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Energy Consumption

in Germany in 2020

Energy Consumption in Germany Drops to Historic Low in 2020 Due to the Covid-19 Pandemic

Contents

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Total Primary Energy Consumption

In 2020, the primary energy consumption in Germany amounted to a total of 11,784 petajoules (PJ) or 402.1 million tons of coal equivalents (Mtce); compared to the previous year, this equals a decrease of 8.0 % (please see Table 1).

Table 1

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Primary Energy Consumption in Germany in 2019 and 2020 [1)]

Energy Carrier	2019	2020	2019	2020	Changes in 2020 Compared to 2019			Proportions in %	
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	Mtce	%	2019	2020
Mineral Oil	4,511	3,973	153.9	135.6	- 538	- 18.4	- 11.9	35.2	33.7
Natural Gas	3,214	3,136	109.7	107.0	- 78	- 2.7	- 2.4	25.1	26.6
Hard Coal	1,084	904	37.0	30.8	- 180	- 6.1	- 16.6	8.5	7.7
Lignite	1,164	956	39.7	32.6	- 207	- 7.1	- 17.8	9.1	8.1
Nuclear Energy	819	702	27.9	24.0	- 117	- 4.0	- 14.2	6.4	6.0
Renewable Energy	1,904	1,961	65.0	66.9	57	1.9	3.0	14.9	16.6
Electricity Exchange Balance	- 118	- 72	- 4.0	- 2.5	46	1.6	-	- 0.9	- 0.6
Other	228	224	7.8	7.6	- 4	- 0.1	- 1.8	1.8	1.9
Total	**12,805**	**11,784**	**436.9**	**402.1**	**- 1,021**	**- 34.8**	**- 8.0**	**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, for example, the gradual phase-out from nuclear energy until the end of 2022, the scheduled exit from coal fired power generation (by the end of 2038) as well as the continued promotion undertaken to expand 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, the objectives pursued for climate protection in the non-ETS sector, the requirements for improving energy efficiency (for example, the EU Energy Efficiency Directive (EED)) as well as binding targets for the progressive expansion of renewable energy (EU Renewable Energy Directive (Directive 2009/28/EC)).

In 2020 as well, the most important energy carrier continued to be mineral oil with a share of 33.7 %. It was followed by natural gas with a slightly increased share of 26.6 % (2019: 25.1 %). Renewables were able to expand their position at third place to 16.6 %; in 2019, their contribution had still been 14.9 %. The primary energy consumption of hard coal and lignite in 2020 fell noticeably by 16.6 % and 17.8 % respectively so that lignite covered only about 8.1 % and hard coal 7.7 % of the domestic demand for primary energy. Compared to the previous year, the primary energy consumption of nuclear energy decreased by 14.2 % in 2020 (decommissioning of the nuclear power plant Philippsburg as of December 31, 2019). Thus, nuclear energy currently covers still about 6 % of the demand for primary energy. The surplus obtained from the flow of electric power to foreign countries continued to decline in 2020. Consequently, the balance in the electricity exchange had a consumption-reducing effect (by 0.6 percentage points) on primary energy consumption also in 2020.

General Conditions for the Development in Consumption in 2020

The development of primary energy consumption depends on numerous influencing factors. These factors include, in addition to changes in the general political and regulatory framework, primarily the macroeconomic and sectoral development (structural change), demographic factors, energy prices, and temperature fluctuations. The individual factors which played a specific role in the decline in primary energy consumption during the years 2019/2020 will be outlined briefly 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 of privately and commercially used rooms. The temperature influence is usually measured by means of degree day figures; in simple terms, this index reflects the cumulative number of the specific days on which the average temperature falls below a certain level (heating threshold temperature; here: 15 degrees Celsius).[1)]

In 2020, the number of degree days was noticeably below the long-term average (arithmetic average between 1990 and 2019 taken from 16 measurement stations). The small number of days with heating threshold temperatures of less than 15° C generally points towards a higher average temperature level in the reporting year and an associated drop in the observed energy demand (in particular, for the heating of residential premises).[2)]

When compared to the previous year, the number of degree days decreased as well by 83 to 3,136 because it was somewhat warmer in 2020 than it had been in 2019. In 2020, the degree day figures fell about 2.6 % below those of the previous year (higher temperatures) so that energy consumption in 2020, also when compared to 2019, ought to have decreased just because of the influence of the weather alone.

When considering the development of the degree day figures during the individual months, it becomes apparent that the year 2020, particularly during the months of March, October, and December, was significantly cooler than the previous year. In contrast, and as measured by the degree day figures, the temperatures in January and September significantly exceeded those of 2019. When compared to the long-term average, the year 2020 was consistently warmer (except for the month of May during which the temperatures exceeded the long-term average by 23 %) (please see Figure 1).

The impact of short-term temperature effects on the development of primary energy consumption is typically eliminated in that temperatures are assumed as indicated in the long-term average[3)] and that inventory-adjusted data are taken into account for mineral oil consumption[4)]. When taking these assumptions as a basis, then primary energy consumption would not have declined by 8 %; instead, the decrease would have been 7.5 % in 2020.

1) *Degree day figures (in accordance with DIN VDI 3807) are specifically defined as the sum of the differences between a fixed indoor temperature (here: 20° C) and the daily average of those days on which the air temperature falls below the heating threshold temperature (here: 15° C).*
2) *When compared to the long-term average (average number of degree day figures between 1990 and 2019), the year 2020 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, the temperatures were 11.8 % higher than the values of the long-term average. If one were to shift one's considerations solely towards a long-term perspective, then primary energy consumption would have been above the level observed both in 2019 and 2020 provided that the weather conditions during these years had equaled those of the long-term average. Using the long-term average number of degree day figures between 1990 and 2020 would actually not change this basic assumption either. As measured by these values, the year 2020 would have been about 11.4 % warmer than the long-term average.*
3) *For assessing the long-term developments of energy consumption (as of 1990), the temperature adjustments in this report are generally conducted by taking the long-term average into account (please see Table 15, Diagrams 15 and 16). For short-term comparisons (for example, with the previous year), the weather conditions prevailing during the comparative period could, of course, also be considered as an alternative. It is obvious that both the level of the temperature-adjusted absolute energy consumption and the rate of change compared to the previous year depend on the reference period chosen for the respective adjustment procedure.*
4) *The information on mineral oil consumption provided in the energy balance (particularly on 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-statisiklangfassung.pdf?__blob=publicationFile&v=7 (download date: 2021-02-13; currently only available in German).*

Figure 1

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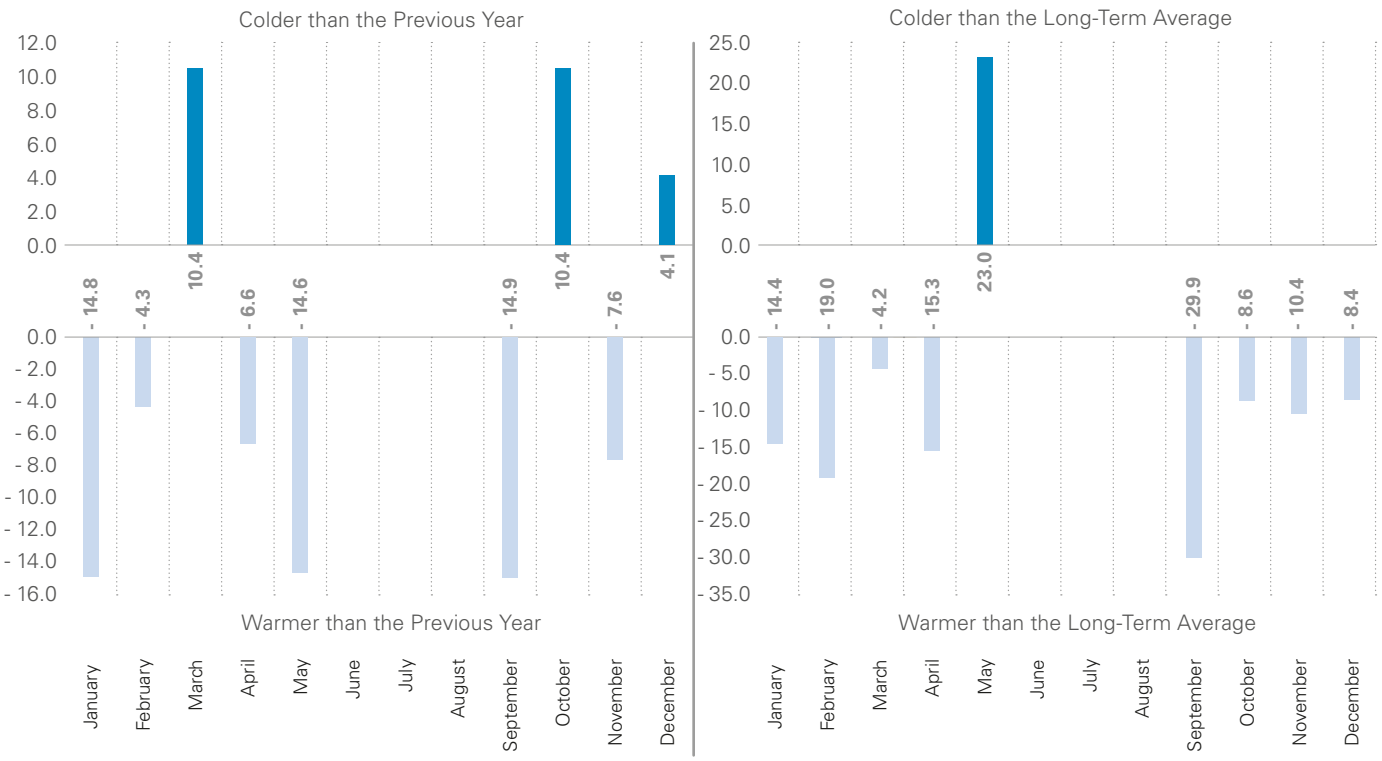
Monthly Degree Day Figures in Germany in 2020 (16 Measurement Stations)

Changes in 2020 compared to the previous year and to the long-term average (1990-2019) in %.
Due to their limited informative value, the months of June and August are not included.



Source: Germany's National Meteorological Service (DWD)

Figure 2

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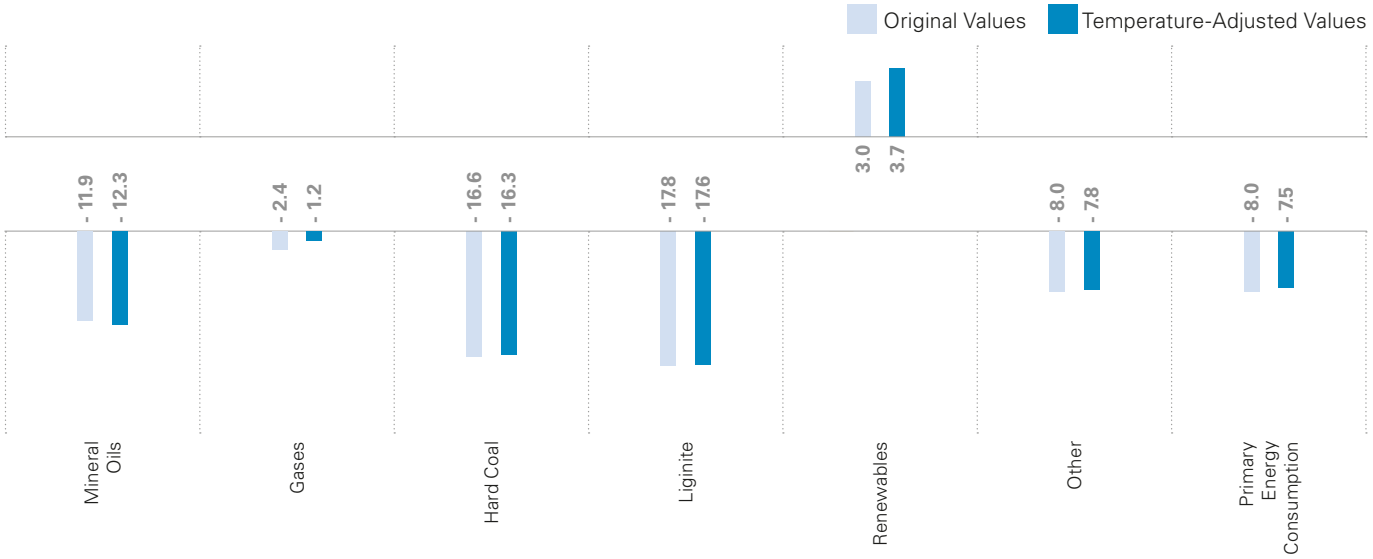
Primary Energy Consumption in Germany According to Energy Sources

Changes between 2020 and 2019 in %



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

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).

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 of course to a large extent on global economic trends. According to estimates of the International Monetary Fund (IMF), the global economy shrank by about 3.5 % in 2020 which was, above all, due to the economic impact of the Covid-19 pandemic, but also due to an increasing number of trade barriers. For comparison: In 2019, the global economy had still expanded by 2.8 %. Just this development alone caused the growth perspectives of the German economy to worsen noticeably.

The price-adjusted gross domestic product (GDP) decreased by about 5.0 % in 2020 (thus, the economic slump was lower than had initially been anticipated; at the same time, the GDP declined less significantly than had been the case during the financial and currency crisis (2009: -5.7 %)). In the preceding year, the gross domestic product had still grown by 0.6 %. In 2020, growth impulses came primarily from governmental consumption expenditure (2020: +3.4 %) and construction investments[5] (+1.5 %). In contrast, exports of goods and services exhibited a strong decline in 2020 with a minus of 9.9 %. At the same time, imports dropped by 8.6 % when compared to the previous year.

In particular, the effects of the first "lockdown" designed to fight the Covid-19 pandemic as well as the temporary interruption of supply chains hit the industrial production sectors in the economy with full force. All told, the production in the producing industry shrank by 7.8 % in 2020 (2019: -3.5 %); in the manufacturing industry, the production (also measured by the production index) even decreased by 10 % in 2020 (2019: -4.5 %). In the aftermath of the economic recovery which commenced gradually during the summer of 2020, the new "lockdown" which was imposed within the scope of the second corona wave (since November 2020) affected primarily private consumption and the service sectors (hotel and restaurant trade, tourism).

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 service sectors (without the construction industry) were affected by the indirect income-induced effects of the Covid-19 measures (short-time allowance, extraordinary economic aid, etc.) as well as by lockdown measures. Only those 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 of the manufacturing industry (aggregated at the two-digit level of the economic branch classification WZ) between 2019 and 2020:

- In 2020, none of these economic branches was able to attain increases in production, which means that all branches of the manufacturing industry recorded setbacks in growth.

- Compared to the manufacturing industry as a whole, significant slumps were reflected by production decreases in the sectors manufacture of motor vehicles, trailers, and semi-trailers (-21.8 %), manufacture of machinery and equipment (-13.1 %) as well as in the very energy-intensive sector manufacture of basic metals (-12.2 %).

5) Residential and non-residential buildings, including building construction and civil engineering.

Figure 3

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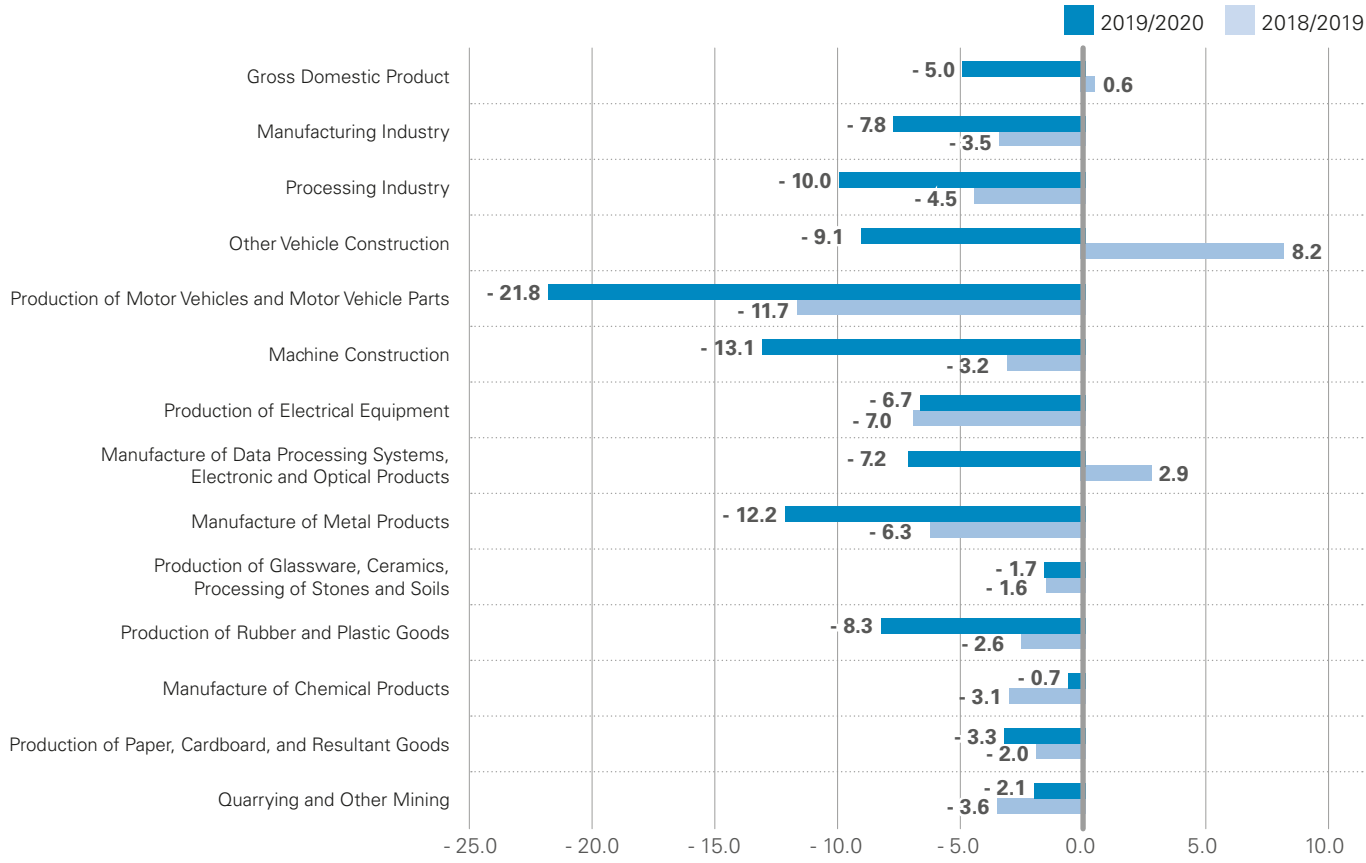
Production Index in Germany's Manufacturing Industry between 2019 and 2020

Changes Compared to the Previous Year in %



Source: Federal Statistical Office (Destatis)

- Compared to the development in the manufacturing industry, the overall declines in production in the remaining energy-intensive branches were below average. In 2020, the manufacture of chemicals and chemical products dropped by 0.7 %, the manufacture of paper and paper products by 3.3 %, and the manufacture of glassware and ceramics as well as the processing of stones and soils (this sector also includes such energy-intensive processes as, for example, the burning of cement, lime, or bricks) by 1.7 %.

