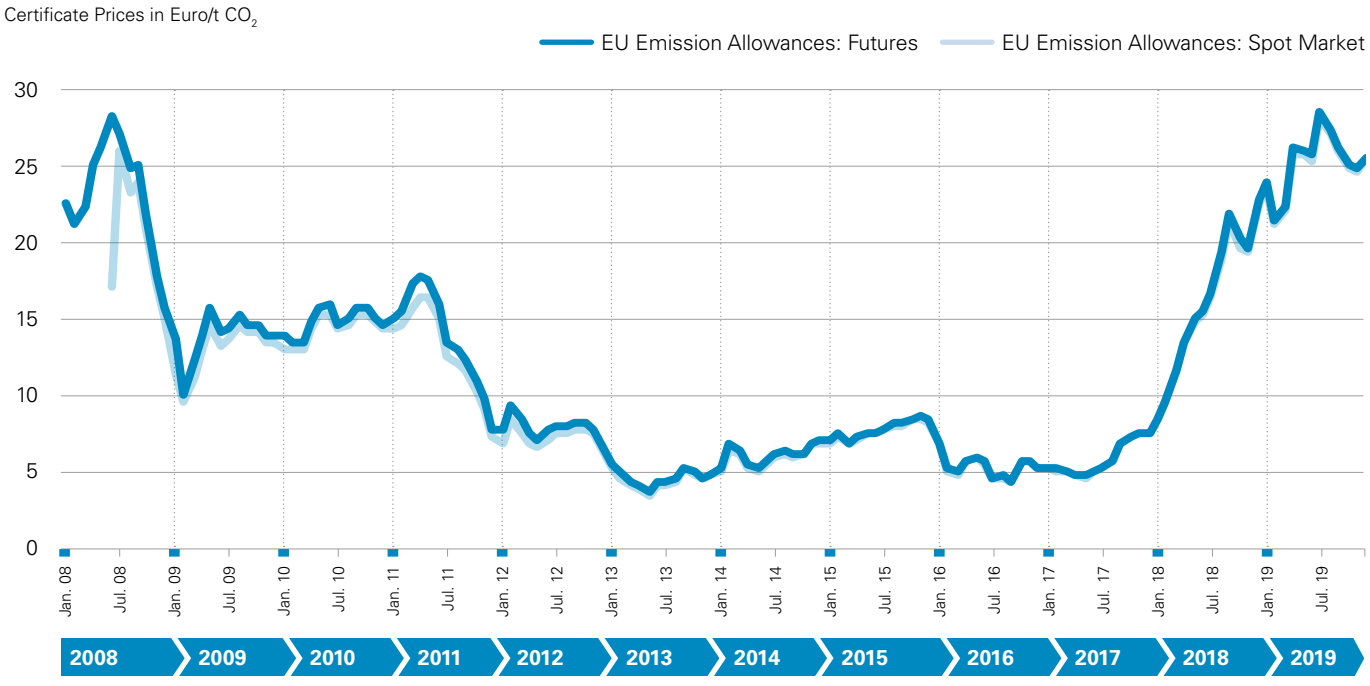
European Emission Allowances on the EEX Spot Market between 2008 and 2019



Source: Federal Ministry for Economic Affairs and Energy (BMWi)

Renewable Energy[8]

In 2019, the consumption of renewable energy sources amounted to a total of 1,896 PJ (please see Table 14). When compared to the previous year 2018 (1,802 PJ), this equals a total increase of 5.2 % which translates into an absolute increase of 94 PJ. This development was essentially due to a considerable rise in electricity production from renewables and an increased use of fuelwood as an energy source in private households and the trade, commerce, and service sector.

With a total of 879 PJ in 2019, which translates into 244 billion kilowatt hours, electricity production from renewable energy sources exceeded for the first time ever the entire amount of electricity produced in lignite fired and hard coal fired power plants. This development was decisively determined by wind energy which increased by 15 % compared to the previous year and superseded lignite as the most important energy carrier in the German energy mix: With 454 PJ, which translates into 126 billion kWh, onshore and offshore wind turbines, thus, produced as much electricity as no other energy carrier in Germany (396 PJ in 2018). The main drivers for this were the superb wind conditions in 2019 in conjunction with the expansion of state-of-the-art, efficient and effective power plant generations over the previous years. To be mentioned against this backdrop, however, is the drastic decline in newly installed production capacities in 2019: While the expansion phase for wind energy off shore was essentially completed to a great extent with the commissioning of the last wind parks by the early 2020s (+1.1 GW), the installation of new net wind power capacities on shore experienced a major slump; namely, from 4.9 GW in 2017 to 2.3 GW in 2018 to just 0.9 GW in 2019. Only once during the past 20 years have there been fewer installations of new capacities; namely, in 2008.

Compared to the particularly sunny previous year 2018, electricity production from photovoltaic systems went up by approximately 4 % to 171 PJ, which translates into 47.5 billion kWh, in 2019. More unfavorable weather conditions were, thus, overcompensated by the new upswing in the installation of additional capacities: For example, the global radiation of 1,147 kilowatt hours per square meter (kWh/m²), which actually exceeded the long-term average, fell significantly below the record value of the previous year (1,207 kWh/m²). However, the installed PV capacity increased substantially already during the first months of 2019: Due to additional degression levels as laid down in the Renewable Energies Act (EEG), more than 1,100 MW of new system capacities were installed just in January and February alone. Subsequently, the monthly installation of new capacities leveled off at around 270 MW. With a total of 3,835 MW, the installation of additional net photovoltaic capacities in 2019 exceeded the previous year's value by 32 % (2,888 MW in 2018).

Since electricity production from hydropower also reached an intermediate level again when compared to the long-term average and to the previous year with its extremely low precipitation, the yield and supply dependent energy carriers wind energy, photovoltaics, and hydropower jointly accounted for 698 PJ which translates into a 37 % share in the total primary energy consumption of renewables. When interpreting these results, it needs to be kept in mind that primary energy consumption is ascertained in line with national and international conventions on the basis of the so-called efficiency principle (for more details about this principle and about the impact of such alternative procedures as, for example, the substitution method on the contributions of individual energy carriers to primary energy consumption, please see the gray box).

Compared to the previous year, the primary energy consumption of biomass and biogenic waste went up by 1.6 % in 2019. With a joint proportion of 1,101 PJ, about 58 % of the total primary energy consumption of renewables in 2019 accounted for the diverse biogenic energy carriers which will be examined closer below, both from a sectoral point of view and by their nature and type:

The use of biogenic fuels for the production of electricity and district heat as well as for covering the own in-house consumption of the production plants in the conversion sector (505 PJ) was responsible

8 This text is based on the work conducted by the Working Group on Renewable Energies-Statistics (AGEE-Stat). For further information on the development of renewables in 2019, please turn to the background paper published by the Federal Environment Agency (UBA) under the title: "Erneuerbare Energien in Deutschland - Daten zur Entwicklung im Jahr 2019" [Renewable Energy in Germany – Data on the Development in 2019] [only available in German].

