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Energie. Wasser. Leben.

ENERGY MARKET GERMANY

2019

BDEW Bundesverband der Energie- und Wasserwirtschaft e. V.

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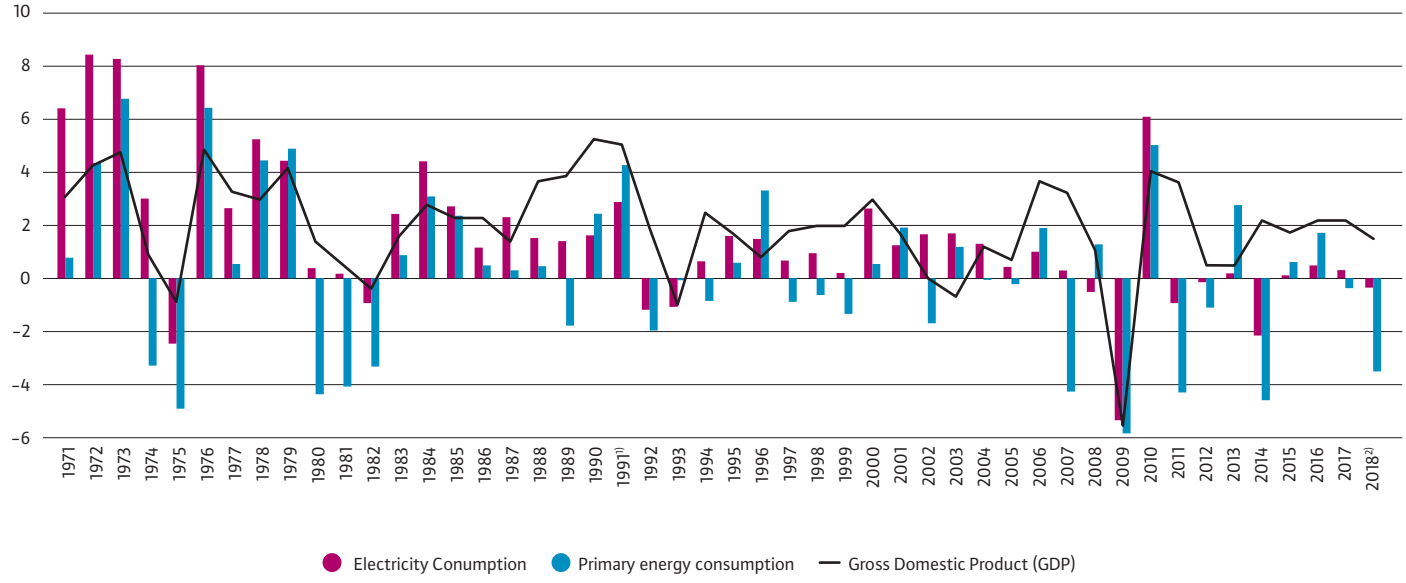
ENERGY AND THE ECONOMIC SITUATION

Consumption falls sharply in 2018

Annual rates of change 1971–2018[2] (per cent)



Sources: AGEB, DESTATIS, BDEW; Status: 03/2019

1) Up to 1991, West Germany only 2) Preliminary figures

ENERGY AND THE ECONOMIC SITUATION

Consumption falls sharply in 2018

Economic growth and energy consumption were closely interrelated between 1971 and 1990, however the development of GDP and of energy consumption began to diverge at the beginning of the nineties. From 1991 to 2010, electricity consumption increased on average by around 0.7 per cent annually whilst the economy grew on average by 1.2 per cent. After 2010, electricity consumption was then on a general downward trend, however in the past three years it has increased slightly again, primarily due to strong economic growth.

Primary energy consumption fell in 2018 by 3.5 per cent to 12 693 PJ. That is the lowest level since the beginning of the 1970s. The main causes of the decline were increased energy prices, the mild weather and improvements in energy efficiency. Adjusted for the consumption-reducing effects of the weather, energy consumption sank by around 2.4 per cent.