- 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 2020; even though it should be remembered in this context that part of the consumption that decreased due to the economic situation was presumably nullified again because of the associated low capacity utilization.[6)]

Demographic Factors

Between 2019 and 2020, the population in Germany merely grew from 83.093 million people to around 83.158 million people; this equals an increase in population of less than 0.1 %. For comparison: In the previous year, the population had still grown by 187,000 people (which equals an increase of more than 0.2 %).

6) *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.*

Under these premises (updated statistical figures are not yet available), the number of households is likely to slightly increase further as well. In 2019, about 41.5 million households existed in Germany, of which around 42.3 % were single-person households.

The increase in the number of households is not only due to the demographic development, but at the same time also due to the existing trend of living in smaller households. Currently, approximately 2.0 persons live in one household.

That is why "in terms of figures," the demographic development in 2020 is likely to have had a consumption-enhancing impact on energy consumption even though, considering the negligible demographic development, its influence might have only played a minor role in this.

Energy Prices

In addition, the energy prices also play an important role when it comes to the consumption behavior, efficiency improvements, and substitutions (between energy and capital as well as materials and/or resources). Generally speaking, the higher the prices for individual energy carriers are, the sooner efficiency improvements and substitutions occur.

The Covid-19 pandemic and/or the associated effects on the global demand for energy had a substantial impact on the condition of the global energy markets in 2020. On average, the import prices for crude oil, natural gas, and hard coals dropped between 23.3 % and 34.1 % in 2020 after having decreased significantly in particular for natural gas and hard coals already in the previous year (please see Table 2).
The import prices based on dollars decreased not quite as substantially. The development of the exchange rate (appreciation of the Euro against the US Dollar) partially intensified 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 2020 to 2019 in %

	2019	2020				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average
	Import Prices					
Mineral Oil	- 2.3	- 15.5	- 56.4	- 29.4	- 33.2	- 34.1
Natural Gas	- 20.6	- 33.9	- 40.0	- 24.0	- 8.4	- 27.1
Hard Coal	- 13.3	- 26.8	- 24.4	- 25.5	- 15.3	- 23.3
	Consumer Prices					
Fuel Oil, Light	- 2.5	- 10.2	- 26.9	- 34.6	- 32.0	- 25.9
Natural Gas	3.9	2.4	1.6	- 0.9	- 1.8	0.3
Electricity	3.4	4.3	4.3	2.0	1.6	3.0

Source: Federal Statistical Office (Destatis)

Dependence on Energy Imports

When it comes to the German economy's vulnerability to energy crises, an outstanding 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.

Against this backdrop, a glance at Germany's foreign trade balance for energy carriers is of particular interest. Germany is a considerable net importer of virtually all fossil fuels (i. e. hard coals, mineral oil, and natural gas). In 2019, domestic primary energy consumption had been covered by imports which amounted to 98 % for mineral oil and 94 % for natural gas. 100 % of the hard coals were sourced from imports. 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 72 % of the German energy supply had been dependent on imports in 2019.

This situation remained basically unchanged in 2020 as well. However, the domestic production of fossil fuels (above all, lignite with a minus of 18.2 %) continued to decrease whereas the domestic production of renewables increased by 3 %. When it comes to electrical energy, the export surplus remained virtually unchanged in 2020 as well; compared to the previous year, however, it declined by 46 PJ (about 12.8 billion kWh respectively). According to first rough calculations, the changes outlined above (with a considerable decline in the overall primary energy consumption due to the Covid-19 pandemic) were reflected by a slight decrease in the import quota (by 0.3 percentage points); nonetheless, the dependence on imports ought to still amount to more than 71 % also in 2020.

As already stated earlier in this report, the import prices for fossil fuels changed significantly. As a result, the decrease in import prices and import volumes caused the import calculation for coal, oil, and gas to drop substantially from about 63 billion euros in 2019 by 20.7 billion euros, or by approximately one third, to 42.2 billion euros in 2020.

A glance at the individual energy carriers reveals the following picture: The value of oil imports decreased by more than 37 %, the value of natural gas imports by 18.4 %. The value-based import balance for coals even decreased by nearly 44 %. When it comes to electric power, the export surplus decreased by about 44 % (please see Table 3).

Table 3

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Balance of Foreign Trade with Energy Carriers in Germany between 2015 and 2020

	2015	2016	2017	2018	2019	2020	2020 ./. 2019	
	Foreign Trade Balance (Imports ./. Exports) in Billion Euros						Billion Euros	%
Coal, Coke, and Briquettes	4.0	3.5	5.2	5.0	4.1	2.3	- 1.8	- 43.5
Petroleum, Petroleum Products, and Related Goods	38.0	29.0	36.1	43.8	42.8	26.9	- 15.9	- 37.2
Gas [1]	20.5	16.1	15.0	18.0	15.9	13.0	- 2.9	- 18.4
Total Fossil Fuels	**62.5**	**48.6**	**56.3**	**66.8**	**62.9**	**42.2**	**- 20.7**	**- 32.9**
Electric Power	- 2.1	- 1.7	- 1.8	- 1.9	- 1.6	- 0.9	0.7	- 43.9
Total	**60.4**	**46.9**	**54.5**	**64.9**	**61.3**	**41.3**	**- 20.0**	**- 32.6**

1) Including transit volumes

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

Primary Energy Production in Germany

Except for renewables, domestic energy production continued to decrease for all other energy carriers in 2020 which resulted in an overall decline of approximately 5.2 % to 3,425 PJ or 116.9 Mtce (please see Table 4). The strongest decline was recorded for lignite with a quantitative minus of about 211 PJ (-17.7 %). 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 2020: Compared to the previous year, natural gas production and petroleum gas production decreased by 15.5 % (30 PJ) whereas domestic petroleum production decreased by almost 0.5 % (about 1 PJ) in 2020.[7)]

Renewable energy carriers managed to significantly expand their position as the most important indigenous energy source ahead of lignite; their proportion of the total domestic production now amounted to well above 57.7 %, followed by lignite which accounted for approximately 28.6 % of the domestic energy production. Both energy carriers continued to rank far ahead of natural gas and petroleum.

When taking primary energy consumption in 2020 into account, the proportion of domestic production increased; namely, from 27.5 % in 2019 to now about 29.1 % (please see Table 4). This development was due to the fact that the Covid-19 pandemic caused primary energy consumption to go down by 8 % in 2020; this was a much more significant decline than was recorded for the domestic production of primary energy carriers.

Table 4

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Primary Energy Production in Germany in 2019 and 2020

	Production				Changes in 2020 Compared to 2019		Proportions	
	2019	2020	2019	2020			2019	2020
	Petajoules (PJ)		Million Tons of Coal Equivalents (Mtce)		PJ	%	%	
Mineral Oil	82	81	2.8	2.8	- 1	- 0.5	2.3	2.4
Natural Gas, Petroleum Gas	194	164	6.6	5.6	- 30	- 15.5	5.4	4.8
Hard Coal	0	0	0.0	0.0	0	0.0	0.0	0.0
Lignite	1,190	979	40.6	33.4	- 211	- 17.7	32.9	28.5
Renewable Energy	1,920	1,977	65.5	67.5	57	3.0	53.2	57.7
Other Energy Carriers	226	224	7.7	7.6	- 2	- 0.9	6.3	6.5
Total	**3,612**	**3,425**	**123.2**	**116.9**	**- 187**	**- 5.2**	**100.0**	**100.0**
For information purposes: Proportion of Primary Energy Consumption	-	-	-	-	-	-	27.5	29.1

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); Federal Association for Natural Gas, Crude Oil, and Geoenergy (BVEG); Association of the German Petroleum Industry (MWV)

7) It needs to be pointed out 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

With 3,973 PJ (135.6 Mtce) in 2020, the primary energy consumption of mineral oil in Germany fell 11.9 % below the previous year's level.

Except for light fuel oil and naphtha, all products (domestic sales) recorded a minus. 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 decreased by 7.1 % to 35.2 million tons. But with more than 35 million tons, the consumption of diesel fuels continued to be almost twice as high as that of gasoline whose demand decreased by 9.7 % in 2020. As a result of the Covid-19 pandemic, the consumption of aviation fuels exhibited a decline of almost 54 % during the reporting year. Thus, sales in this segment dropped to a historic low of 4.7 million tons in 2020 (2019: 10.2 million tons).

All told, the demand for fuels (2020: About 56.1 million tons), which accounted for an approximate share of 62.6 % in Germany's total oil consumption, was more than 15 % lower in 2020 than it had been in 2019.

Table 5

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Consumption and Volume of Mineral Oil in Germany in 2019 and 2020

		2019	2020 [1]	Change
		in Million Tons	in Million Tons	in %
Total Consumption		**107.7**	**94.9**	**- 11.9**
Self-Consumption and Losses [2]		5.6	5.3	- 4.3
Domestic Consumption		102.2	89.6	- 12.3
Proportion of:	Gasoline	18.0	16.2	- 9.7
	Diesel Fuel	37.8	35.2	- 7.1
	Aviation Fuels	10.2	4.7	- 53.9
	Fuel Oil, Light	15.1	15.6	3.3
	Fuel Oil, Heavy [3]	1.6	0.8	- 50.5
	Naphtha	11.3	11.9	6.1
	Liquid Gas	3.9	3.6	- 7.8
	Lubricants	1.0	0.8	- 19.4
	Other Products	10.4	10.7	2.6
	Recycling (to be deducted)	- 6.3	- 5.8	- 7.4
	Biofuels [4] (to be deducted)	- 3.4	- 4.0	18.8
Total Volume		**99.6**	**89.6**	**-10.0**
Domestic Production		1.9	1.9	- 0.5
Refinery Production		98.7	95.0	- 3.8
Generated from:	Input of Crude Oil	87.0	84.0	- 3.4
	Input of Products	11.7	10.9	- 6.3
Foreign Trade Products (Balance)		20.1	12.1	-
	Imports	42.1	34.3	- 18.5
	Exports	22.1	22.2	0.7
Compensation [Balance (Bunker, Differences)]		- 11.0	- 12.2	-
Refining Capacity		102.7	102.7	0.0
Utilization of Refining Capacity in %		84.8	81.9	-
Primary Energy Consumption of Mineral Oil (Mtce)		**4,511**	**3,973**	**- 11.9**

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

Discrepancies in the totals are due to rounding off

Source: Association of the German Petroleum Industry (MWV)

With an increase of 3.3 %, sales of light fuel oil experienced a slight upward trend. In light of the weather, which was only slightly milder in 2020 when compared to the previous year, 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 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.

Prices for light fuel oil decreased at an annual average between 2019 and 2020 from 67.3 c/liter to 49.9 c/liter, which equals a decline of more than one quarter (25.9 %). Due to the price reductions in conjunction with the mild weather, the fuel stock volumes were likely to have been increased by about 3 million tons (which translates into 128 PJ) which occured first and foremost in private households. If this were indeed the case, then the actual consumption would most likely be correspondingly lower than the volume of fuel oil sold in 2020.

With a minus of 3.8 %, refinery production decreased to a level of 95 million tons in 2020. Towards this end, refinery production from crude oil, which accounted for a share of about 88.5 %, went down by only 3.4 % whereas the processing of products actually decreased by 6.3 %. In light of the declining production, the refining capacity of 102.7 million tons, which (compared to the previous year) remained unchanged once again, was actually utilized at 81.9 % in 2020; in 2019, the degree of utilization had still amounted to 84.8 %.

Foreign trade in mineral oil products changed significantly in 2020. On balance, imports predominated in 2020; with 34.3 million tons, they topped the exports of 22 million tons by only about 12 million tons.

Due to its very limited domestic petroleum resources, Germany is primarily dependent on crude oil imports which fell below the previous year's level by 3.4 % with 83 million tons in 2020. In 2020, the by far most important supplier countries for crude oil continued to be Russia with a further increased share (33.9 %) and the United Kingdom (11.6 %). The USA assumed third place among the major countries of importation in

Table 6

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Germany's Crude Oil Imports in 2019 and 2020 According to Countries of Origin

Important Supplier Countries/ Production Regions	2019	2020	Changes 2019/2020	2019	2020
	in Million Tons		in %	Proportions in %	
Russia	27.1	28.2	3.9	31.5	33.9
United Kingdom	10.2	9.6	- 5.8	11.9	11.6
USA	5.3	9.4	76.0	6.2	11.3
Norway	9.7	8.2	- 15.9	11.3	9.8
Kazakhstan	6.3	7.4	17.4	7.4	8.9
Nigeria	5.2	5.2	- 1.1	6.1	6.2
Other Countries	22.1	15.1	- 31.6	25.7	18.2
Total	**86.0**	**83.0**	**- 3.4**	**100.0**	**100.0**
OPEC	20.4	13.5	- 33.6	23.7	16.3
North Sea [1] (excld. FRG)	24.6	24.5	- 0.4	28.6	29.5
Former CIS	36.1	35.7	- 1.2	42.0	43.0
Other	4.9	9.3	91.2	5.7	11.2
Total	**86.0**	**83.0**	**- 3.4**	**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

2020 with a share of crude oil imports that increased by 5.1 percentage points to 11.3 percentage points. Norway, which had still ranked third among the most important supplier countries in the previous year, dropped to fourth place with a supply share of 9.8 % (8.2 million tons) in 2020. Other important supplier countries in 2020 were Kazakhstan and Nigeria (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) increased against the backdrop of a generally shrinking market; it went up from 42 % (2019) to 43 % in 2020. In contrast, the OPEC states (2019: 23.7 %) recorded losses in their shares (2020: 16.3 %) whereas the countries bordering the North Sea were able to virtually retain their supply share at just below 30 %.

In 2020 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, with an annual average of about 64 US dollars per barrel (US-$/bbl; 1 barrel = 159 liters) in 2019 had already fallen almost 7 US dollars below the previous year's values but was still far from the peak levels which had been attained in 2011/2012 (amounting to US-$ 112/bbl), the average price in 2020 dropped significantly to almost US-$ 42/bbl due in no small part to the Covid-19 related weak demand. The development in 2020 showed a u-shaped price curve which is a characteristic feature of the Covid-19 crisis. Based on the average level of the previous year, the crude oil price initially went down at the beginning of the year, reached its monthly low in May (about US-$ 18/bbl), and gradually increased again to a level of approximately US-$ 50/bbl by the end of the year.

Figure 4

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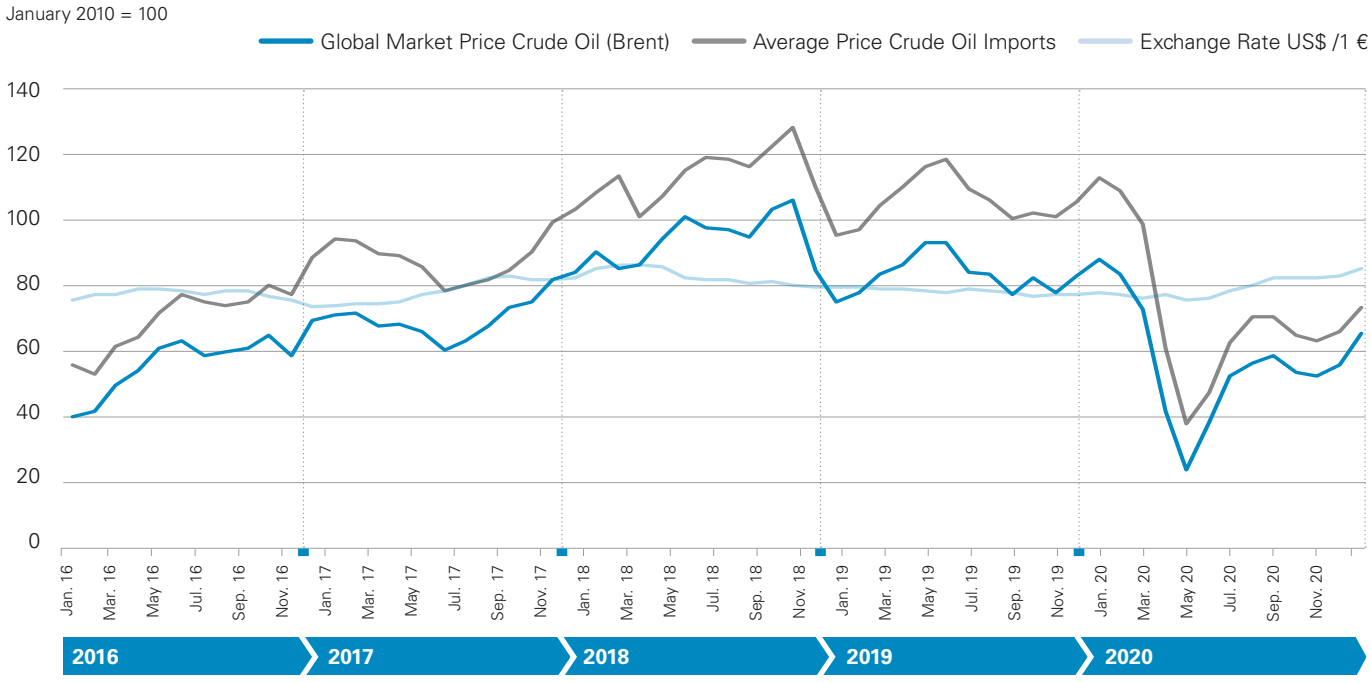
Global Market Prices for Crude Oil (Brent) [1], Border-Crossing Prices for German Crude Oil Imports [2] and Exchange Rates between 2016 and 2020



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)

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 2020, the Euro had increased against the US Dollar (appreciation), and by the end of the year, the exchange rate went up to about € 1.22/US-$ (December 2020). Compared to January 2020 (€ 1.11/ US-$ per Euro), the exchange rate increased by almost 10 % until the end of the year. The appreciation of the Euro against the US Dollar cushioned the increase in crude oil prices on the global market for German consumers particularly during the second half of the year. All told, German crude oil import prices (on an annual basis and calculated in Euro/bbl) decreased somewhat stronger (-34.9 %) than the global market prices for crude oil (-33.7 %) between 2019 and 2020.