Table 14

Renewable Energy in Germany in 2018 and 2019 According to Its Use and Energy Sources

	Hydropower			Wind Energy (Onshore and Offshore)			Solar Energy			Geothermal Energy			Biomass			Waste			Total		
	2018	2019	Changes	2018	2019	Changes	2018	2019	Changes	2018	2019	Changes	2018	2019	Changes	2018	2019	Changes	2018	2019	Changes
	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%
Domestic Production	65	73	12	396	454	15	197	202	2	61	66	8	950	986	4	129	126	-2	1,797	1,906	6
Foreign Trade Balance	-	-	-	-	-	-	-	-	-	-	-	-	4	-11	-	-	-	-	4	-10	-
Primary Energy Consumption	**65**	**73**	**12**	**396**	**454**	**15**	**197**	**202**	**2**	**61**	**66**	**8**	**955**	**975**	**2**	**129**	**126**	**-2**	**1,802**	**1,896**	**5**
Use in Power Plants (Electricity)	65	73	12	396	454	15	165	171	4	6	7	10	333	332	-	59	58	-2	1,023	1,094	7
Use in Power and Heating Plants (Heat)	-	-	-	-	-	-	-	-	-	3	3	-	42	42	2	49	47	-3	93	92	-1
Consumption during Conversion, Losses	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**26**	**26**	**-**	**-**	**-**	**-**	**26**	**26**	**-**
Final Energy Consumption	**-**	**-**	**-**	**-**	**-**	**-**	**32**	**31**	**-4**	**52**	**56**	**8**	**555**	**575**	**4**	**21**	**21**	**-**	**660**	**683**	**4**
Industry	-	-	-	-	-	-	-	-	-	-	-	-	92	89	-3	21	21	-	113	111	-2
Transportation	-	-	-	-	-	-	-	-	-	-	-	-	113	114	1	-	-	-	113	114	1
Households, Trade, Commerce, Services	-	-	-	-	-	-	32	31	-4	52	56	8	350	372	6	-	-	-	433	458	6

All values for 2019 are preliminary.

Source: AGEE-Stat

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for almost half (46 %) of the total primary energy consumption of biomass. Compared to 2018 (509 PJ), the use of biogenic fuels in the conversion sector decreased slightly by about 1 %.

In 2019, the final energy sectors accounted for approximately 54 % of the biogenic primary energy consumption. In absolute figures, the consumption of biogenic energy carriers increased by about 4 % to 596 PJ in 2019 (compared to 576 PJ in 2018). With 372 PJ, the majority of which (62 %) was attributable to the private household sector and the trade, commerce, and service sector whereas the transportation sector contributed 114 PJ, which equals a share of 19 %, and the industrial sector 110 PJ, which equals 18 %. When comparing the years 2019 and 2018 with one another, then the industrial sector recorded a decline of about 3 % while consumption in the transportation sector remained stable and the consumption figure in the trade, commerce, and service sector went up by approximately 6 %.

Depending on its state of aggregation, biomass is generally divided into solid, gaseous, and liquid biogenic energy carriers: With 528 PJ in 2019, almost half (48 %) of the biogenic primary energy consumption was allotted to such solid biogenic fuels as firewood, wood chips, pellets, briquettes, charcoal as well as mature wood, sewage sludge, and other residual materials. 59 % (312 PJ) of the solid biogenic fuels were consumed as fuelwood in the private household as well as trade, commerce, and service sectors. Due to the higher demand for thermal heating in 2019 when compared to the very warm previous year, the largest increase with 6 % was actually recorded here. In the conversion sector, 25 % of the solid biogenic fuels were used primarily for the production of electricity and district heat (130 PJ). Compared to the previous year (133 PJ), this equals a decline of approximately 4 %. And finally, the demand for space heat and process heat in industry was covered by 16 % of the solid biogenic fuels (86 PJ). Due to the economic situation, this equals a decline of approximately 3 %.

Approximately 29 % (324 PJ) of the total primary energy consumption of biomass accounted for gaseous biogenic fuels. The latter include biogas, sewage gas, and landfill gas, which are used above all decentrally for the generation of electricity and heat, as well as biomethane, which is upgraded to natural gas quality and distributed within the natural gas grid where it is consumed elsewhere as a fuel or combustible. In 2019, more than four fifths (approximately 82 %) of the gaseous biogenic fuels contributed to the generation of electricity and district heat in the conversion sector as well as for covering the in-house consumption of production plants (including losses) (267 PJ). Closely linked to this was the fuel input for decentrally used heat from cogeneration plants (53 PJ), which accounted for another 16 % of the gaseous biomass and which is allocated to the final energy consumption sectors private households as well as trade, commerce, and services. With 1 % each, the consumption of biogenic gases in industry and the transportation sector was of subordinate relevance, even though the use of biomethane in the transportation sector increased by approximately 70 % in 2019. When comparing the years 2019 and 2018 with one another, the other sectors recorded just a moderate increase of 1 %.

With 123 PJ and 126 PJ respectively, liquid biogenic materials and the biogenic proportion of residential waste contributed an additional 11 % each to the total biogenic primary energy consumption in 2019. Towards this end, 83 % of the biogenic waste were used in waste incineration plants for the generation of electricity and district heat (105 PJ compared to 108 PJ in 2018) and 17 % for covering the industrial demand for space heat and process heat. When it comes to liquid biomass, admixed as well as pure biofuels are particularly relevant; according to currently accessible information, their use remained stable when comparing the years 2019 and 2018 with one another.

Wind energy, photovoltaics, hydropower, and biomass taken together accounted for 95 % of the primary energy consumption of renewables in 2019. The remaining 5 %, which translate into 97 PJ, were attributable to the renewable energy carriers deep geothermal energy as well as environmental heat including near-surface geothermal energy and solar thermal energy.

In 2019, 53 PJ of renewable environmental heat were generated by means of heat pumps. When compared to the previous year, this equals an increase of 8 % which is due to the continuously growing market for this heat generating technology: According to the Federal Heat Pump Association (BWP), 86,000 heat pumps for heating purposes as well as 16,500 hot water heat pumps were newly installed last year.

The primary energy consumption of deep geothermal energy including its balneological use (thermal baths) amounted to about 13 PJ in 2019 (+5 % compared to 2018). The rise was primarily due to a 10 % increase in geothermal power generation.