Calculated in euros and per ton, German crude oil import prices dropped from an annual average of 428 Euro/t in 2019 to 278 Euro/t in 2020. Considering the import volumes, which decreased by nearly 3.4 % in 2020 when compared to the previous year while the crude oil prices for German consumers dropped by almost 35 % over the same period of time, the overall costs for crude oil imports went down considerably by more than 37 % from 36.8 billion euros to 23.1 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 already decreased slightly at an annual average between 2018 and 2019, they experienced further noticeable declines in 2020 which were primarily due to the economic and sectoral impact of the corona crisis: On an annual average, the prices for premium gasoline decreased by 9.7 %, for diesel fuel by 11.3 %, and for light fuel oil even by 25.9 %.

Yet over the course of the year 2020, an increasing trend became apparent once again for all three products so that in December 2020, all prices exceeded the level which had still been observed (depending on the specific product) in the spring or summer of that year. Until the end of 2020, it was above all the prices for light fuel oil which started to rise again; in December of the same year, they once again peaked at a level of approximately 51 cents per liter (compared to January 2020, this still equals a price reduction of 23.7 %). As measured by the producer price index, the prices for mineral oil products in Germany were at an annual average and in total 14.5 % lower in 2020 than in 2019.

Figure 5

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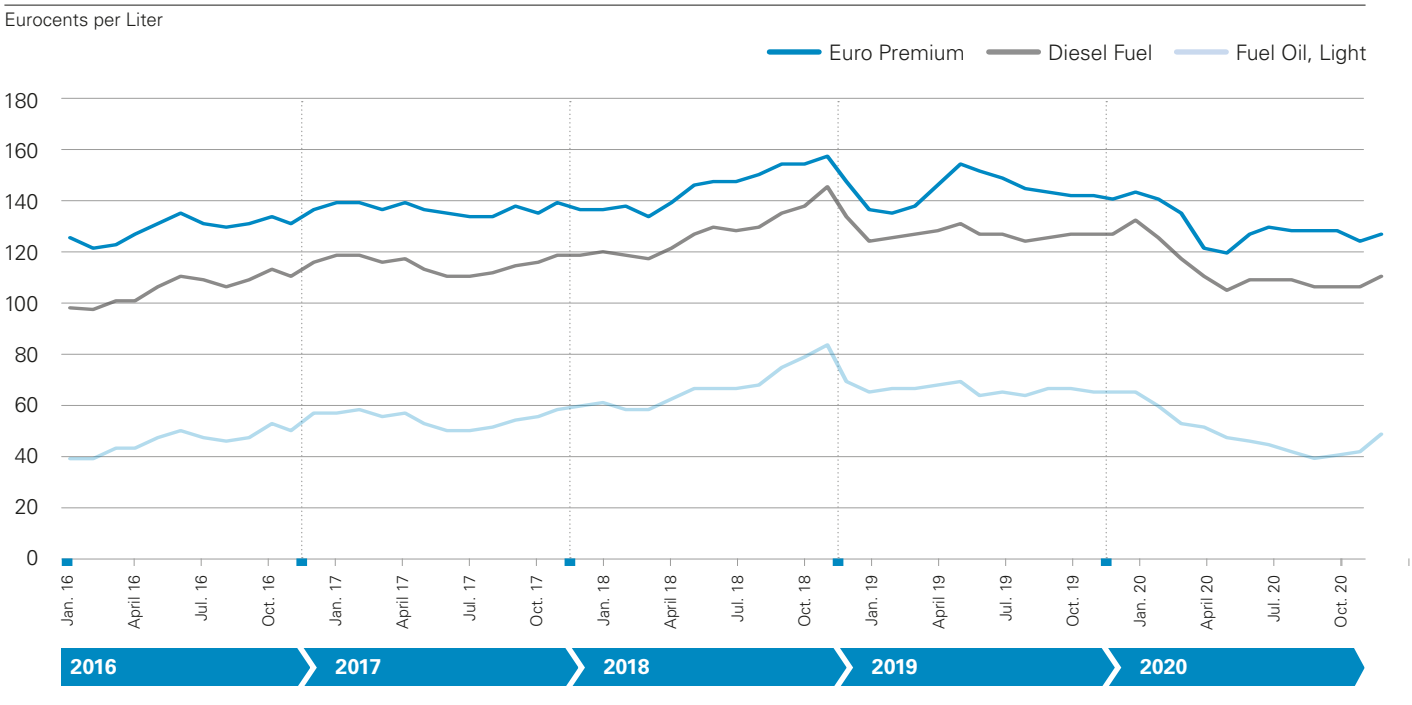
Prices for Fuels and Light Fuel Oil in Germany between 2016 and 2020



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

Natural Gas

According to preliminary data, natural gas consumption in Germany decreased by 2.4 % to about 965 billion kWh in 2020.

Domestic production of natural gas dropped over the course of the reporting year by an estimated rate of almost 16 % to about 50 billion kWh. One reason for the sharp decline was the revision of a natural gas processing plant for a period of nine weeks during the second half of 2020. Inspection and maintenance work to this extent is carried out only about every 10 years. In 2020, domestic production of natural gas covered only about 5.2 % of Germany's natural gas consumption. Approximately 95 % of the natural gas used in Germany were imported.

Since the reporting year 2018, the data reflecting the development of natural gas imports and exports have also included all transit volumes which pass through the Federal Republic of Germany's territory to our neighboring countries. That is why only the foreign trade balance (net imports) will be examined closer here. In 2020, the import volume of natural gas remaining in Germany (imports minus exports) amounted to about 859 billion kWh. Thus, the net import volume decreased noticeably when compared to the previous year; namely, by 12.2 %.

After the underground storage facilities for natural gas connected to the German natural gas grid had been filled to almost 100 % by the end of 2019, and after a rather mild winter, the year 2020 commenced with correspondingly high storage filling levels. During the second half of the year, for example, the price trends on the wholesale market resulted in increased withdrawals of gas from the storage facilities. On December 31, 2020, 73.1 % of the domestic natural gas storage facilities were filled. On balance, about 56 billion kWh of natural gas were withdrawn from storage facilities in 2020. For comparison: 48 billion kWh of natural gas had still been stored in 2019.

When it comes to the utilization of natural gas in the individual consumption sectors, heterogeneous developments become apparent for 2020 (please see Table 7):

- Due to the effects of the Covid-19 pandemic, but also because of the economic downturn during the 3rd quarter of 2018, industry's demand for natural gas exhibited a noticeable decline in 2020. The data available so far show that the natural gas consumption in the industrial sector (mining and manufacturing industries including power plants operated by these companies themselves) decreased by approximately 4 %.

- The natural gas consumption of companies in the trade, commerce, and service sector declined noticeably as well. The drop in consumption by more than 5 %, which has become apparent so far, was to a major extent due to closures of retail businesses, restaurants, hotels, and close contact service providers in the spring and to the shutdown of public life during the 4th quarter of 2020.

- In contrast, sales to private households (and to the housing companies supplying them) increased by an estimated 2.5 % as people were forced to stay more at home this year because of the measures undertaken to contain the Covid-19 pandemic ("lockdown"). This increase was reinforced by the continued construction of new homes that are heated with natural gas. The anticipated consumption plus was dampened slightly by the milder weather in 2020 when compared to the previous year.

- The use of natural gas as a fuel in power plants and heating stations supplying electricity increased in 2020. It was only in October when considerable volumes of wind power were fed into the grid which caused gas fired power plants to significantly cut back electricity production. All told, about 92 billion kWh of electricity were generated in the power plants of electricity suppliers and industrial enterprises as well as in the combined heat and power plants of other electricity producers in 2020. This equals an increase of 2.1 % when compared to the previous year. Even though the generation of electricity in industrial power plants experienced a decline, power generation plants supplying the general public produced 6.8 % more electricity.

- More natural gas was also used by district heating suppliers for the generation of heat. Preliminary figures indicate a plus of 4.8 % when it comes to the use of natural gas as a fuel in the heating and thermal power stations supplying the general public (≥1 MW_{el}).

Compared to 2019, the proportion of natural gas of the total primary energy consumption increased by 1.5 percentage points to 26.6 % in 2020.

According to initial figures, about 9.9 billion kWh of biogas processed to natural gas quality were fed into the German natural gas grid in 2020. Almost 8 billion

Table 7

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Volume and Use of Natural Gas in Germany in 2019 and 2020

	Unit	2019	2020 [1]	Change in %
Domestic Production	Billion kWh	59.6	50.3	- 15.6
Imports [2]	Billion kWh	1,714.8	1,684.9	- 1.7
Total Volume of Natural Gas	Billion kWh	1,774.4	1,735.3	- 2.2
Exports [2]	Billion kWh	736.9	826.0	12.1
Storage Balance [3]	Billion kWh	- 48.2	56.0	-
Domestic Sales of Natural Gas	Billion kWh	**989.2**	**965.3**	**- 2.4**
Primary Energy Consumption	**Billion kWh**	**989.2**	**965.3**	**- 2.4**
	Petajoules (H_u)	**3,213.6**	**3,136.0**	**- 2.4**
	Mtce (H_u)	**109.7**	**107.0**	**- 2.4**
Structure of Natural Gas Generation by Origin				
Domestic Production [4]	%	6.0	5.2	
Import Quota	%	94.0	94.8	
Structure of Natural Gas Consumption According to Consumer Groups				
Industry (Including Industrial Power Plants)	Billion kWh	359.4	345.0	- 4.0
Power Supply (Including CHP Plants)	Billion kWh	124.8	129.0	3.3
Provision of District Heating and Cooling (Including CHP Plants)	Billion kWh	63.1	63.2	0.1
Private Households	Billion kWh	284.8	292.0	2.5
Trade, Commerce, Services	Billion kWh	120.6	114.3	- 5.3
Transportation	Billion kWh	1.8	1.8	1.1
Total Sales of Natural Gas	**Billion kWh**	**954.6**	**945.3**	**- 1.0**
Self-Consumption and Statistical Differences	Billion kWh	34.6	20.0	- 42.2
Natural Gas Consumption	**Billion kWh**	**989.2**	**965.3**	**- 2.4**

1) Preliminary data; some figures are estimates
2) Import and export volumes including all transit volumes
3) Minus = storage; plus = withdrawal
4) Share of domestic natural gas supply

Discrepancies in the totals are due to rounding off

Sources: Federal Statistical Office (Destatis); Federal Association for Natural Gas, Crude Oil, and Geoenergy (BVEG); German Association of Energy and Water Industries (BDEW)

kWh of which went into combined power generation. Around 1.0 billion kWh were used as a fuel, another approximately 0.5 billion kWh were sold on the heating market (space heating, hot water). The remaining quantities were used, for example, 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 2019, there had been 1,320 enterprises; at the end of 2020, there were already 1,343. A closer look reveals that seven of these enterprises were active as natural gas producers, 30 as storage operators, 65 as mere wholesalers, 15 as long-distance gas grid operators, 722 as gas distribution grid operators, and 1,049 as distribution companies in the end customer business.[8] The number of employees in the gas industry increased slightly by 2.4 % and amounted to 40,160 persons at the end of the year 2020.

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. 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 2020, the import prices initially exhibited a significant decline until mid-year before they increased once again during the second half of the year and attained more or less the level of January 2020 in December of the same year. At an annual average, the border-crossing price amounted to 1.22 ct/kWh. This equals a decline of almost 24 % when compared to 2019. All told, the import prices for natural gas in the reporting year were still significantly below the peak levels which had been observed, for example, in 2012.

The development of import prices has different effects on domestic sales prices (please see Figure 7).

Figure 6

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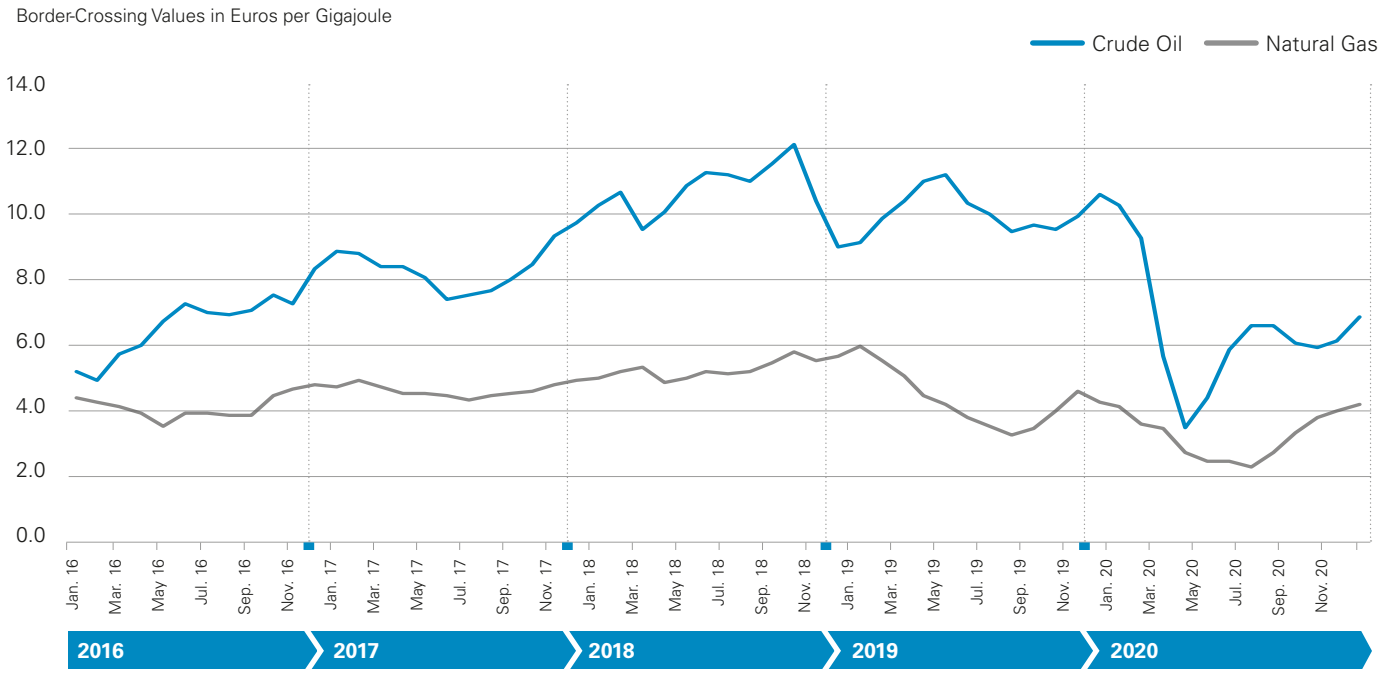
Monthly Border-Crossing Values for Crude Oil and Natural Gas between 2016 and 2020



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

8) 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.

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 dropped; albeit the wholesale price decreased by only about 2.1 % while the sales prices to power plants went down by 19.2 %. For large industrial clients (annual supply of more than 500 GWh), the purchase prices decreased by more than 23 % 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 about 10 % less. Due to early procurement, the gas prices for the trade, commerce, and service sector as well as for private households increased by about 1.9 %. For private households, an average increase in prices of approximately 1.6 % was observed in 2020 when compared to the previous year.

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

However, the diverging price trends for various customer groups are mainly attributable to different contract periods. For longer contract periods, the requisite gas volumes are purchased in advance on futures markets already at the beginning of the contract period in order to meet the obligation to deliver over the course of the contract period (the so-called "back-to-back procurement"). As a general rule, procurement periods as well as contract periods tend to be shorter for large consumers while they are longer for household customers and small businesses. 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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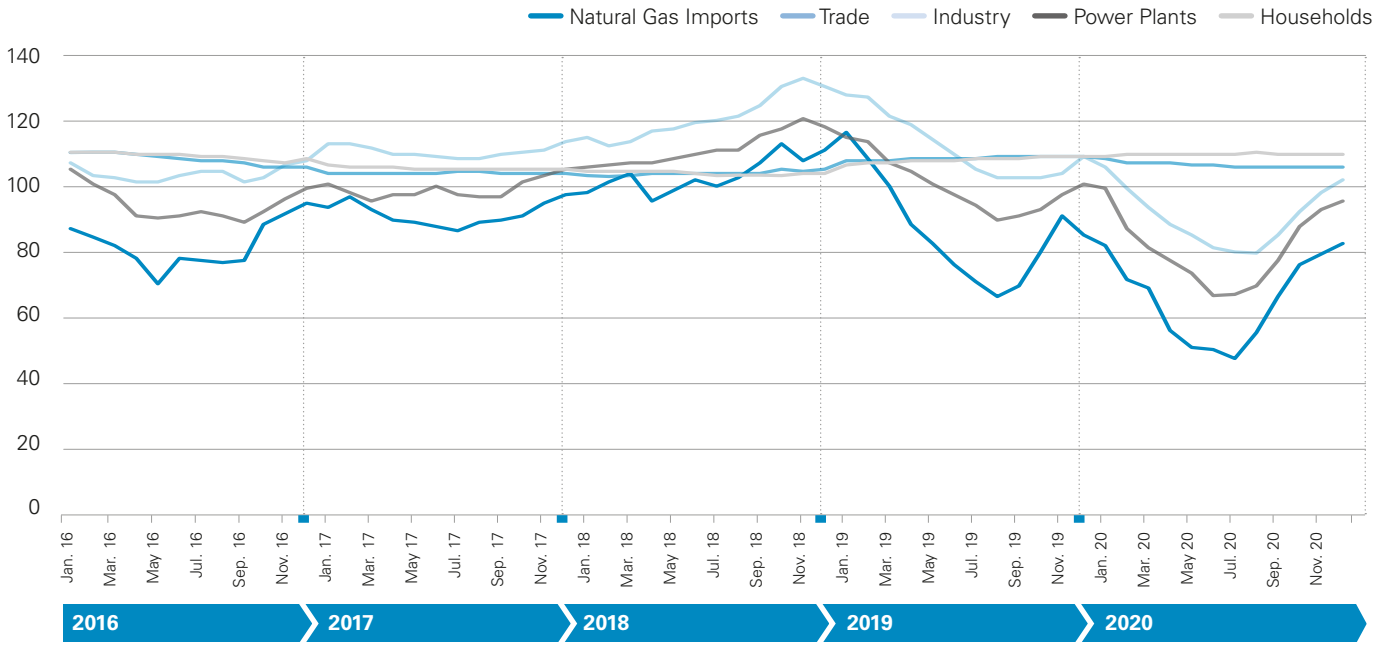
Prices for Natural Gas Imports and Natural Gas Sales in Germany between 2016 and 2020

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, the primary energy consumption of hard coal continued to decrease in 2020 – by 16.6 % to 904 PJ (30.8 Mtce). Thus, the lowest annual consumption was once again recorded for hard coal in the entire post-war period (please see Table 8).

The continuous downward trend, which has persisted for a period of seven years now, is above all due to the fact that, on the one hand, more and more hard coal fired power plant capacities were withdrawn from the market and, on the other hand, renewables – particularly wind power and photovoltaics – were significantly expanded in the electricity sector and given priority in the merit order of power plants. Hard coal was, thus, increasingly displaced from the medium load, also in favor of natural gas, which initially benefited from a relatively low price level and was favored over hard coal due to significantly increased CO_2 certificate prices during the period under review. With the Coal Fired Power Generation Termination Act (KVBG), which entered into force last year, and with the first auctions to decommission these power plants, the effects on the capacity utilization will increase even further to the detriment of hard coal in Germany over the next few years.

Compared to the previous year, all three sectors in which hard coal is used (power plants, the steel industry, and the heating market) exhibited a strong downward trend – each with double-digit percentages – last year. The use of hard coal in form of coking coal and coke in the steel industry, for example, dropped by more than 12 % to 443 PJ (15.1 Mtce). Decisive for this trend was, above all, a reduced crude iron production which decreased also by 12 % to about 22 million tons in 2020.

The use of hard coal in power plants that generate electricity and heat once again declined even more significantly and dropped by more than 26 % to 413 PJ (14.1 Mtce). Over the course of the year, the monthly rates of change for the generation of electricity in hard coal fired power plants were mostly in the double-digit negative range. Increases were recorded only during the months of September and December. After decades of dominance, the power plant sector was, thus, surpassed for the first time ever by the steel sector as the most important field of application for hard coal in Germany. In addition to the structural developments mentioned above, the drastic decline of hard coal in power plant usage was, for example, also due to the economic effects of the Covid-19 pandemic which reduced the overall electricity consumption to a lower level.

Table 8

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Volume and Use of Hard Coal in Germany in 2019 and 2020

	2019		2020 [1]		Change
	PJ	Mtce	PJ		in %
Primary Energy Consumption	**1,095**	**37.4**	**904**	**30.8**	**- 17.4**
Power Plants and Thermal Power Stations	561	19.1	413	14.1	- 26.2
Steel Industry	504	17.2	443	15.1	- 12.1
Heating Market	54	1.8	48	1.6	- 10.5
Import of Hard Coal and Coke [2]	1,179	40.2	870	29.7	- 26.2
Hard Coal Production	**0**	**0**	**0**	**0**	**0,0**

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 2019 and 2020 (January to November)

	2019	2020 [2]	Change	2019	2020
	in Million Tons		in %	Proportions in %	
Poland	1.3	1.1	- 15.8	3.3	3.9
Czech Republic	0.3	0.2	- 39.4	0.7	0.6
Russia	17.5	12.5	- 28.4	44.8	45.2
South Africa	0.7	0.3	- 58.3	1.9	1.1
USA	7.8	4.9	- 37.5	20.1	17.7
Canada	1.2	1.2	- 3.4	3.1	4.3
Columbia	1.6	1.7	6.3	4.1	6.2
Australia	4.4	3.4	- 22.9	11.2	12.2
Other EU Countries [3]	4.2	2.4	- 41.3	10.8	8.8
Total Imports	**39.0**	**27.7**	**- 29.0**	**100.0**	**100.0**
Total Year (Expansion) [4]	**40.2**	**29.73**	**- 26.2**		

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 2019; projected values for 2020 based on imports accrued during the specific period of time

Discrepancies in the totals are due to rounding off

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

Substantially higher volumes of renewable energy carriers that were fed into the grid – particularly from photovoltaic systems – as well as a slightly increased use of natural gas were at the expense of hard coal which, due to unfavorable market constellations of the wholesale prices for fuels, CO_2, and electricity particularly when compared to natural gas, was, thus, encumbered in the operational ranking of power plants ("merit order"). In fact, the average annual price for power plant coals free at Northwest European ports (ARA – Antwerp, Rotterdam, Amsterdam) dropped by almost 18 % to US-$ 50.53/t cif ARA in 2020 when compared to the previous year. Yet this did not offset the encumbrances when compared to natural gas. Moreover, the prices for power plant coals went up once again during the fourth quarter of 2020 and were quoted on average at US-$ 58.53/t cif ARA. The decommissioning of hard coal fired power plant capacities, though, was of minor relevance. Albeit according to the Federal Network Agency (BNetzA), net capacities of almost 1.15 GW had permanently gone off the grid in 2019, the fact that capacities of 0.017 GW were dismantled in the subsequent year 2020 was hardly worth mentioning. In terms of volume, the heating market, which encompasses the consumption of hard coal for the generation of heat in industry, district heating plants, small businesses, and private households, played a minor role. The use of hard coal in these sectors decreased by 10.5 % to 48 PJ (1.6 Mtce).

After the termination of domestic hard coal mining at the end of 2018, the volume side of Germany's hard coal market has been sourced merely 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 2020 and compared to the previous year, Germany's hard coal imports decreased by about 26 % to 27.7 million tons. Of this figure, 60.3 % (16.7 million tons) accounted for power plant coals, 32.1 % (8.9 million tons) for coking

coals, 2.6 % (0.7 million tons) for anthracite coals and briquettes, and around 5 % (1.4 million tons) for coke. Extrapolated to the entire year, hard coal imports in 2020 are, thus, likely to amount to a converted volume of almost 30 Mtce. When compared to the previous year, this would equal a decline of more than 26 %.

During the period under review between January and November 2020, Russia was once again the most important country of origin with a share of 45 % in Germany's total hard coal imports (please see Table 9). As measured by absolute figures, imports from Russia decreased by 28 % to 12.5 million tons. With a proportion of 18 % (4.9 million tons), the United States continued to be the secondmost important country of origin; despite a decline of 38 %. In a sectoral breakdown according to the individual coal types, Russia was the most important supplier country by far for power plant coal with a share of 67 %.
When it comes to coking coal imports, Australia dominated the field with a share of 38 %. And coke imports came mostly from Poland (66 %).

According to estimates of the German Coal Importers Association and compared to the previous year, it was above all the worldwide Covid-19 pandemic which caused global hard coal production to decrease by approximately 185 million tons (-2.6 %) to about 7 billion tons in 2020. Towards this end, China and India with +3 % each were the only producing countries which recorded increases at all. The hard coal production of all other countries of origin exhibited, in part, a strong downward trend; in particular, the hard coal production of the United States (-25 %) and Canada (-26 %). During the last quarter of 2020, however, first indications of a recovery became apparent on the global market. The most significant producing country was once again China with a production volume of 3.8 billion tons. This equals a 54.2 % share in global production.

About 15 % of the global production was distributed through maritime trade, the majority was used in the producer countries. In addition, a smaller portion accounted for domestic trade with neighboring countries and includes cross-border transports via inland navigation vessels and/or via rail transports. Compared to the previous year, maritime trade dropped by nearly 11 % to 1.1 billion tons. Here as well, the reduction was specifically due to the effects of the Covid-19 pandemic. The most important exporting countries in maritime trade were Australia with 372 million tons, Indonesia with 329 million tons, and Russia with 156 million tons. Together, these countries attained an approximate proportion of 78 % of the entire global seaward hard coal trade. In the maritime trade of 2020, the highest declines in exports when compared to the previous year were attributable to Indonesia (-44 %), Columbia (-25 %) as well as Australia and the United States (-23 % each).

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. The import price for steam coals dropped from about US-$ 72/tce (annual average 2019) to approximately US-$ 59/tce in 2020. After a low had still been noticed with a price level of around US-$ 44/tce in May 2020, the import price for steam coals increased to more than US-$ 72/tce by December 2020.

Figure 9 shows 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 further decline over the course of the year 2020 when compared to 2019.

Figure 8

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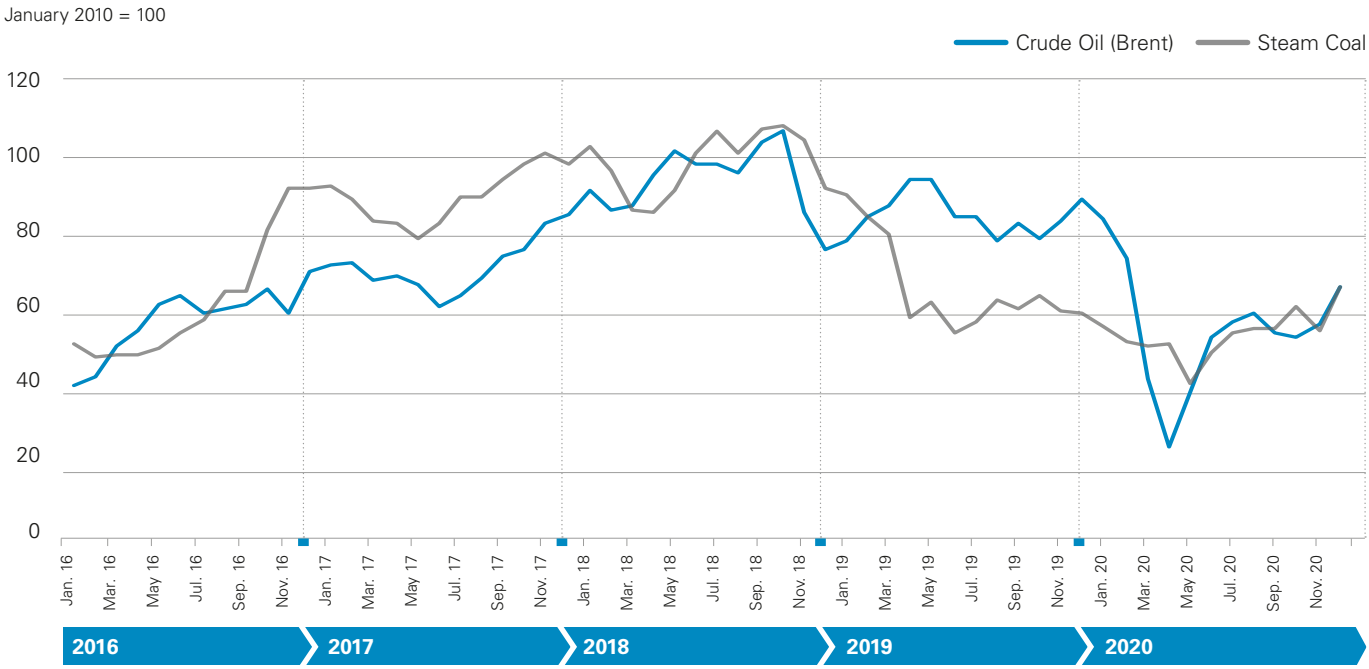
Global Market Prices for Crude Oil (Brent) and Steam Coal between January 2016 and December 2020



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

Figure 9

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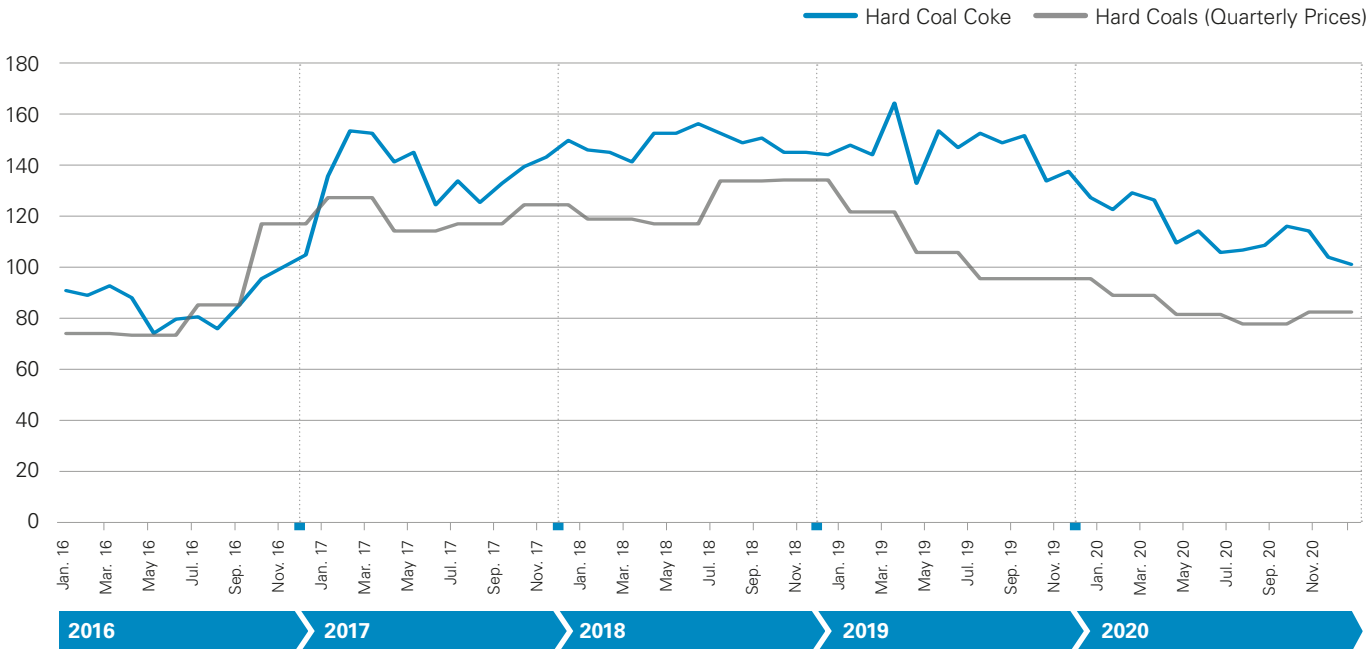
Development of Selected Hard Coal Import Prices between 2016 and 2020



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

Lignite

With about 107.4 million tons in 2020, lignite production as a whole fell 18.2 % below the previous year's result. Yet the decline was quite different in the individual mining districts: The Rhineland area (-21 %) exhibited a particularly high drop; but even in Lusatia (-17%) and Central Germany (-12 %), the rate of change was also in the double-digit range.

Table 10

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Volume and Use of Lignite in Germany in 2019 and 2020

	Unit	2019	2020 [1]	Change in %
1. Domestic Raw Lignite				
Total Lignite Production	**Million Tons**	**131.3**	**107.4**	**- 18.2**
	Mtce	**40.6**	**33.4**	**- 17.7**
	PJ	**1,189.9**	**979.2**	**- 17.7**
2. Foreign Trade				
Total Imports	1,000 tce	25.5	29.1	14.3
Total Exports	1,000 tce	969.9	787.4	- 18.8
Foreign Trade Balance	1,000 tce	- 944.4	- 758.3	-
3. Primary Energy Consumption				
	Mtce	39.7	32.6	- 17.8
	PJ	1,164	956	- 17.8
4. Sales				
Total Sales	**Million Tons**	**115.8**	**93.8**	**- 19.0**
to Power Plants Supplying the General Public	Million Tons	115.0	93.1	- 19.1
to Other Customers	Million Tons	0.7	0.7	- 2.9
Use for Refinement	Million Tons	13.2	11.5	- 12.7
Use in Lignite Mining Power Plants	Million Tons	2.5	2.1	- 16.1
Change in Stocks	Million Tons	- 0.1	0.0	-
5. Electricity Production from Lignite				
Power Plants Supplying the General Public	Billion kWh	110.7	89.4	- 19.3
Industrial Power Plants	Billion kWh	3.3	2.54	- 22.1
Total Electricity Production from Lignite	**Billion kWh**	**114.0**	**91.9**	**- 19.4**

1) Preliminary data; some figures are estimates

Discrepancies in the totals are due to rounding off

Source: The German Coal Industry's Statistical Office

This change generally corresponds to the development of deliveries to power plants supplying the general public (a total of 93.1 million tons; -19.1 %) which receive around 90 % of the production.