Compared to the previous year, solar thermal heat generation experienced a decline of approximately 4 % in 2019. On the one hand, the total installed collector surface stagnated because there was an almost even balance between the dismantling of existing capacities and the once again declining installation of new ones. On the other hand, albeit exceeding the long-term average, global radiation fell below the record value achieved in the extremely sunny previous year (please see above) which, thus, resulted in a decline in heat generation.

An analysis of the individual technologies designed to utilize renewables clearly illustrates that the energy carrier specific primary energy consumption shows different tendencies (please see Figure 14). While biomass lost quite a few shares in the growing market (2018: 53 %; 2019: 51.4 %), it was above all wind energy which was able to expand its contribution by 1.9 percentage points to 23.9 % in 2019.

Figure 14

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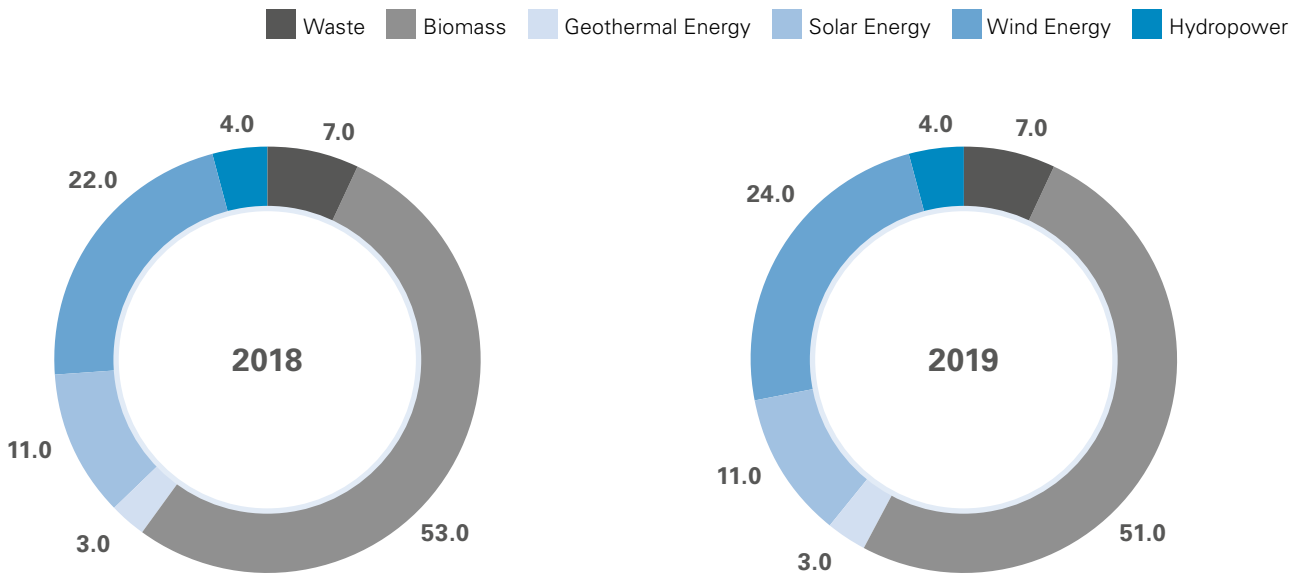
Structure of Renewable Energy Sources in Germany between 2018 and 2019

Shares in Total Renewable Energy in %



All values for 2019 are preliminary.

Source: AGEE-Stat

Energy Efficiency in Germany

Already within the scope of Germany's national sustainability strategy, the Federal Government had established the objective of doubling the macroeconomic energy productivity by 2020 when compared to the respective figures ascertained for 1990. The Energy Concept 2050 also continues to see the improvement of energy efficiency as a key strategy for a successful energy turnaround.

Towards this end, empirically determining energy efficiency is by no means clear and simple, and not every technically feasible increase in energy productivity is, at the same time, also economically viable. Because efficiency improvements actually require not only time, but usually also the application of innovative technologies and, thus, the increased use of physical capital.

A typical indicator for the measurement of energy efficiency is considered to be the energy intensity; namely, the consumption of primary or final energy in relation to such guiding economic parameters as, for example, the gross domestic product or the population. Every reduction of the energy intensity defined that way is synonymous with an increase in energy productivity and/or energy efficiency.

In light of a 0.6 % increase in the macroeconomic performance and the substantial decline in energy consumption, Germany's macroeconomic energy productivity related to the original values ascertained for primary energy consumption improved substantially by 2.7 % in 2019. Temperature and stock level adjusted, the macroeconomic energy productivity exceeded this rate significantly with a plus of 3.1 %, and it was also noticeably above the level exhibited by the long-term trend (between 1990 and 2019: About 2.2 % p.a.). These figures aptly demonstrate that the decoupling process between the overall economic development and energy consumption continued even more so than before (please see Table 15 and Figure 15).

Table 15

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Macroeconomic Energy Productivity in Germany between 1990 and 2019

	Unit	2017	2018	2019	Average Annual Change in %	
					2018 to 2019	1990 to 2019
Gross Domestic Product (Price Adjusted: Reference Year 2015)	Concatenated Volume Figures in Billion Euros	3,174.0	3,222.5	3,241.8	0.6	1.8
Population [3]	1,000	82.7	82.9	83.1	0.2	0.1
Primary Energy Consumption (Unadjusted)	Petajoules	13,523	13,102	12,832	-2.1	-0.5
Primary Energy Consumption (Adjusted) [5]	Petajoules	13,652	13,425	13,104	-2.4	-0.5
Total Electricity Consumption [4]	Billion kWh	601.3	594.7	574.9	-3.3	0.1
Energy Productivity (Unadjusted)	Euros/GJ	234.7	246.0	252.6	2.7	2.3
Energy Productivity (Adjusted) [5]	Euros/GJ	232.5	240.0	247.4	3.1	2.2
Electricity Productivity	Euros/kWh	5.3	5.4	5.6	4.1	1.6

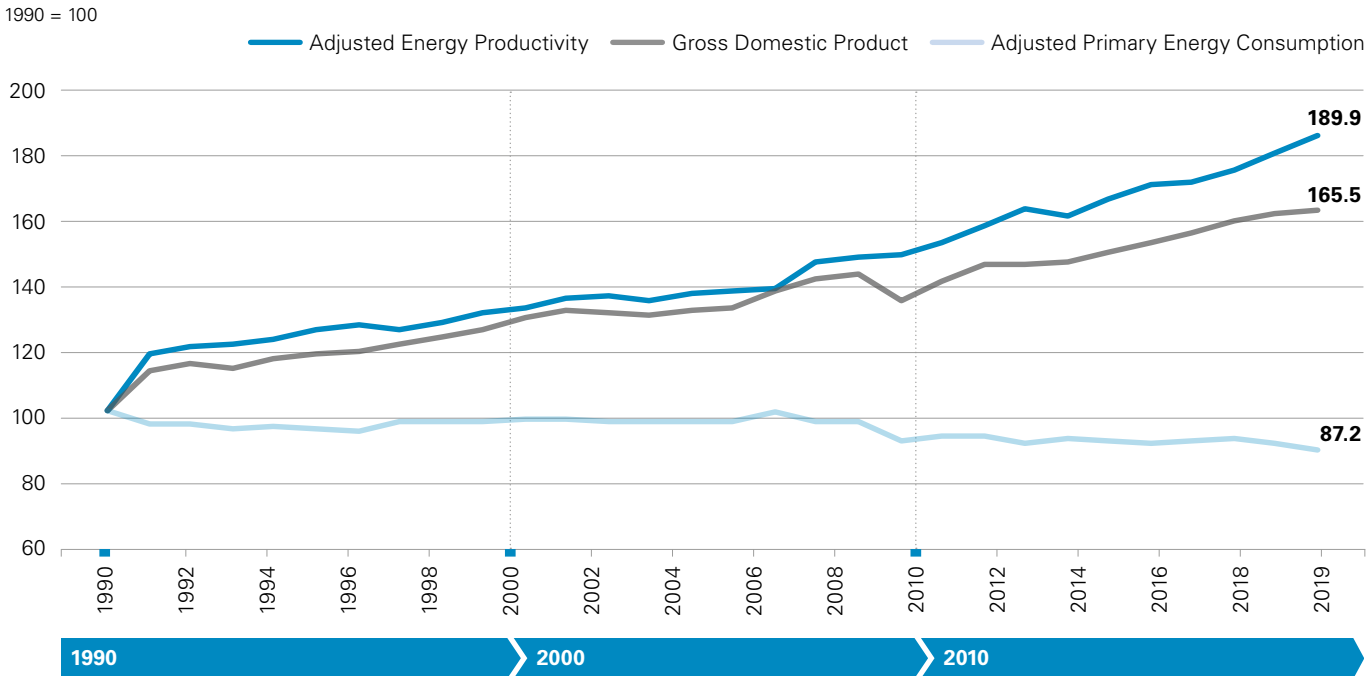
1) Some figures are estimates
2) Preliminary data
3) Average population based on the 2011 census (result as per the closing date May 9, 2011: 80,219,695 inhabitants)
4) Including pump current generation
5) Values adjusted for temperature, mineral oil adjusted for inventory

Discrepancies in the totals are due to rounding off

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

Figure 15

Gross Domestic Product, Primary Energy Consumption, and Energy Productivity in Germany between 1990 and 2019



**) Preliminary data*

Sources: Federal Statistical Office (Destatis); Federal Ministry for Economic Affairs and Energy (BMWi); Federal Ministry of Finance (BMF); Working Group on Energy Balances (AGEB)

However, such a review of the macroeconomic energy productivity, which is based on primary energy consumption, also reflects statistical effects. These effects are associated with the assessment of hydropower, wind energy, photovoltaics as well as nuclear energy (which are all used for electricity production) from a primary energy perspective, for which no uniform conversion standard such as the calorific value (for fossil fuels) exists. Within the scope of preparing its energy balances, the AG Energiebilanzen evaluates and assesses these energy carriers according to the so-called efficiency method (which is also applied internationally for calculating the primary energy consumption and for preparing energy balances).

In the past, the substitution method used to be the common evaluation standard in Germany. Depending on the respective substitution processes in the mix of energy carriers, any decision made in favor of the one or the other method actually influences not only the level, but also the development of primary energy consumption and the associated macroeconomic energy productivity. Details of the effects both assessment methods have on primary energy consumption – based on the current reporting years 2018 and 2019 – are highlighted in the gray box below.

Effects of the Assessment Methodology for Nuclear Energy and Renewables on Primary Energy Consumption

When interpreting the development of primary energy consumption (as well as the indicators derived therefrom such as, for example, energy productivity), a purely statistical effect needs to be taken into account in addition to numerous influencing factors (for example, economic growth, structural change, weather, changes in stock levels); whereby this statistical effect results from the fact that due to international conventions, the balancing of those energy carriers which do not have any calorific value is done according to the so-called efficiency method ("physical energy content" method). Since nuclear energy does not possess any "natural" calorific value, the degree of efficiency of the appropriate plants is set at 33 % according to this method. When it comes to solid, liquid, or gaseous biogenic renewables, the respective input materials are evaluated directly according to their calorific value; however, this does not apply to the renewable energies water, wind, and photovoltaics as well as the electricity trade balance with foreign countries: Here, the respective energy used is equated with the calorific value of the electrical energy produced, which equals a degree of efficiency of 100 %.

Compared to the previously used so-called substitution method, where nuclear energy as well as the above mentioned renewable energy carriers for electricity production and the electricity trade balance were evaluated according to the average specific fuel consumption in conventional thermal power stations, the transition to the efficiency method, which is generally used around the globe, entails that a higher primary energy consumption is calculated for nuclear energy, whereas a lower primary energy consumption is ascertained for renewable energy carriers and the electricity trade balance. That is why according to the substitution method, the biggest "savings effect" is created if and when the electricity produced in nuclear power plants is completely substituted by renewables and/or electricity imports. If, for example, the entire electricity production from nuclear power plants in 2019 (75.2 billion kWh) were to be substituted completely by the above mentioned renewable energy carriers, then this would result in "savings" of 67 % when calculating the difference in efficiency according to the substitution method. This would cause the estimated primary energy consumption for 2019 to decrease by 550 PJ and/or by about 4.3 %.

Conversely, it can be concluded from all these aspects that the application of the substitution method (compared to the efficiency method) would result in a noticeably higher primary energy consumption. According to the substitution method, the primary energy consumption for 2019 would rise to a calculated figure of 13,309 PJ; this equals an increase of about 477 PJ (which translates into 3.7 %) compared to the primary energy consumption that is calculated according to the efficiency method (12,832 PJ).

In light of the observed decline in electricity production from nuclear energy (-0.8 billion kWh), on the one hand, as well as the significantly increased electricity production from the renewables under review here (+20.0 billion kWh) and the decreased electricity trade balance (-12.1 billion kWh), on the other hand, the **substitution method**, when applied to the described changes in primary energy consumption between 2018 and 2019 and with an average efficiency of 45 %, would lead to an increase in the primary energy consumption of both energy carriers by 336 PJ for 2018 and by 477 PJ for 2019. In a comparison of the years 2019 and 2018, this represents a decrease of -1.0 % (instead of -2.1 %) in the total primary energy consumption. For the macroeconomic energy productivity (unadjusted), this would result in an improvement of only -1.6 % (instead of -2.6 %). Hence, the statistical effect outlined here exerts a noticeable influence on the evaluation and assessment of the efficiency ratios which are generated at the primary energy consumption level. Both the final energy consumption (and, if need be, the efficiency ratios related to this value) are not affected by this because the type of primary energetic assessment does not have any impact at this level.