This development was caused by the pandemic-related decline in electricity consumption, the weather-related increase in power generation from wind turbines and PV systems, the transfer of additional power plant units into the standby mode for backup purposes, unplanned power plant outages as well as shifts within the competitive situation due to low natural gas prices and high CO_2 prices on the national and European electricity markets. These factors had different effects during the individual months. While during the months of February to August, the figures fell, in part, significantly below the respective months of the previous year, the month of September marked the start of a clear recovery and the previous year's values were actually reached or exceeded.

With a total of about 91.9 TWh, power generation from lignite was, thus, once again lower than in the previous year. Lignite's share in power generation decreased to approximately 16 % (previous year: 18.7 %). Lignite fired power plants made, however, an indispensable contribution towards a secure and reliable energy supply not just during those times when the electricity production from wind and solar power was low.

The manufacture of refined products based on lignite decreased in total by approximately 12 % to more than 5 million tons. The declines amounted to -13.0 % for briquettes, -9 % for pulverized coals, -49 % for fluidized bed coals, and -8 % for coke.

With about 33.4 Mtce (979 PJ), the energy content of the extracted lignite fell about 17.8 % short of the previous year's result. The contribution of lignite to domestic energy production amounted to approximately 28.6 %. Lignite, thus, continues to be an important domestic energy carrier.

Table 11

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Lignite Balance for Germany in 2019 and 2020
in 1,000 tce

		2019	2020 [1]	Change
				in %
	Domestic Production	40,600	33,412	- 17.7
+	Imports	28	29	3.6
=	**Volume**	**40,628**	**33,441**	**- 17.7**
+/–	Change in Stocks (Reduction: +, Replenishment: -)	29	- 29	-
–	Exports	1,036	787	- 24.0
=	**Primary Energy Consumption**	**39,621**	**32,625**	**- 17.7**
–	Use in Power Plants	36,383	29,850	- 18.0
–	Other Conversion Input	4,329	3,770	- 12.9
+	Conversion Output	4,317	3,800	- 12.0
–	Consumption during Production and Conversion as well as Non-Energetic Consumption	367	350	- 4.6
=	**Final Energy Consumption**	**2,859**	**2,455**	**- 14.1**
	Industry	2,447	2,085	- 14.8
	Households, Trade, Commerce, Services, Concessionary Coal	412	370	- 10.2

1) Preliminary data; some figures are estimates

Source: The German Coal Industry's Statistical Office

With 32.6 Mtce (956 PJ), lignite-based primary energy consumption was about 17.8 % lower than in the previous year. Lignite, thus, met approximately 8 % of the entire domestic demand for energy (please see Table 1).

With a total consumption of about 2.4 Mtce in 2020, the final energy sectors used in total less lignite and lignite products than in the previous year (-14 %) (please see Table 11). When it comes to industry, the use of lignite dropped by about 14.8 % while sales to private households (including the trade, commerce, and service sector) declined to a lesser extent (-10 %).

At the end of 2020, the number of employees working in the German lignite industry amounted to almost 19,500 people. This figure includes approximately 1,260 apprentices and about 4,600 employees who worked in the lignite companies' power plants supplying the general public. Employment statistics listed 9,418 employees in the Rhineland area, 7,822 in Lusatia, and 2,190 in Central Germany. After the end of coal mining and after the end of the power plant Buschhaus's standby mode for backup purposes, only about 50 employees still worked on behalf of the lignite industry in the Helmstedt District.

The Electric Power Industry

According to preliminary figures, gross electricity production in Germany amounted to 572.2 billion kWh in 2020. The production of electric power, thus, decreased by 6.1 % when compared to the previous year's figure. However, power generation from the individual energy carriers developed differently. In 2020, 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 by 14.2 %. According to preliminary estimates of the AG Energiebilanzen, gross electricity consumption decreased by 4.3 % to 552.2 billion kWh during the reporting year (2019: 576.7 billion kWh) (please see Table 12).

In 2020, lignite fired power plants generated almost 92 billion kWh of electricity. This equals a decline of 19.4 % when taking into account that production had decreased by more than one fifth already in 2019. According to preliminary data, a net power plant capacity of 20,709 MW was installed at the end of the year; however, 2,378 MW of which were already in the standby mode of lignite for backup purposes and, thus, no longer on the market. Another 297 MW were decommissioned as per December 31, 2020, in line with the agreements that had been reached on the termination of coal fired power generation. The contribution of lignite fired power plants to the gross electricity production amounted to 16.1 %.

An expected total of 91.9 billion kWh of electricity were generated from natural gas in the power plants of electricity producers and industrial enterprises as well as in the combined heat and power plants of other electricity producers. Notwithstanding the fact that the overall electricity production was at a low level, electricity production in gas fired power plants, thus, increased by 2.1 %. It was, in particular, the considerable decline in spot market prices for gas over the course of the year as well as the persistently high price level for CO_2 certificates which strengthened the competitive position of gas fired power plants over coal fired power plants in such a way that gas fired power plants were able to improve their standing on the market. Compared to the previous year, the installed capacity (net) increased slightly to 30,158 MW. However, 2,747 MW of which are currently in the grid reserve. Another 1,262 MW were applied to the capacity reserve that has been in place since October 1, 2020, which is why they do not participate in the market as well.

With 43.2 billion kWh in 2020, hard coal fired power plants also delivered once again less electricity than in the previous year. Their electricity production dropped by an additional 24.8 % in 2020 after having decreased by more than 30 % already in the previous year. By the end of the year, the installed capacity of hard coal fired power plants amounted to 23,957 MW. The increase in the installed capacity resulted, above all, from the commissioning of the power plant Datteln 4. By the end of the year 2020, though, 4,788 MW were withdrawn from the market because the respective power plants had won the bid in the first tender for the fossil fuel phase-out. Another 2,734 MW are currently in the grid reserve so that at the beginning of the year 2021, just about 16,400 MW will be active on the market. Thus, hard coal's share in the mix of energy sources supplying electric power amounted to 11.3 %.

During the reporting year, Germany's nuclear power plants generated 64.4 billion kWh of electricity which was 14.2 % less than in the previous year. The decline was primarily due to the decommissioning of the nuclear power plant Philippsburg 2 as of December 31, 2019. Thus, the installed capacity went down by 1,402 MW to 8,113 MW at the beginning of 2020.

In total, about 251 billion kWh of electricity were generated from renewable energy during the reporting year 2020. Renewable energy's contribution to meeting the gross domestic electricity consumption, thus, amounted to 43.9 % in 2020 (2019: 39.8 %).

Table 12

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Gross Electricity Production, Electricity Exchange, and Gross Electricity Consumption in Germany between 1990 bis 2020 According to Energy Carriers

	1990	2015	2016	2017	2018	2019	2020	2019 to 2020	1990 to 2020
	in Billion kWh							Average Annual Change in %	
Lignite	170.9	154.5	149.5	148.4	145.6	114.0	91.9	- 19.4	- 2.0
Nuclear Energy	140.8	117.7	112.2	92.9	82.6	57.5	43.2	- 24.8	- 3.9
Hard Coal	152.5	91.8	84.6	76.3	76.0	75.1	64.4	- 14.2	- 2.8
Natural Gas	35.9	61.5	80.6	86.0	81.6	90.0	91.9	2.1	3.2
Mineral Oil	10.8	6.1	5.7	5.5	5.1	4.8	4.3	- 9.9	- 3.0
Renewables	19.7	188.8	189.7	216.3	224.5	242.4	251.0	3.5	8.9
Other	19.3	27.3	27.3	27.5	27.6	25.7	25.5	- 0.8	0.9
Gross Electricity Production	**549.9**	**647.6**	**649.7**	**652.9**	**642.9**	**609.4**	**572.2**	**- 6.1**	**0.1**
Electricity Flows from Foreign Countries	31.9	37.0	28.3	27.8	31.7	40.1	47.1	17.4	1.3
Electricity Flows into Foreign Countries	31.1	85.3	78.9	80.3	80.5	72.8	67.1	- 7.8	2.6
Foreign Electricity Exchange Balance	0.8	- 48.3	- 50.5	- 52.5	- 48.7	- 32.7	- 20.0	- 38.7	-
Gross Electricity Consumption	**550.7**	**599.3**	**599.1**	**600.5**	**594.2**	**576.7**	**552.2**	**- 4.3**	**0.0**
Change versus Previous Year in %		1.0	0.0	0.2	- 1.1	- 3.0	- 4.1		
	Structure of Gross Electricity Production in %								
Lignite	31.1	23.9	23.0	22.7	22.6	18.7	16.1		
Nuclear Energy	27.7	18.2	17.3	14.2	12.8	9.4	7.6		
Hard Coal	25.6	14.2	13.0	11.7	11.8	12.3	11.3		
Natural Gas	6.5	9.5	12.4	13.2	12.7	14.8	16.1		
Mineral Oil	2.0	0.9	0.9	0.8	0.8	0.8	0.8		
Renewables	3.6	29.2	29.2	33.1	34.9	39.8	43.9		
Other	3.5	4.2	4.2	4.2	4.3	4.2	4.5		
Gross Electricity Production	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		

1) Preliminary data; some figures are estimates

Discrepancies in the totals are due to rounding off

Sources: German Association of Energy and Water Industries (BDEW); The German Coal Industry's Statistical Office; Working Group on Energy Balances (AGEB); Federal Statistical Office (Destatis); AGEE-Stat (for renewables)

Wind energy was able to expand its leading position as the most significant renewable energy source even further in 2020. With 103.7 billion kWh, onshore wind turbines produced about 2.5 % more electricity than in 2019. With 27.3 billion kWh, offshore wind turbines also supplied more electricity than in the previous year (+10.3 %). Over the next few years, however, growth rates to this extent can no longer be expected because there will not be any substantial increases in the capacities for offshore wind energy again until the years 2023 to 2025. In 2020, the installed capacity of wind energy on shore increased by almost 1,800 MW to currently 55,100 MW; about 200 MW were newly connected to the grid off shore. Thus, the offshore wind capacity installed in Germany now amounts to 7,725 MW.

With 50.6 billion kWh in 2020, photovoltaic systems supplied about 9.1 % more electricity than had been the case in 2019. 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. An additional photovoltaic capacity of approximately 4,400 MWp was installed in 2020; thus, 53,300 MWp were installed at the end of the year.

In 2020, 44.9 billion kWh of electricity were produced from solid, liquid, and gaseous biomass (including landfill gas, sewage gas as well as sewage sludge); this was slightly more than in the previous year (+1 %). Its total contribution to the German electricity producers' mix of energy sources, thus, amounted to 7.8 %.

Due to low precipitation during the first half of 2020, electricity production from hydropower decreased by 5.6 % to 18.6 billion kWh in 2020 when compared to the previous year.

In 2020, storage facilities (with a net nominal capacity of at least 1 MW or a storage capacity of at least 1 MWh) are likely to have collected a total of 8.9 billion kWh of electric power and fed 6.6 billion kWh back into the grid again. So far, pumped storage plants have assumed the largest proportion in this development. While the pumping capacity was 8.0 billion kWh, 6.1 billion kWh were withdrawn from the plants. The total withdrawal capacity of these storage facilities amounted to 6.8 GW of which 6.5 GW accounted for pumped storage plants.

The trend of a continuously increasing negative balance in Germany's electricity exchange has been interrupted since 2018. According to the German Association of Energy and Water Industries (BDEW), whose data exhibit a slightly divergent differentiation when compared to the data published by the Federal Statistical Office, the balance once again fell below the previous year's value with an export surplus of 21 billion kWh in 2020 (2019: 34.9 billion kWh) (please see Figure 10).
The largest amounts of electricity flowed in the direction of Austria, followed by Switzerland and Poland (Austria: 15.2 billion kWh, Switzerland: 12.3 billion kWh, Poland: 11.2 billion kWh). The largest import volumes of electricity in 2020 came from France to Germany, followed by the Netherlands and Switzerland (France: 13 billion kWh, Netherlands: 8.7 billion kWh, Switzerland: 7.4 billion kWh).

All told, 68.6 billion kWh of electricity flowed from German power grids to foreign countries (2019: 74.5 billion kWh) while Germany sourced 47.6 billion kWh from abroad (2019: 39.6 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 that flows from Germany to the Netherlands actually moves farther in the direction of Belgium and the United Kingdom. It also needs to be mentioned that two new power lines were put into operation during the second half of the year. Thus, Germany now also exchanges electricity directly with Norway and Belgium.

According to initial estimates, electricity consumption in the mining and manufacturing industries (without considering those amounts of electricity which in the energy balance are attributed to the conversion sector such as, for example, refinieries or coking plants, etc.) went down by 7.2 % from 218.4 billion kWh in the previous year to 202.6 billion kWh in 2020; this decline was primarily caused by the economic downturn resulting from the Covid-19 pandemic. It was, above all, such economic branches as the manufacture of motor vehicles (-27.7 %), the manufacture of machinery and equipment (-12.9 %), and metalworking (-12.7 %) which exhibited high double-digit percentage

Figure 10

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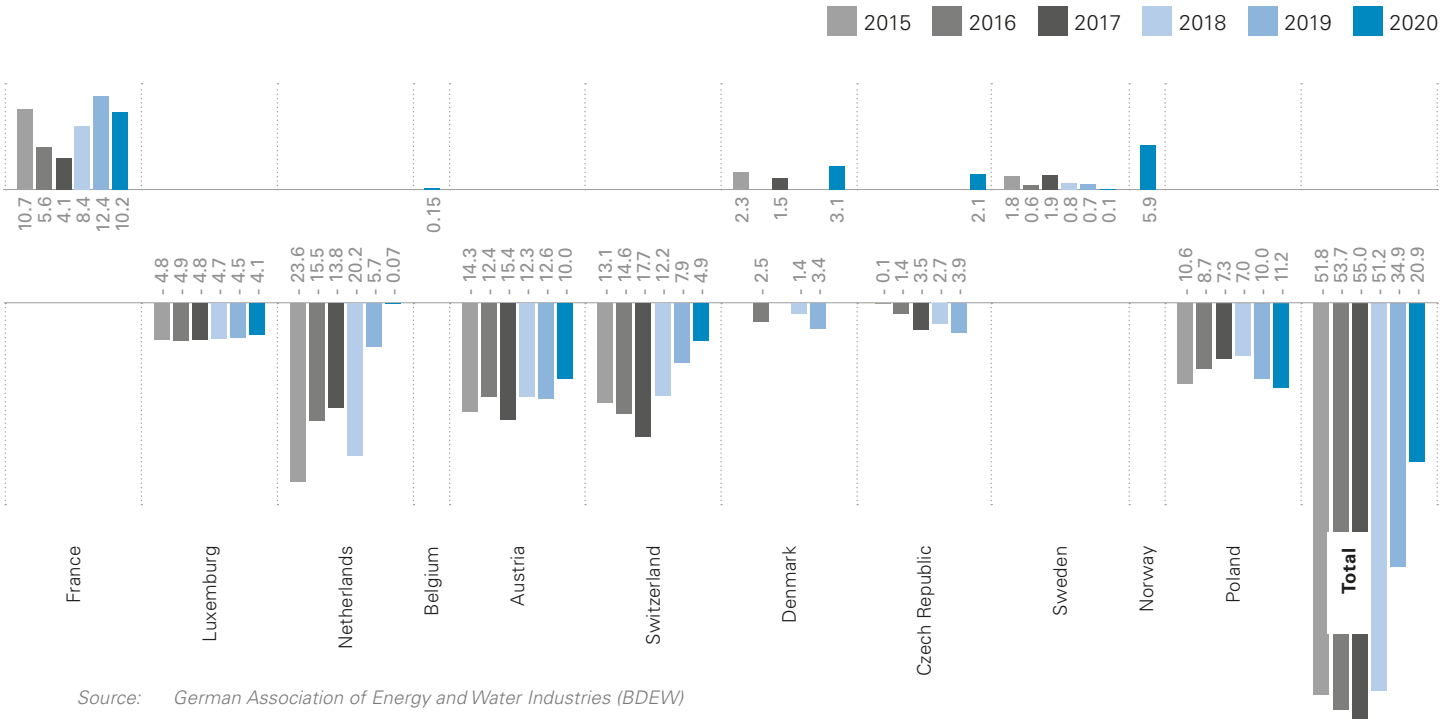
Germany's Electricity Exchange Balance with Neighboring Countries between 2015 and 2020

Electricity Flows in Billion kWh



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

Table 13

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Electricity Balance of Germany's Power Supply between 2018 and 2020

	2018	2019	2020 [1]	Changes 2019/2020
		Billion kWh		Change in %
Gross Electricity Production	**642.9**	**609.4**	**572.2**	**- 6.1**
Self-Consumption in Power Plants	- 33.4	- 30.1	- 28.5	- 5.3
Net Electricity Production	**609.5**	**579.3**	**543.7**	**- 6.1**
Electricity Flows from Foreign Countries	31.7	40.1	47.1	17.4
Electricity Flows into Foreign Countries	80.5	72.8	67.1	- 7.8
Net Domestic Electricity Volume	**560.8**	**546.6**	**523.7**	**- 4.2**
Pump Current Consumption	8.3	8.1	8.84	9.5
Grid Losses and Unrecorded Factors	26.8	27.5	27.1	- 1.5
Net Electricity Consumption	**525.6**	**511.1**	**487.7**	**- 4.6**
Proportion of:				
Mining and Manufacturing Industries	226.1	218.4	202.6	- 7.2
Households	126.6	125.7	126.8	0.9
Commerce and Trade, Public Institutions	149.0	144.3	136.2	- 5.6
Transportation	11.7	11.7	11.8	0.9
Energy Consumption in the Conversion Sector (without Own Power Plant Consumption)	12.3	11.0	10.3	- 6.4
Gross Domestic Electricity Consumption	**594.2**	**576.7**	**552.2**	**- 4.3**

1) Some figures are preliminary and estimates

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

declines in consumption (when compared to the previous year). In contrast, electricity consumption in the sectors processing of stones and soils as well as food, beverages, and tobacco increased by 3.6 % and 3.2 % respectively when compared to 2019. For the private households sector, initial figures revealed a slight increase in consumption of 0.9 % when compared to the previous year to approximately 126.8 billion kWh (2020). For the trade, commerce, and service sector, though, initial figures indicated a noticeable decline in electricity consumption by about 5.6 % to 136.2 billion kWh. Electricity consumption in the transportation sector slightly exceeded the previous year's figure as well.