As exemplified by the years 2018 and 2019, the two assessment methods influence and affect the requisite shares of nuclear energy and/or renewable energies in the primary energy consumption as follows (figures in %):

	Nuclear Energy		Renewables	
	2018	2019	2018	2019
Efficiency Method	6.3	6.4	13.8	14.8
Substitution Method	4.5	4.5	19.1	14.2

In addition, the highly aggregated focus on macroeconomic energy efficiency prevents a clear view of many other factors which characterize energy consumption. With the component decomposition method, it is possible to illustrate the key factors which influence the changes in the (adjusted) primary energy consumption (please see Figure 16).

Towards this end, the long-term changes between 2019 and 1990 aptly demonstrate the considerable influence of the decreased energy intensity (in other words, the improvement of the energy efficiency) on the reduction of the (temperature-adjusted) primary energy consumption (-9,417 PJ). This way, it was possible to significantly overcompensate the consumption-enhancing effects of macroeconomic growth (+6,876 PJ) and the increase in population (+610 PJ).

The correlations outlined above apply in a similar way to the short-term consideration of the changes between 2018 and 2019: Yet other than in a long-term comparison, it was now primarily economic growth (+47 PJ) which had only a relatively minor consumption-enhancing effect. Hence, it was possible to largely offset the consumption-enhancing effects of both the income and population components (together +79 PJ) by improving the efficiency (-400 PJ) so that the result was a reduction of the (adjusted) primary energy consumption by 321 PJ.

However, when it comes to the assessment of the results of such a component decomposition, it must be noted that the changes in primary energy consumption are of course not only influenced by the factors which are taken into account here (economic growth, population trend, and macroeconomic energy efficiency).

The development of energy consumption can neither be sufficiently explained from a monocausal perspective nor in an extremely simplified form; it is rather the result of a very complex interaction between numerous (partially interdependent) determinants which, in addition to the influencing factors considered within this component decomposition, also have an impact on the consumption trend.

These factors and/or determinants include, above all, the impact of the structural change. Typically, a distinction is made between two types of structural change: The intersectoral structural change, which refers to the shifting of economic activities between different industrial branches, as well as the intrasectoral, branch-internal structural change (in other words, the demand and/or sales induced shifting of product portfolios within a single industrial branch). The structural change may result in energy savings (declining relevance of energy-intensive branches and/or products) or increase the consumption of energy (growing relevance of energy-intensive processes). In Germany, the sectoral structural change tended

Figure 16

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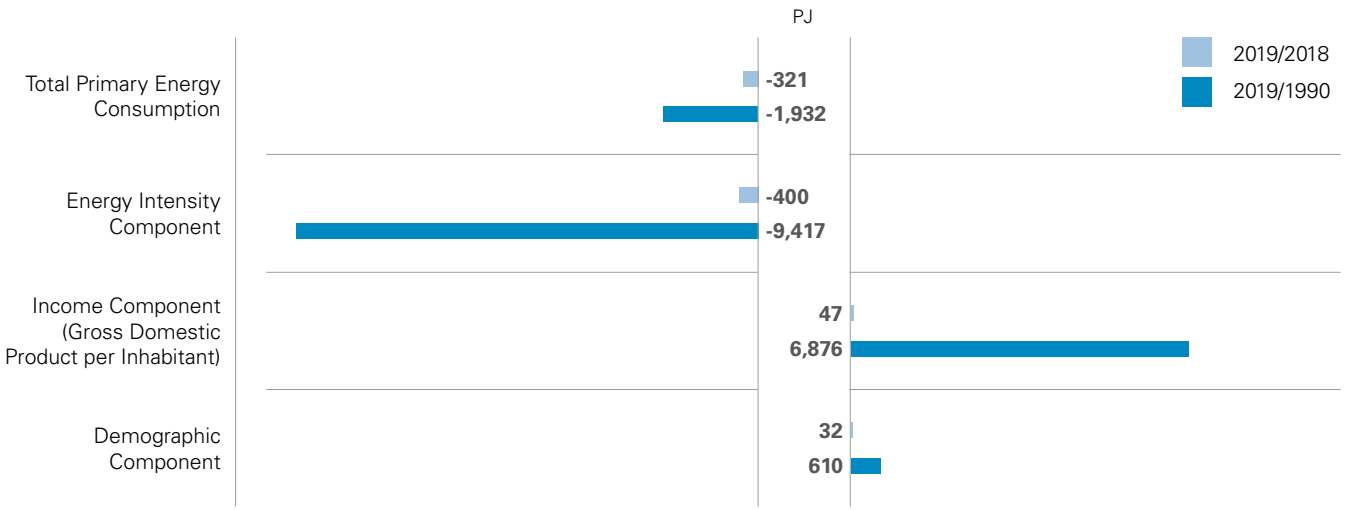
Contributions of Diverse Influencing Factors to the Changes in the Adjusted Primary Energy Consumption in Germany

Changes in 2019 Compared to 2018 and 1990 in Petajoules



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

to cause energy consumption to decrease in the past. Notwithstanding the above, this component decomposition, which is assumed here in a simplified manner, does not contain any structural effects.

When assessing the macroeconomic energy productivity, it must also be kept in mind that above average gains in efficiency in the use of fuels and heat are often contrasted by comparably moderate savings in the specific electricity consumption. This is due to the fact that an improvement of the energy productivity in numerous economic branches can in many cases only be attained through the increased use of state-of-the-art production facilities, and that a lot of the applied process technologies which are designed to save fuels actually increase the specific electricity consumption. Yet there were also the increased requirements with regard to matters revolving around environmental protection as well as the persistent trend towards automation and the electronic control of processes which, for example, resulted in the fact that the electricity savings potentials, which are to be rated lower anyway, were partially compensated for by the increased use of this energy carrier in new fields of application.

Against this backdrop, the macroeconomic electricity productivity (expressed as the ratio of the price-adjusted gross domestic product to gross electricity consumption) went up by 4.1 % in 2019 (compared to 2018), which was due to the significant decline in electricity consumption and to a simultaneous slowdown of the economic growth. When taking the long-term period between 1990 and 2019 into account, the electricity productivity increased by an annual average of 1.6 %. For comparison: The total energy productivity increased by 2.2 % p.a. over the same period of time (for more details on this topic, please see Table 15 as well as Figures 17 and 18).

The impact of select components (economic growth, population trend, and electricity productivity) on the changes in electricity consumption in Germany between 1990 and 2019 and/or 2018/2019 is illustrated in Figure 19, which concludes this section. The diagram shows that the reduction of the total electricity consumption, which declined by 20 billion kWh in 2019 when compared to 2018, was primarily caused by higher electricity productivity (electricity intensity component) (-23 billion kWh) and by the increase in population (+1 billion kWh).

Figure 17

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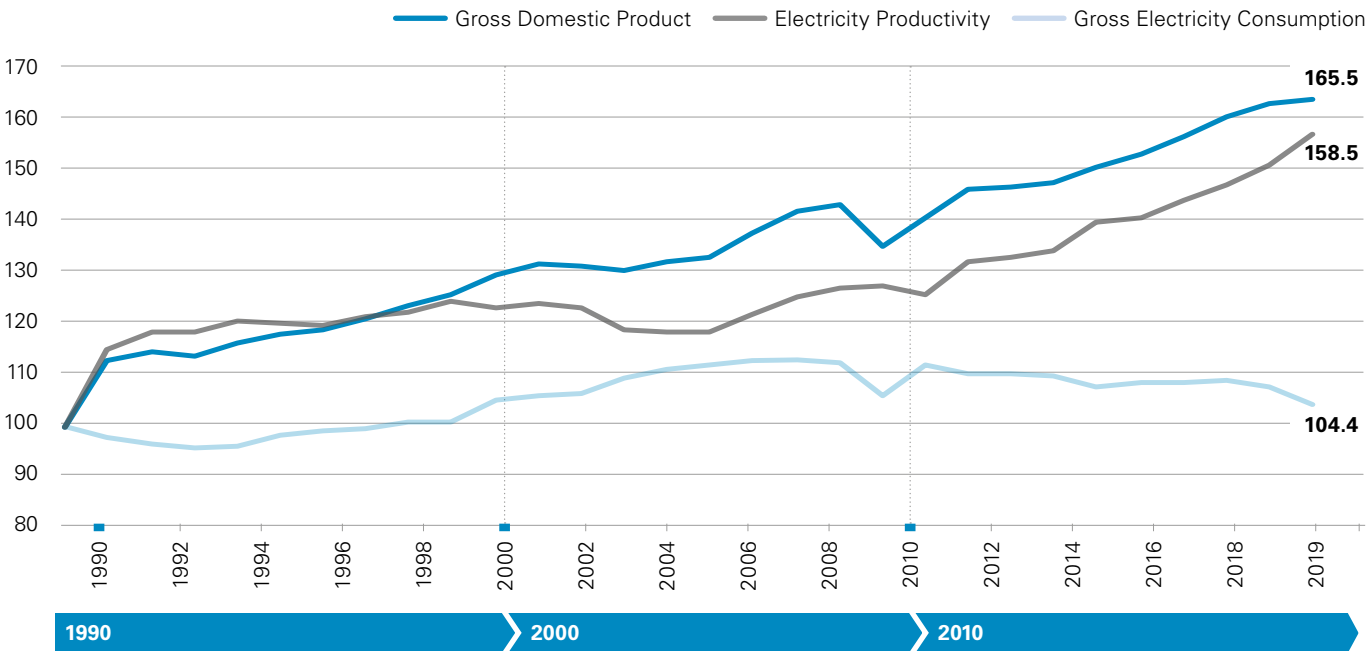
Gross Domestic Product[1)], Gross Electricity Consumption, and Macroeconomic Electricity Productivity[2)] in Germany between 1990 and 2019



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

Sources: Federal Statistical Office (Destatis); Federal Ministry for Economic Affairs and Energy (BMWi); Federal Ministry of Finance (BMF); German Association of Energy and Water Industries (BDEW)

Figure 18

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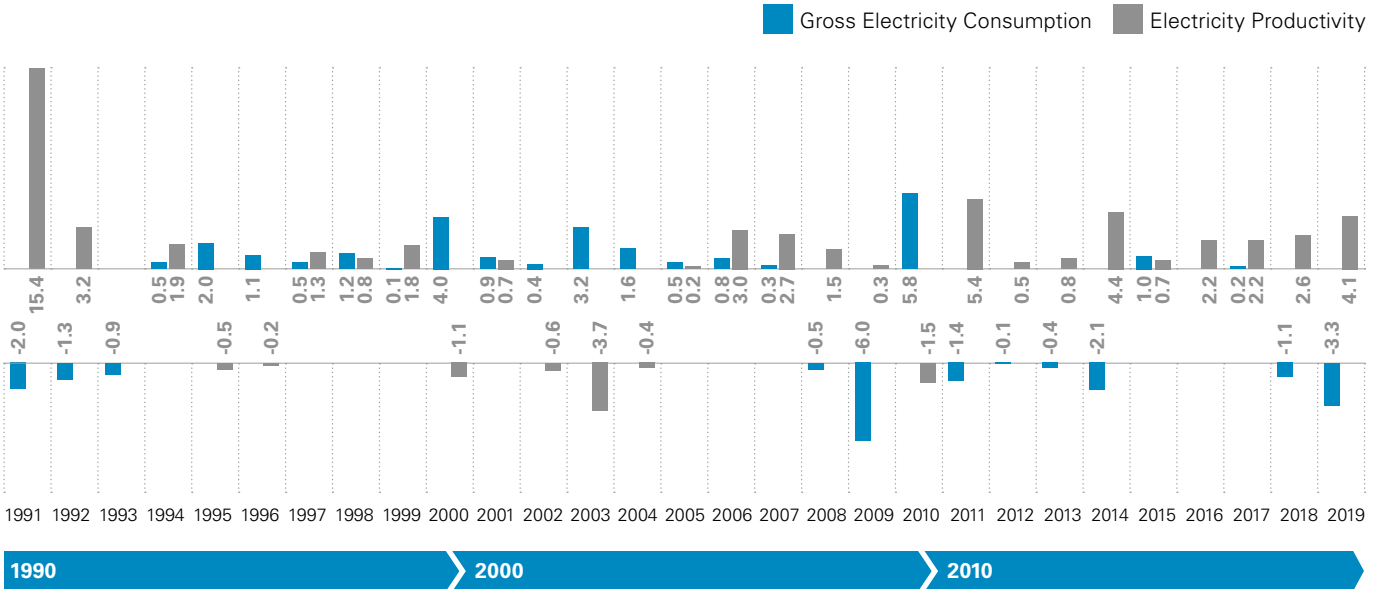
Changes in Gross Electricity Consumption and Electricity Productivity between 1991 and 2019

Changes Compared to the Previous Year in %



*) Preliminary data

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

When considering the entire period between 1990 and 2019, though, the long-term increase in electricity productivity did not result in an absolute reduction of the electricity consumption. On the contrary, gross electricity consumption increased by about 24 billion kWh between 1990 and 2019.