All these figures resulted in a total net electricity consumption of 487.7 TWh in Germany for the reporting year 2020. In 2019, the net electricity consumption had still amounted to 511.1 TWh (this equals a minus of 4.6 %) (please see Table 13).

The number of companies which work in the electric power industry has been growing continuously since the start of the liberalization process in 1998. In late December 2019, 1,952 companies had been dedicated to the supply of electric power; by the end of 2020, the number of companies increased to 1,978. A closer examination reveals that 96 of the companies which were active in the electricity market in 2020 worked as electricity producers with a power plant park larger than 100 MW, 903 as power distribution grid operators, four as transmission grid operators, 123 as operators of power storage facilities, 60 as electricity wholesalers, and 1,350 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 139,900 persons, increased slightly in 2020 when compared to the previous year (+0.3 %).

Electricity prices for industrial clients (supply at the medium voltage level, annual consumption between 160,000 kWh and 20 million kWh) decreased in total by about 3.6 %, which was primarily due to a reduction of approximately 10 % in procurement, distribution, and grid usage costs. At the same time, the burdens

Figure 11

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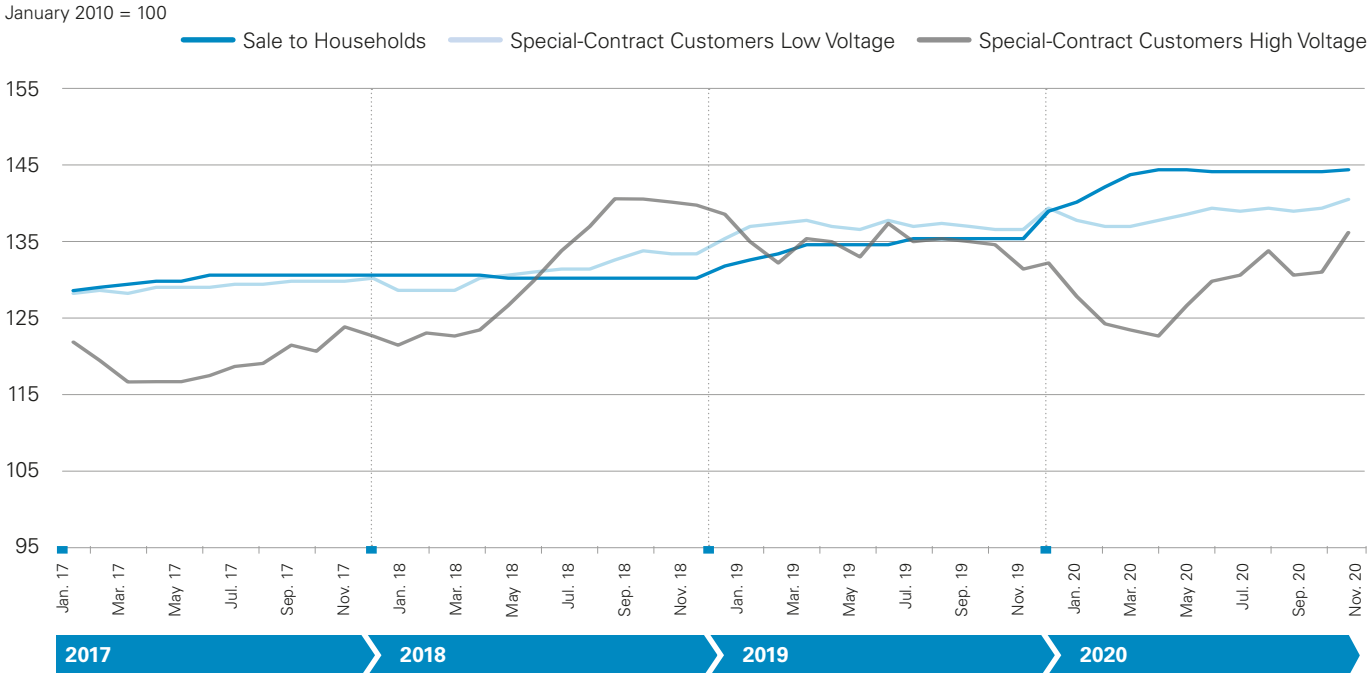
Electricity Producer Price Index for Special-Contract Customers and Sale to Households in Germany between 2017 and 2020



Source: The German Coal Industry's Statistical Office

Figure 12

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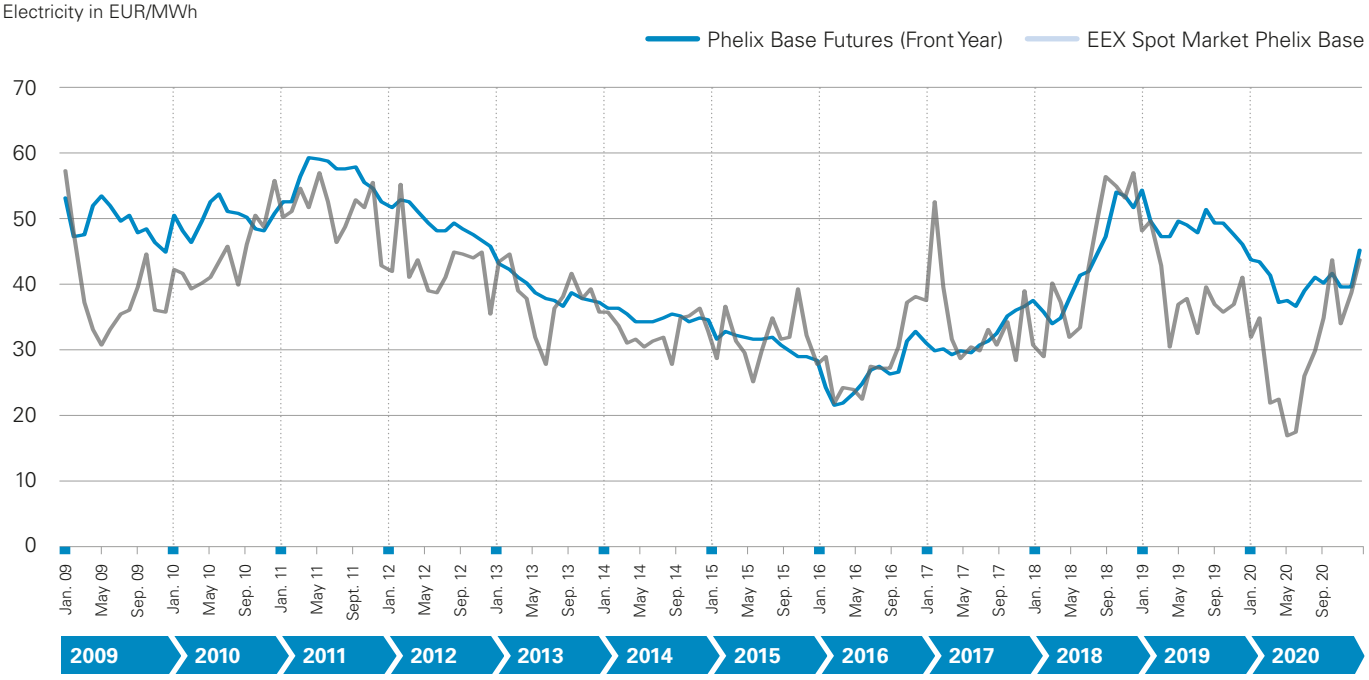
Development of Electricity Prices on the EEX Spot Market and Futures Market (Front Year) between 2009 and 2020

Electricity in EUR/MWh



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

imposed on industry in the form of taxes, duties, and levies increased by approximately 3.7 % in 2020. As a result, the proportion of governmental charges included in the electricity price for industrial customers, which had still amounted to 48.6 % in 2019, increased to about 52 % in 2020 (including the electricity tax).

Electricity prices for private households went up by 6.3 % in 2020. This was caused by increased procurement costs on the wholesale market as well as increased grid usage charges. The proportion of taxes, duties, and levies included in the electricity price for private households dropped to 52 % in 2020 (which was also due to the temporary lowering of the value added tax) compared to 53 % in the previous year. However, this item continued to be the largest item on the customer bill again in 2020 (please see Figure 11).

If one were to take a look at the monthly development of the stock market prices for electricity since 2009, then this curve initially exhibited, after a temporary high in early 2011, a downward trend until about February 2016 when the procurement costs fell below the level of € 25/MWh. Subsequent to this downward trend in prices, a temporary increase in stock market prices could be observed which finally peaked at € 54/MWh in December 2018. Since then, the wholesale prices had been subject to fluctuations and dropped once again just below the level of € 37/MWh until May 2020. However, there was once again a clear upward price trend during the second half of the reporting year so that the wholesale prices once again exceeded the level of € 44/MWh in December 2020 (please see Figure 12).

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 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 cannot be 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). The year 2020 was initially characterized by a significant decline in the CO_2 price which, most likely due to the impact of the economic repercussions resulting from the measures undertaken to contain the Covid-19 pandemic, fell below the level of approximately 20 euros per ton during the months of March, April, and May. Since June 2020, the prices for emission rights had increased again; in December 2020, they peaked at 31 euros per ton (please see Figure 13).

Figure 13

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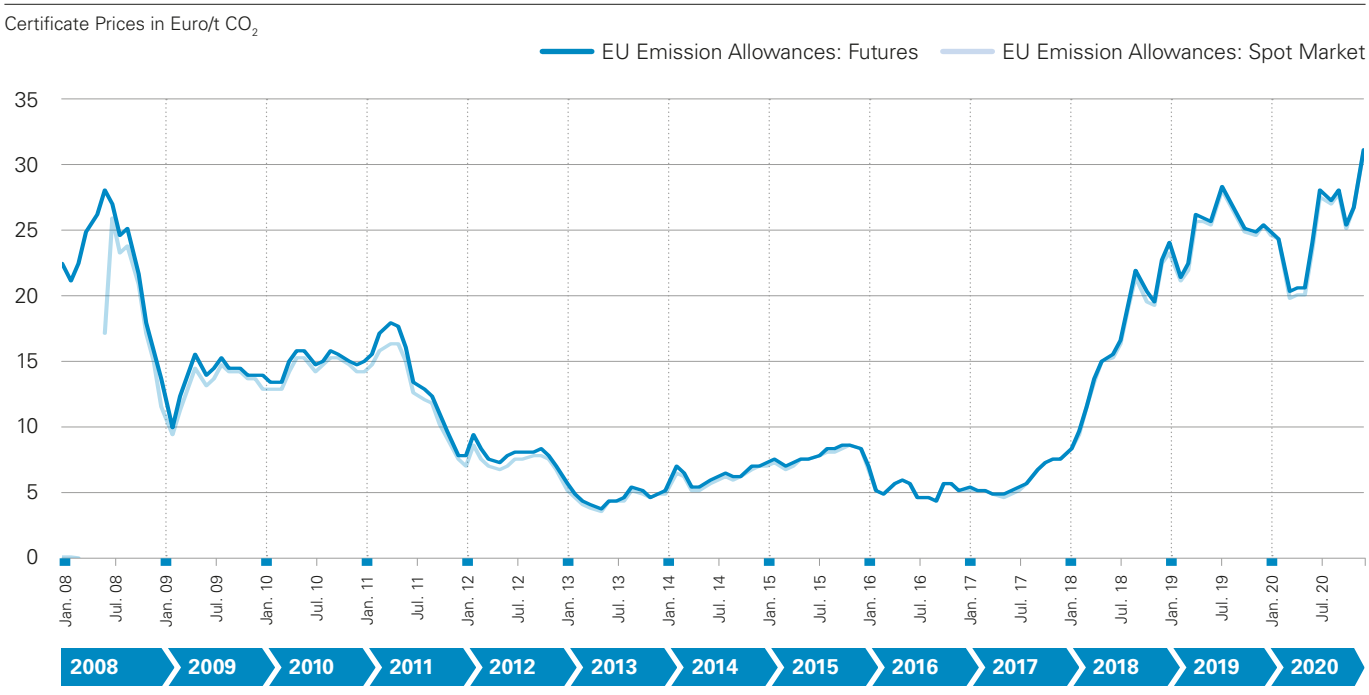
European Emission Allowances on the EEX Spot Market between 2008 and 2020



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

Renewable Energy [9]

In 2020, the primary energy consumption of renewable energy sources amounted to a total of 1,961 PJ (please see Table 14). When compared to the previous year (1,904 PJ), this equals an increase of 3.0 % which translates into an absolute increase of 57 PJ. The main drivers were a rise in electricity production from renewables and an increased admixture of biofuels in the transportation sector within the scope of the greenhouse gas reduction rate.

In 2020, electricity production from renewables exceeded for the first time ever electricity production from the fossil fuels lignite, hard coal, natural gas, and mineral oil – this was also caused by the effects of the Covid-19 pandemic. A total of 904 PJ, which translates into 251.0 billion kilowatt hours of electricity, were produced. Compared to the previous year (242.4 billion kWh), this equals an increase of 3.5 %.

Once again, wind energy contributed more than half of the renewable power. At the same time, wind energy generated almost as much electricity as all coal fired power plants combined. Approximately four fifths of the wind-generated electricity came from onshore wind turbines (103.7 billion kWh; +2.5 % compared to 2019), another fifth was supplied by offshore wind parks (27.3 billion kWh; +10.3 % compared to 2019). Due to the overall weather conditions, which were similar to those of the previous year, the increase in electricity production corresponded, in terms of figures, approximately to the production potential of the additional wind capacity that had been installed on shore and off shore in 2019. This is remarkable insofar as the dynamic expansion of wind energy continued to weaken in 2020: In fact, the expansion activities on shore broke the downward trend of the previous year (865 MW) with the installation of an additional net capacity of about 1,250 MW. Off shore, however, except for a few capacity increases and final additions in 2020 (+219 MW compared to +1,135 MW in 2019), a pause in expansion lasting several years has commenced until new grid connection capacities will be installed and new wind parks put into operation presumably as of 2023.

Compared to the previous year, gross electricity production from photovoltaics went up by approximately 4.2 billion kWh to 50.6 billion kWh in 2020. This equals a growth of 9 %. In addition to the newly installed production capacity in the previous year, this was above all due to the global radiation, which was far above average in the spring. Furthermore, the installation of additional capacities in new photovoltaic systems exhibited an increase of 22 % when compared to the previous year (about 4,750 MW compared to about 3,900 MW in 2019). And towards the end of the year, the first open space PV systems, which are financed via long-term power purchase contracts, went into regular operation.

In 2020, electricity production from hydropower declined slightly by one billion kWh whereas electricity production from biomass including biogenic waste recorded a slight increase of 0.4 billion kWh. What needs to be mentioned at this point is the international energy-statistical convention of the efficiency principle according to which a fictitious efficiency of 100 % is assumed for the energy carriers hydropower, wind power, and photovoltaics. Hence, the efficiency principle implicates that the primary energetic contribution of electricity production from these energy carriers, when compared to electricity production from biogenic and fossil fuels whose conversion efficiency can be derived from the respective fuels' calorific values, is systematically indicated as a smaller figure.

Compared to the previous year, the primary energy consumption of biomass and biogenic waste increased slightly by 2.2 % to 1,136 PJ in 2020. Thus, about 58 % of the total primary energy consumption of renewables accounted for the diverse biogenic energy carriers which will be examined closer below, both according to their major sectoral consumption areas and their individual state of aggregation:

In 2020, approximately 43 % of the biogenic energy carriers were used in the conversion sector, essentially for the generation of electricity and district heat including the amount needed to cover the in-house

9) This text is based on the work conducted by the Working Group on Renewable Energies-Statistics (AGEE-Stat); last update: February 1, 2021. For further information on the development of renewables in 2020, 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 2020" [Renewable Energy in Germany – Data on the Development in 2020] [currently only available in German]: https://www.umweltbundesamt.de/publikationen/erneuerbare-energien-in-deutschland-2020.

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		
	2019	2020	Changes	2019	2020	Changes	2019	2020	Changes	2019	2020	Changes	2019	2020	Changes	2019	2020	Changes	2019	2020	Changes
	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%	Petajoules		%
Domestic Production	71	67	- 6	453	471	4	198	214	8	67	73	8	1,002	1,025	2	129	128	- 1	1,920	1,977	3
Foreign Trade Balance													- 15	- 16					- 15	- 16	
Primary Energy Consumption	**71**	**67**	**- 6**	**453**	**471**	**4**	**198**	**214**	**8**	**67**	**73**	**8**	**987**	**1,008**	**2**	**129**	**128**	**- 1**	**1,904**	**1,961**	**3**
Use in Power Plants (Electricity)	71	67	- 6	453	471	4	167	182	9	7	8	10	331	335	1	58	58	0	1,087	1,122	3
Use in Power and Heating Plants (Heat)							0	0	0	3	3	0	45	46	1	48	47	- 2	97	96	- 1
Consumption during Conversion, Losses													24	24	- 1	0	0	0	25	24	- 1
Final Energy Consumption							**31**	**31**	**3**	**56**	**61**	**8**	**586**	**603**	**3**	**23**	**23**	**0**	**696**	**719**	**3**
Industry							0	0	0	0	0	0	90	90	0	23	23	0	113	113	0
Transportation													112	140	24				112	140	24
Households, Trade, Commerce, Services							31	31	3	56	61	8	385	374	- 3				471	467	- 1

All values are preliminary (last update: February 2021)

Source: AGEE-Stat

consumption of the production plants. Compared to the previous year, both the use of solid and the use of gaseous biogenic fuels in electricity production increased slightly. In 2020, the final energy sectors accounted for approximately 55 % of the biogenic primary energy consumption. In absolute figures, the final energy consumption of biogenic energy carriers increased by 17 PJ (+2.8 %) to 626 PJ in 2020. Of this figure, about 60 % accounted for the private household as well as the trade, commerce, and service sectors whereas the transportation sector's proportion amounted to 22 % and the industrial sector's proportion to about 18 %. In a comparison of the years 2020 and 2019, it was in particular the consumption in the transportation sector which went up by four percentage points due to the increased admixture of biofuels whereas consumption in the private household as well as the trade, commerce, and service sectors decreased by approximately four percentage points.