The above mentioned increase in the electricity productivity within the same period of time was the reason why the increase in gross electricity consumption had been limited by 269 billion kWh to about 24 billion kWh and/or a plus of about 4.3 % (0.1 % p.a. respectively) despite the fact that there was a considerable increase in consumption due to the growing economy.

Figure 19

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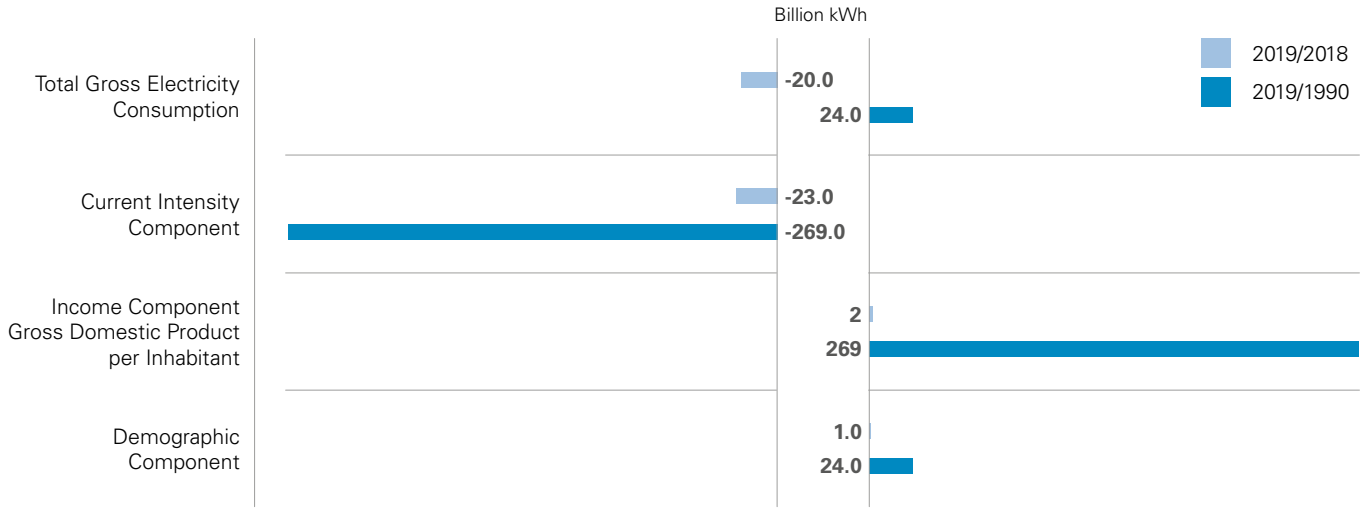
Contributions of Diverse Influencing Factors to the Changes in Gross Electricity Consumption in Germany

Changes in 2018 Compared to 2017 and 1990 in Billion kWh



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

CO_2 Emissions

According to initial calculations, power generation and heat generation plants supplying the general public emitted about 195 million tons of CO_2 in 2019. This was about 47 million tons of CO_2 or 19 % less than in 2018. The largest share by far of this emissions reduction accounted for electricity production (whereby the electricity was merely produced in condensation units and cogeneration plants); the requisite facilities managed to reduce their carbon dioxide emissions by well above 45 million tons.

Thanks to efficiency improvements, substitutions of energy carriers, and the economy-related decrease in electricity and heat production, power generation in the plants of mining facilities and the manufacturing industry also contributed its share to a further reduction of CO_2 emissions between 2018 and 2019. According to initial estimates, the CO_2 emissions in this segment ought to have decreased by about 2 million tons in 2019.

From the preliminary data and estimates compiled in this report on the energy consumption trend in 2019, the following general assumptions can, thus, be derived for the development of energy-related carbon dioxide emissions in other sectors:

- In 2019, the rise in fuel sales (gasoline, diesel fuels, and aviation fuels) as well as slight shifts within the sales mix are likely to result in an increase in CO_2 emissions of about 2.4 million tons in the transportation sector.[9]

- In the manufacturing industry, however, it is anticipated that the energy-related CO_2 emissions are likely to have decreased by approximately 4 million tons when compared to the previous year. Just the reduced coal input in crude steel production alone, which due to the economic situation dropped to 39.6 million tons in 2019 when compared to the previous year, ought to have relieved the industry's emissions balance by 2.1 million tons in the reporting year.

- Despite the slightly cooler weather when compared to the previous year, the ongoing modernization of heating systems and building envelopes in private households resulted in a declining consumption of fuel oil and natural gas for heating residential premises. Against this backdrop and according to initial estimates, the CO_2 emissions of private households are likely to have decreased by 1.5 million tons in 2019.

- Finally, a slight reduction of the emissions is to be anticipated also for the trade, commerce, and service sector (2019: -0.5 million tons).

If one were to summarize the developments outlined above for an initial assessment, then according to rough calculations an overall decline in energy-related CO_2 emissions of about 53 million tons could be anticipated for the year 2019. As a result, the energy-related CO_2 emissions would have decreased by about 7.4 % in 2019 when compared to the previous year. (The short-term forecast published by the Federal Environment Agency (UBA) estimates the energy-related CO_2 emissions for 2018 at 710.1 million tons.) This "bottom up" estimate as outlined above corresponds very closely to the reduction of energy-related CO_2 emissions which to some extent is ascertained "top down" from the development of primary energy consumption which is explained in the first section of this report.[10]

9 It must be noted in this context that the sales volumes for diesel fuel and gasoline deliver only an incomplete picture of the effects of "fuel tourism" which seeks to benefit from differences in fuel prices in regions close to national borders (fuel volumes with which foreigners refuel their tanks in Germany and which are, if applicable, used abroad are recorded therein whereas the sales volumes do not include those fuel volumes which are refueled abroad and used in Germany); consequently, the requisite calculations of CO_2 emissions in the transportation sector may also be distorted. All the more so as the aforementioned "fuel tourism" has moved in the opposite direction during the past few years due to the substantial increase in the taxes on fuels in some neighboring countries (for example, France, Belgium, the Netherlands).

10 The Federal Environment Agency (UBA) estimates that the entire greenhouse gas emissions declined by 6.3 % in 2019 when compared to the previous year (please see the press release of the Federal Environment Agency dated 2020-03-16). According to this trend assessment, the total carbon dioxide emissions (including processes) decreased by about 50 million tons (or 6.6 %) during the same period of time. From an overall perspective, the assessments conducted by the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group) and by the Federal Environment Agency regarding the emissions trend are quite close to one another. When it comes to the estimates made by the AG Energiebilanzen and the Federal Environment Agency, it needs to be kept in mind that the requisite calculations are subject to considerable uncertainties at this point in time due to the limited availability of final and definitive as well as sufficiently detailed statistical data.

In this context, a continuing problem should once again be highlighted which is associated with the fact that those emissions which originate from domestic electricity production and are accompanied by the high export surplus are allocated to Germany according to the territorial principle while conversely the emissions that would most likely be associated with the generation of electricity in those supplied countries is disregarded which consequently results in lower emissions in those countries. But it is questionable whether the emissions balance will be positive when viewed from an international 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.

Summary

According to preliminary calculations made by the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group), energy consumption in Germany decreased by 2.1 % to 12,832 petajoules (PJ), which translates into 437.8 million tons of hard coal equivalents (Mtce), in 2019. Thus, Germany's energy consumption dropped to its lowest level since the early 1970s.

Responsible for the reduced energy consumption in Germany were, above all, the weaker economy as well as progressive improvements in energy efficiency. The price trend for energy also provided an impetus for saving energy. Even though the global market prices for oil, natural gas, and hard coal experienced to some extent a noticeable decline over the course of the year 2019, the energy prices of grid-bound energy carriers (natural gas, electric power, district heat) actually increased for some consumer groups (for example, private households as well as the trade, commerce, and service sector) on the home market. In light of the slowdown in the economic development, however, the consumption-enhancing effect of the increase in population (+0.2 million people) and of the only slightly cooler weather (when compared to the previous year) actually receded into the background in 2019. Without the influence of the weather, primary energy consumption would have fallen 2.4 % below the level that had been ascertained for 2018.

As measured by the original values, the macroeconomic energy productivity continued to improve in 2019. With a rate of 2.7 %, it did not increase as much as in the previous year (+4.7 %); however, it was still significantly above the long-term average (between 1990 and 2019: +2.3 % p.a.). Temperature-adjusted, the macroeconomic energy productivity increased by 3.1 % in 2019 when compared to the previous year.

A glance at the individual energy carriers reveals the following picture: Consumption of renewables experienced the strongest increase by far in 2019 (+5.2 %). In contrast, consumption (and/or sales) of mineral oil products and natural gas increased much slower with +2 % and +3.3 % respectively. All other energy carriers lost shares in the generally shrinking market. For example, the consumption of coal (hard coals with a minus of 20.5 % and lignite with a minus of 20.3 %) dropped significantly. Power generation from nuclear energy went down by 1.1 %.

With a share of 35.3 % 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 24.9 %. Renewable energy carriers ranked third with a current share of 14.8 % in primary energy consumption, followed by lignite with 9.1 % and hard coal with 8.8 %. The share of nuclear energy to cover the primary energy consumption stagnated at about 6.4 % in 2019.

When it comes to renewables, the changes diverged considerably in 2019: While the primary energy consumption of biogenic waste decreased by about 2 % and that of biomass and solar energy went up by 2 % each, a significant increase of approximately 15 % could be observed for wind energy and of 12 % for hydropower which was due to the favorable supply situation for wind and water. With 2 %, solar energy (primarily photovoltaics) recorded a moderate increase; at the same time, geothermal energy grew by 8 %.

Similar to primary energy consumption, gross electricity consumption also went down in 2019; albeit the decline of 2.5 % to almost 580 billion kWh was more significant. Compared to the previous year, the macroeconomic electricity productivity improved by 4.1 % in 2019, which was substantially higher than the annual average of 1.6 % between 1990 and 2019.

With a reduction of nearly 4.8 % to about 612 billion kWh in 2019, gross electricity production decreased at a stronger rate than gross electricity consumption. The energy mix of electricity production according to energy carriers exhibited a noticeable change: While electricity production based on the use of hard coal (-30.6 %), lignite (-21.8 %), and nuclear energy (-1.2 %) declined, renewable energy carriers accounted for a strong plus of 8.7 %. At the same time, electricity production based on the use of natural gas increased by a substantial 10 % in 2019 after it had still experienced a decline of 4.9 % (4.2 TWh) between 2017 and 2018.

All told and with a total production volume of about 244 billion kWh, which translates into a share of nearly 40 % in electricity production, renewables were able to further expand their top position ahead of lignite (18.6 %), natural gas (14.9 %), nuclear energy (12.3 %), and hard coal (9.4 %). When it comes to electricity consumption, renewables accounted for a share of more than 42 % in 2019; in the previous year, this share had still amounted to approximately 38 %.

The trend towards a continuous increase in Germany's negative electricity trade balance[11] has been interrupted since 2018. With an export surplus of 34.9 billion kWh, the balance for 2019 fell once again below the previous year's level (2018: 51.2 billion kWh). Particularly high export surpluses were recorded for the exchange with Austria (12.6 billion kWh), Poland (9.9 billion kWh), and Switzerland (7.9 billion kWh); while the Netherlands (5.6 billion kWh) and Luxemburg (4.5 billion kWh) lagged considerably behind. Surpluses in the flow of electric power from abroad traditionally come from France; whereby the import surplus from France increased by more than 46 % from 8.4 billion kWh in 2018 to about 12.4 billion kWh in 2019. The exchange with other countries was at a comparably low level.

At the moment, it is not yet possible to precisely ascertain the energy-related CO_2 emissions for 2019 on the sole basis of final statistical data. However, a rough estimate of the development of energy-related CO_2 emissions can be made on the basis of current estimates and preliminary data on the changes in primary energy consumption according to the respective CO_2 content of the individual energy sources that are referred to and edited in this report. In 2019, the overall structure of energy consumption shifted noticeably towards emission-free (renewables) as well as low-emission energy carriers such as natural gas. Against this backdrop, energy-related CO_2 emissions are likely to have decreased at a stronger rate than primary energy consumption.

As measured by the original values for primary energy consumption and according to a rough estimate, emissions are likely to have been reduced by around 7.4 %, which translates into about 53 million tons of CO_2; temperature-adjusted (related to the long-term average), the decline was somewhat stronger with approximately 7.7 %, which translates into almost 55 million tons of CO_2. The largest contribution by far to reducing the energy-related CO_2 emissions came from the electricity industry (power plants supplying the general public); just here alone, it was possible to reduce carbon dioxide emissions by more than 47 million tons between 2018 and 2019 due to the increased use of renewables and natural gas instead of coal. Successful reductions are likely to have also been achieved by the sectors industry (-4 million tons), private households as well as trade, commerce, and services (-2 million tons), and industrial power plants (-2 million tons). In the transportation sector, the third largest producer of greenhouse gases, CO_2 emissions increased according to preliminary calculations by approximately 2.5 million tons.

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