Depending on its state of aggregation, biomass can furthermore be classified into solid, gaseous, and liquid energy carriers: With 666 PJ in 2020, more than half (59 %) of the biogenic primary energy consumption was allotted to such solid biogenic fuels as firewood, wood chips, pellets, briquettes, charcoal as well as biogenic components in residential waste, mature wood, sewage sludge, and other residual materials. 46 % (305 PJ) of the solid biogenic fuels were consumed as fuelwood products in the private household as well as the trade, commerce, and service sectors. Due to the weather conditions, a decline (-3.5 %) compared to the previous year was actually recorded here. In the conversion sector, about 37 % of the solid biogenic fuels including biogenic waste were used (244 PJ), above all, for the production of electricity and district heat. And finally, like in the previous year, 16 % of the solid biogenic fuels were used for space heat and process heat purposes in industry (108 PJ).

In 2020, gaseous biogenic fuels accounted for a proportion of approximately 28 % of the total biogenic primary energy consumption. Gaseous biogenic fuels include biogas, sewage gas, and landfill gas, which are used on site for the generation of electricity and heat, as well as biomethane, which is upgraded to natural gas quality and distributed within the gas grid where it is withdrawn elsewhere as a fuel or combustible. In 2020, more than four fifths (approximately 82 %) of the gaseous biogenic fuels contributed to the generation of electricity and district heat as well as for covering the in-house consumption of production plants (including losses) (262 PJ). Closely linked to this was the fuel input for decentrally used heat in cogeneration plants (51 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 sales of biomethane in the transportation sector increased by about 34 % in 2020.

With 151 PJ, liquid biogenic materials accounted for a substantially higher share in the primary energy consumption of renewables than had been the case in the previous year. This is a consequence of the increase in the greenhouse gas reduction rate in the transportation sector as of 2020. Hence, the admixture of liquid biofuels went up by 28 PJ, which translates into an increase of 24 %. At the same time, the Covid-19 related declines in the total sales volumes of gasoline and diesel fuels resulted in very different trends for the individual types of biofuels: While sales of bioethanol even went down by 3 %, biodiesel (including hydrogenated vegetable oils, HVO) recorded a significant increase of approximately 35 % when compared to the same period of the previous year.

Despite having grown, the other renewable energy carriers deep geothermal energy, environmental heat including near-surface geothermal energy, and solar thermal energy continued to account for a share of about 5 % in the primary energy consumption from renewables in 2020. The market growth accelerated further, above all, for heat pumps: According to the German Federal Heat Pump Association (BWP), about 120,000 heat pumps for heating purposes as well as 20,500 hot water heat pumps were newly installed in 2020. Consequently, the renewable environmental heat generated by means of heat pumps increased by 10 % to 58 PJ (+5 PJ). And energy production from deep geothermal energy including its balneological use (thermal baths) also increased by 6 % (+1 PJ).

Compared to the previous year, solar thermal heat generation increased by approximately 3 % to 31 PJ in 2020. This was caused, on the one hand, and as already mentioned above, by the fact that the global radiation exceeded the long-term average. On the

other hand, the downward trend in new installations which had continued for several years was stopped: According to the German Solar Industry Association (BSW-Solar), the number of newly installed solar collector systems increased by 17 % to 83,000 units and the newly installed collector surface even increased by 26 % when compared to the previous year.

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 hydropower and biomass lost quite a few shares in the growing market (for example, biomass in 2019: 51.8 %; in 2020: 51.4 %), solar energy (but also geothermal energy) was able to expand its contribution by 0.5 percentage points to nearly 11 % in 2020.

Figure 14

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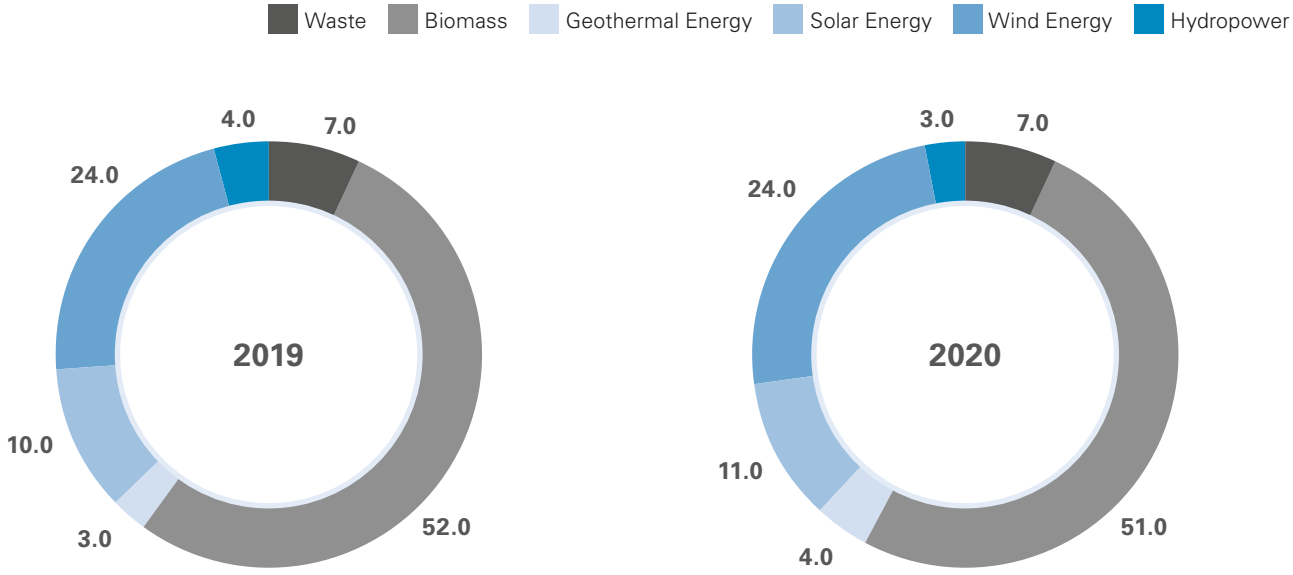
Structure of Renewable Energy Sources in Germany between 2019 and 2020

Shares in Total Renewable Energy in %



All values are preliminary (last update: February 2021)

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 improvements in increasing the energy efficiency as a key strategy for the success of the targeted energy turnaround.

That is why 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 5 % decrease in the macroeconomic performance and the even more substantial decline in energy consumption, Germany's macroeconomic energy productivity related to the original values ascertained for primary energy consumption improved noticeably in 2020 when compared to the previous year; namely, by 3.2 %. Temperature and stock level adjusted, the macroeconomic energy productivity fell slightly below this rate with a plus of 2.7 %; however, it was still noticeably above the level exhibited by the long-term trend (between 1990 and 2020: About 2.3 % p.a.). All told, 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 2020

	Unit	1990	2017	2018	2019	2020	Average Annual Change in %	
							2019 bis 2020	1990 bis 2020
Gross Domestic Product (Price Adjusted: Reference Year 2015)	Concatenated Volume Figures in Billion Euros	1,959.1	3,174.2	3,214.4	3,232.3	3,071.3	- 5.0	1.5
Population [3]	1,000	79.8	82.7	82.9	83.1	83.2	0.1	0.1
Primary Energy Consumption (Unadjusted)	Petajoules	14,905	13,523	13,129	12,805	11,784	- 8.0	- 0.8
Primary Energy Consumption (Adjusted) [5]	Petajoules	15,051	13,634	13,408	12,952	11,980	- 7.5	- 0.8
Total Electricity Consumption [4]	Billion kWh	550.7	600.5	594.2	576.7	551.9	- 4.3	0.0
Energy Productivity (Unadjusted)	Euros/GJ	131.4	234.7	244.8	252.4	260.6	3.2	2.3
Energy Productivity (Adjusted) [5]	Euros/GJ	130.2	232.8	239.7	249.5	256.4	2.7	2.3
Electricity Productivity	Euros/kWh	3.6	5.3	5.4	5.6	5.6	- 0.8	1.5

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

Figure 15

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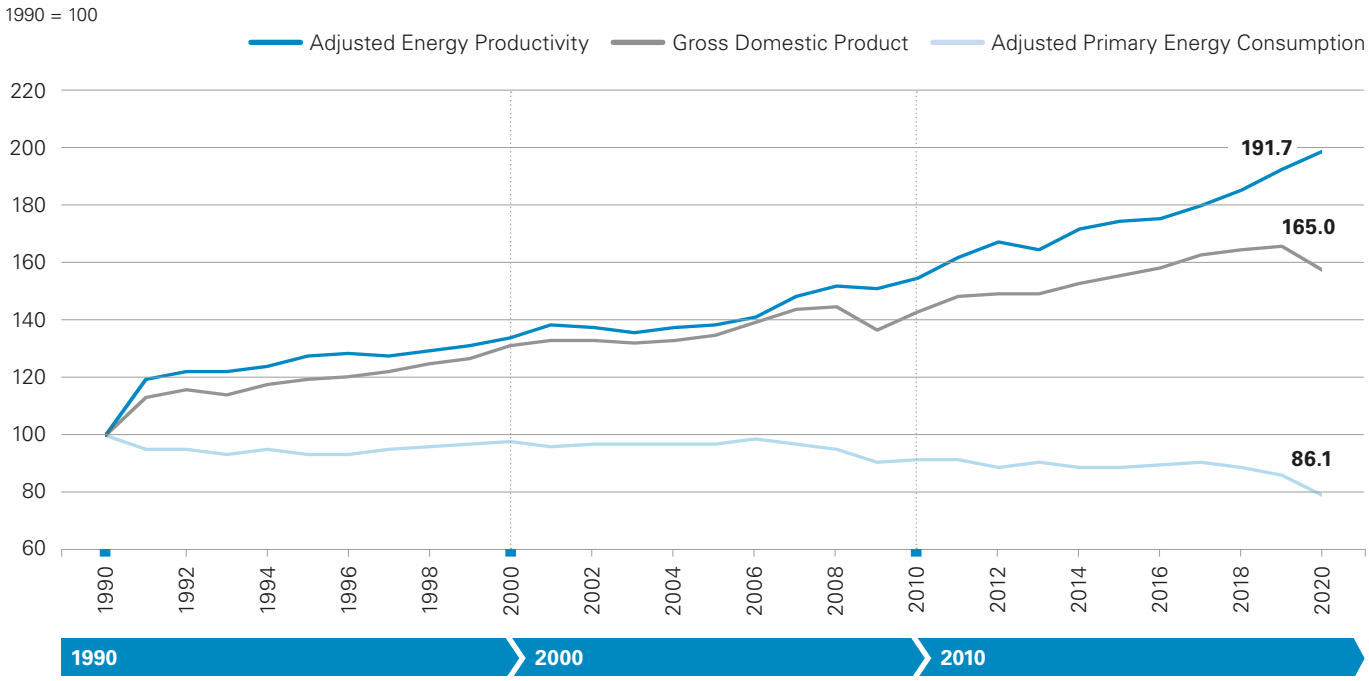
Gross Domestic Product, Primary Energy Consumption, and Energy Productivity in Germany between 1990 and 2020



*) 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 from a primary energy perspective, (which are all used for electricity production and) 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 can be found, for example, in the AGEB publication *Energy Consumption in Germany in 2019*, p. 38, which can be downloaded from the AG Energiebilanzen's website at: https://ag-energiebilanzen.de/index.php?article_id=29&fileName=ageb_jahresbericht2019_20200505_engl_web.pdf

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 2020 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 (-9,485 PJ). This way, it was possible to significantly overcompensate the consumption-enhancing effects of macroeconomic growth (+5,822 PJ) and the increase in population (+593 PJ). All told, the adjusted primary energy consumption decreased by 3,070 PJ between 1990 and 2020.

Figure 16

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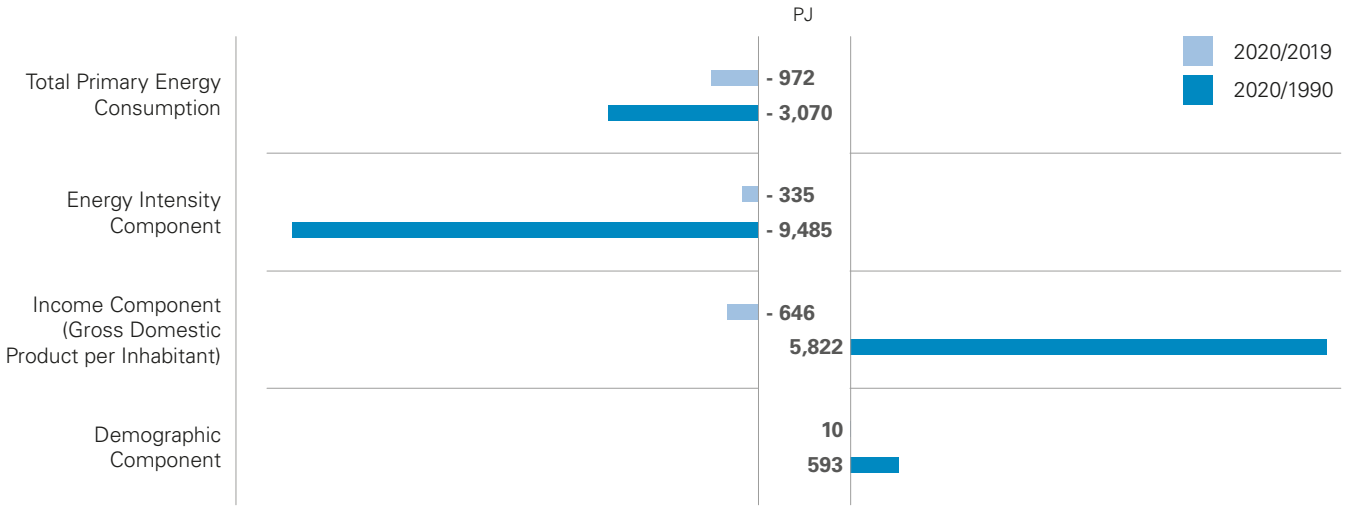
Contributions of Diverse Influencing Factors to the Changes in the Adjusted Primary Energy Consumption in Germany

Changes in 2020 Compared to 2019 and 1990 in Petajoules



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

The correlations outlined above apply in a similar way to the short-term consideration of the changes between 2019 and 2020: Yet other than in a long-term comparison, it was now primarily the decline in the economic activity (-646 PJ) which due to the Covid-19 pandemic had a significant consumption-reducing effect, whereas efficiency gains in the use of energy exerted only a relatively small influence on primary energy consumption (-335 PJ). The consumption-enhancing effect of the population component (+10 PJ altogether) was negligibly small, with the result that the (adjusted) primary energy consumption decreased by 972 PJ (when compared to 2019).

However, when it comes to the assessment of the results of such a component decomposition, it should 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). In fact, 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 shift 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 shift 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 to cause energy consumption to decrease in the past. Notwithstanding the above, such structural effects are not included in this component decomposition which is assumed here in a simplified manner.

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 consumption of electricity. This is due to the fact that an improvement of the energy productivity in numerous economic branches can often only be attained through the increased use of state-of-the-art plant engineering, 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 down slightly by 0.8 % in 2020 (compared to 2019), which was due to the significant decline in electricity consumption (by -4.3 % to 552.2 TWh) and due to a simultaneous slowdown of the economic growth that was even greater than before (-5 %). When taking the long-term period between 1990 and 2020 into account, the electricity productivity increased by an annual average of 1.5 %.
For comparison: The total energy productivity (adjusted) increased by 2.3 % 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 2020 and/or 2019/2020 is illustrated in Figure 19, which concludes this section. The diagram shows that the reduction of the total electricity consumption, which declined by 42 billion kWh in 2020 when compared to 2019, was primarily caused by the consumption-reducing effects of the economic downturn (-28 billion kWh) as well as by higher electricity productivity (electricity intensity component) (-16 billion kWh). The associated consumption reductions were correspondingly higher than the consumption-enhancing effects caused by the increase in population (+2 billion kWh).

When considering the entire period between 1990 and 2020, 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 still increased slightly by about 1.5 billion kWh between 1990 and 2020 (despite the current pandemic-related economic slump).

Figure 17

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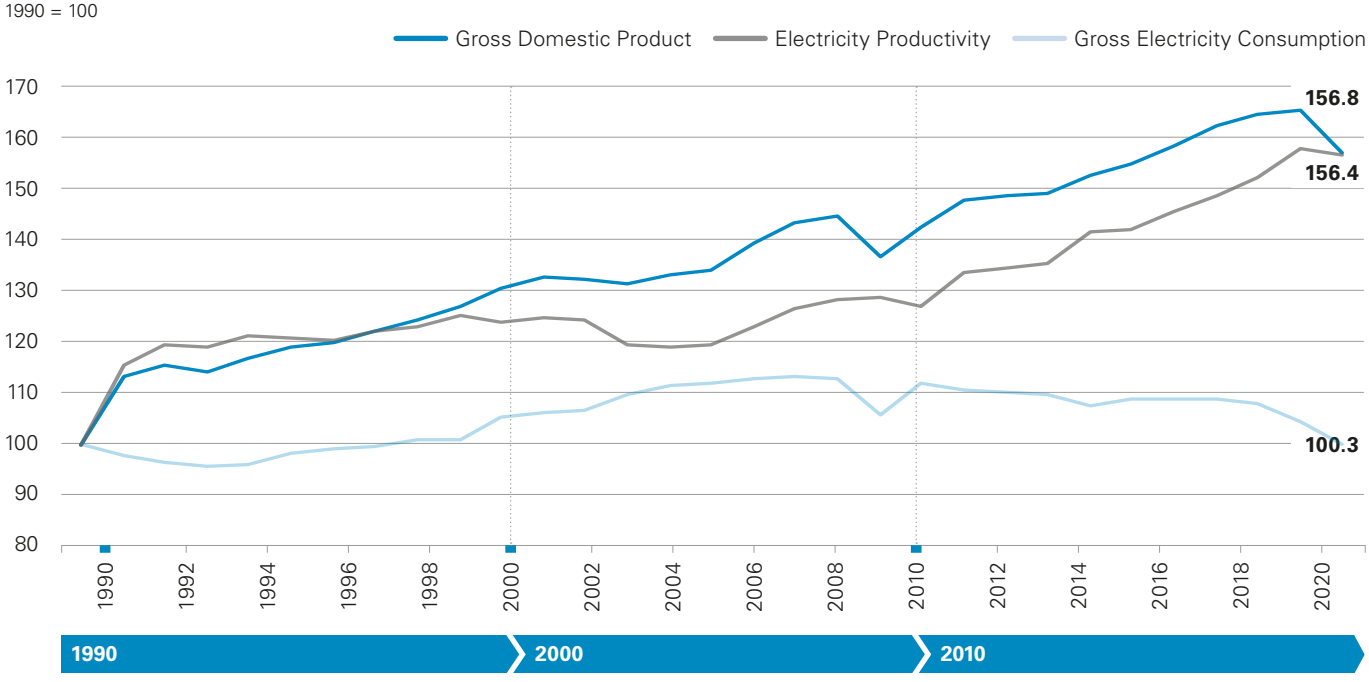
Gross Domestic Product[1], Gross Electricity Consumption, and Macroeconomic Electricity Productivity[2] in Germany between 1990 and 2020



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

Sources: Working Group on Energy Balances (AGEB); 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

AGEB
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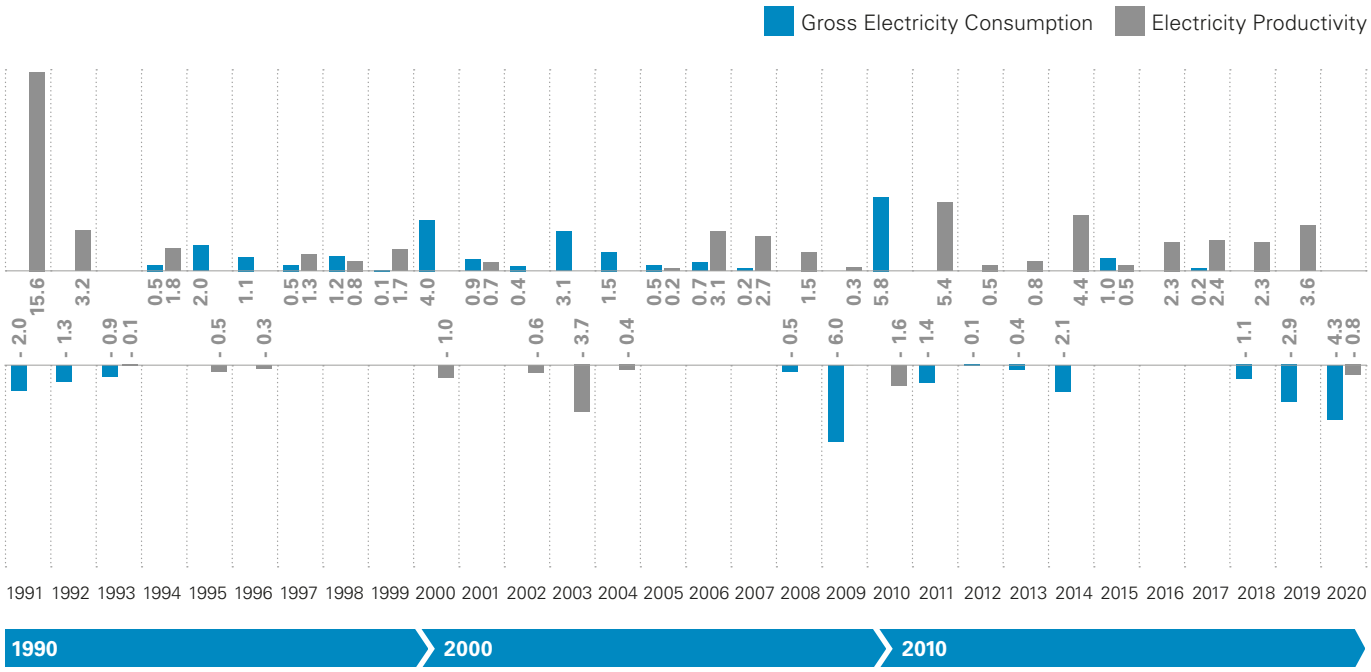
Changes in Gross Electricity Consumption and Electricity Productivity between 1991 and 2020

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)

Figure 19

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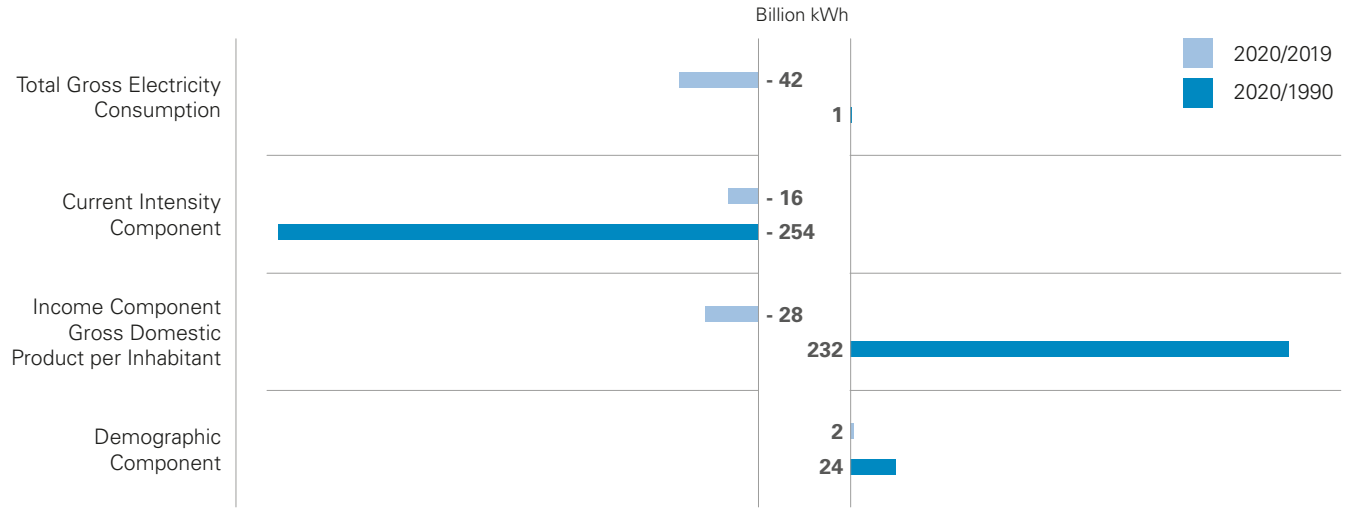
Contributions of Diverse Influencing Factors to the Changes in Gross Electricity Consumption in Germany

Changes in 2020 Compared to 2019 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)

The increase in the electricity productivity (-254 billion kWh) within the same period of time was the reason why it was possible to limit the above mentioned increase in gross electricity consumption (compared to 1990) to less than 1.5 billion kWh despite the fact that there was a considerable increase in consumption due to the growing economy (+232 billion kWh) and demographic influencing factors (+24 billion kWh). Compared to 1990, electricity consumption actually increased by a mere total of 0.3 % and, thus, reached the level of 1997 (or 1990) again for the first time ever in 23 years.

CO_2 Emissions

According to initial calculations, power generation and heat generation plants supplying the general public emitted about 158 million tons of CO_2 in 2020. Compared to 2019, this equals a decline in CO_2 emissions of around 20 %. The largest share by far of this emissions reduction occurred in electricity production (electric power generated in pure condensation units and cogeneration plants) which managed to reduce carbon dioxide emissions by almost 46 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 2019 and 2020. According to initial estimates, the CO_2 emissions in this segment ought to have decreased by more than 1 million tons in 2020.

From the preliminary data and estimates compiled in this report on the energy consumption trend in 2020, the following general assumptions can be made for the development of energy-related carbon dioxide emissions in other sectors, primarily those related to final energy consumption:

- In 2020, the significant decline in fuel sales (gasoline, diesel fuels, and aviation fuels) as well as shifts within the sales mix are likely to result in a reduction of the CO_2 emissions of about 28 million tons (or -15.2 % when compared to 2019) in the transportation sector.[10] By far the largest contribution to this emissions reduction was the result of the drastically declined air traffic in the aviation sector as a direct consequence of the travel restrictions due to the Covid-19 pandemic (-17 million tons of CO_2).

- In the manufacturing industry (without electricity production in industrial power plants and without the energy used in refineries, blast furnaces, and coking plants), it is anticipated that the energy-related CO_2 emissions are likely to have decreased by more than 4 million tons in 2020 when compared to the previous year. Just the reduced coal input in crude steel production alone, which due to the economic situation dropped by more than 4 million tons to 35.7 million tons (-10 %) in 2020 when compared to the previous year, ought to have relieved the industry's emissions balance by 3.8 million tons (without the contribution of blast furnaces which in the energy balance are attributed to the conversion sector) in the reporting year.

- Despite the slightly milder weather and the further advancing modernization of heating systems and building envelopes in private households, an increasing "consumption" of fuel oil and natural gas for heating residential premises was recorded in 2020 when compared to the previous year. Against this backdrop and according to initial estimates based on the energy balance, the CO_2 emissions of private households are likely to have increased by 3.7 million tons in 2020. When interpreting these findings, however, it must be noted that private households significantly increased their fuel stocks in 2020 due to temporarily low prices for light fuel oil. If one were to adjust the information on sales of fuel oil to private households (as they are recorded in the energy balance) for this "not consumption-relevant and/or not emission-relevant" restocking of inventories, then private households – without a doubt also caused by an increased presence of people in their own homes (lockdown/ home office) – would have emitted approximately 2 million tons of CO_2 more for such applications as space heating, hot water, cooking in 2020.

- Finally, a reduction of the emissions (2020: -1.7 million tons) is to be anticipated also for the trade, commerce, and service sector. The emissions

10) 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).

reduction in the trade, commerce, and service sector referred to hereinabove is primarily due to the fact that the economic performance, related to the price-adjusted gross value creation, decreased by 3.7 % in 2020 as a consequence of the lockdown measures which to a large extent affected the service sectors and the retail trade (an increase in value creation of almost 1.9 % had still been observed in the previous year).

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 63 million tons could be anticipated for the year 2020. As a result, the energy-related CO_2 emissions would have decreased by about 9.6 % in 2020 when compared to the previous year.[11] (The short-term forecast published by the Federal Environment Agency (UBA) estimates the CO_2 emissions for 2019 at 706 million tons, of which approximately 656 million tons are directly attributable to the use of fuels.) 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.

In this context, a continuing problem should once again be highlighted which from an emission perspective is associated with the fact that those emissions which originate from domestic electricity production and are accompanied by the high export surplus are to be 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 are displaced which consequently results in lower emissions in those countries. But it is questionable what the emissions balance will reveal when viewed from an international perspective. This depends decisively on the specific emissions of the export flow in relation to the specific emissions of the electricity displaced in the individual recipient countries.

11) After the editorial deadline of this report, the Federal Environment Agency (UBA) published for the first time ever an estimate of the greenhouse gas emissions trend in line with the provisions of the Federal Climate Protection Act (KSG) on March 16, 2021. The figures essentially confirm the information provided by this report. When considered in detail, discrepancies will occur as a result of the divergent differentiation of sectors.

Summary of the Trends

According to preliminary calculations made by the Arbeitsgemeinschaft Energiebilanzen (AG Energiebilanzen) – Working Group on Energy Balances (Energy Balances Group), energy consumption in Germany went down by 8.0 % to 11,784 petajoules (PJ), which translates into 402.1 million tons of hard coal equivalents (Mtce), in 2020. Thus, Germany's energy consumption dropped to its lowest level by far since the early 1970s.

Responsible for the reduced energy consumption in Germany were, above all, the pandemic-related weaker economy as well as progressive improvements in energy efficiency. The price trend for energy hardly provided any impetus for saving energy in 2020. The global market prices for oil, natural gas, and hard coal experienced to some extent a noticeable decline ranging from 34 % to 24 % over the course of the year 2020. However, consumer prices for grid-bound energy carriers (natural gas, electric power, district heat) barely benefited from this trend; instead, these prices actually increased for some consumer groups (for example, private households as well as the trade, commerce, and service sector) on the domestic market. And the essentially stagnating population as well as the milder weather when compared to the previous year did not emanate any consumption-enhancing impulses either.

Without the influence of the weather (and with the exclusion of any inventory changes in storing light fuel oil), primary energy consumption in 2020 would have fallen 7.5 % below the level that had been ascertained for 2019.

As measured by the original values, the macroeconomic energy productivity continued to improve in 2020. With a rate of 3.2 %, it increased somewhat stronger than in the previous year (+3.1 %); however, it was still significantly above the long-term average (between 1990 and 2020: +2.3 % p.a.). Temperature-adjusted, the macroeconomic energy productivity increased by 2.7 % in 2020 when compared to the previous year.

A glance at the individual energy carriers reveals the following picture: Renewables were the only energy carrier whose consumption increased in 2020 (+3.0 %). In contrast, consumption (and/or sales) of mineral oil products and natural gas decreased by 11.9 % and by 2.4 % respectively. All other energy carriers experienced even more substantial losses in their shares of a generally shrinking market. For example, it was primarily the consumption of coal (hard coals with a minus of 16.6 % and lignite with a minus of 17.8 %) which dropped significantly. With a minus of 14.2 % (due to the shutdown of the nuclear power plant Philippsburg as of December 31, 2019), power generation from nuclear energy continued to decrease in 2020.

With a share of 33.7 % 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 26.6 %. Renewable energy carriers ranked third with a current share of 16.6 % in primary energy consumption, followed by lignite with 8.1 % and hard coal with 7.7 %. The share of nuclear energy covering the primary energy consumption decreased to 6.0 % in 2020.

When it comes to renewables, the changes diverged considerably in 2020 as well: While the primary energy consumption of biogenic waste decreased by about 1 % and that of hydropower by 6 % due to the reduced supply of water, wind energy (onshore and offshore) went up by 4 % and solar energy (primarily PV) grew by 8 % in 2020. Geothermal energy also recorded an increase of 8 %.

Similar to primary energy consumption, gross electricity consumption also decreased in 2020 as a consequence of the economic repercussions of the Covid-19 crisis. However, the decline of 4.3 % to almost 552.2 billion kWh was not as significant as was the case for many fossil fuels. Compared to the previous year, the macroeconomic electricity productivity deteriorated marginally by 0.8 % in 2020 and fell, thus, noticeably below the average rate of 1.5 % p.a. which was ascertained for the period between 1990 and 2020.

With a reduction of nearly 6.1 % to about 572.2 billion kWh in 2020, gross electricity production decreased at a stronger rate than gross electricity consumption. The structure of electricity production according to energy carriers continued to change: While electricity

production based on the use of hard coal (-24.8 %), lignite (-19.4 %), and nuclear energy (-14.2 %) declined, renewable energy carriers once again accounted for a plus of 3.5 %. At the same time, electricity production based on the use of natural gas went up by 2.1 % in 2020 after it had still experienced an increase of 10 % (8.4 TWh) between 2018 and 2019.

All told and with a total production volume of about 251 billion kWh as well as a share of nearly 44 % in electricity production, renewables were able to further expand their top position ahead of lignite and natural gas (both about 16.1 %) and hard coal with more than 11 %. When it comes to electricity consumption, renewables accounted for a share of more than 45 % in 2020; in the previous year, this share had still amounted to approximately 42 %.

In light of the slightly stronger decline in electricity production when compared to electricity consumption, the surpluses in the exchange of electricity with foreign countries[12)] decreased to about 20 billion kWh (2019: Almost 33 billion kWh). Particularly high export surpluses were recorded for the exchange with Poland (11.2 billion kWh), Austria (10 billion kWh), and Switzerland (5 billion kWh). Surpluses in the flow of electric power from abroad traditionally come from France; whereby the import surplus from this region decreased slightly from approximately 12.4 billion kWh (2019) to about 10 billion kWh in 2020.

At the moment, it is not yet possible to precisely ascertain the energy-related CO_2 emissions for 2020 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 2020 as well, the overall structure of energy consumption shifted further 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 9.6 %, which translates into about 63 million tons of CO_2; adjusted by the influences of the weather as well as by inventory effects, the decline was somewhat stronger with approximately 9.9 %, which translates into almost 65 million tons of CO_2. The largest contribution by far to reducing the energy-related CO_2 emissions came from the electricity industry (electricity production in power plants supplying the general public); just here alone, it was possible to reduce carbon dioxide emissions by almost 46 million tons between 2019 and 2020 due to lower electricity consumption and fewer electricity exports as well as the growing proportion of renewables and natural gas instead of coal in electricity production.

Additional successful reductions in 2020 are likely to have been achieved primarily by the transportation sector as the third largest producer of greenhouse gases (-28 million tons). And in the trade, commerce, and service sector, CO_2 emissions dropped as well by about 1.7 million tons which was, above all, the result of the lockdown measures designed to fight the Covid-19 pandemic. Carbon dioxide emissions of private households (adjusted by inventory effects for light fuel oil) increased by an estimated 2 million tons in 2020, which was a direct consequence of the increased presence of people in their own homes and the excess consumption relating thereto (hot water, cooking, heating of residential premises).

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