Natural gas consumption in Germany decreased in 2018 by 1.6 per cent to 945 bn kWh. The main reasons for this were the sustained period of mild weather and the slight economic downturn. Natural gas accounted for 23.7 per cent of the domestic energy mix.

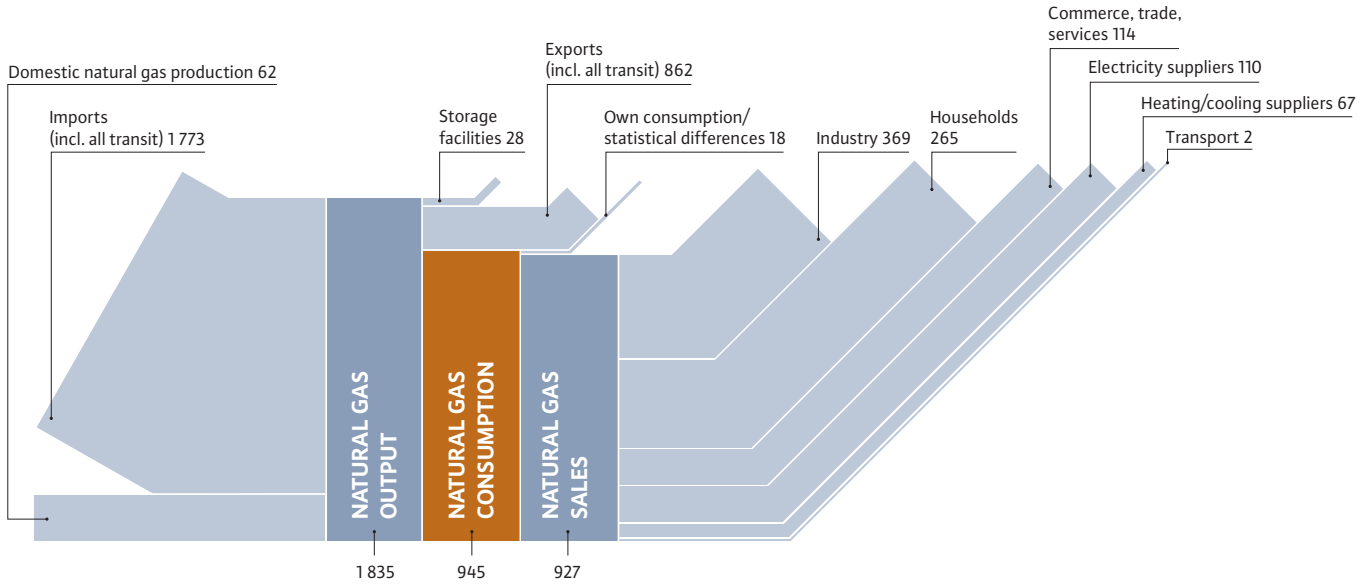
Gross electricity consumption also fell in 2018 compared to 2017. At 596 bn kWh, consumption was 0.5 per cent lower than the previous year's level. Electricity productivity, which for the economy as a whole experienced average year-on-year growth of 1.0 per cent between 1990 and 2017, increased in 2018 by 2.0 per cent.

Gross domestic product, after adjustment for inflation, increased by 1.4 per cent in comparison to the previous year. The growth was driven mainly by domestic consumption, however investment played a role. The picture varied greatly, however, across the various areas of industry: whilst industrial production rose by 1.2 per cent overall, production growth in the energy intensive sectors fell.

GAS FLOW

From import and production to consumption

Gas flow in 2018[1] (bn kWh)



In 2018 a further 10 bn kWh of biogas upgraded to natural gas quality was injected into the German natural gas network.

Sources: DESTATIS, BVEG, dena, BDEW

1) Preliminary figures

KEY DATA – GAS

The most important figures at a glance

Gas suppliers	2008	2017	2018[1)]	Change from previous year (per cent)
Employees (thousand)	37.0	36.6	37.0	+ 1.1
Revenue (€ bn) from gas sales to end users[2)]	41.8	30.9	30.2	– 2.4
Investment (€ bn)	2.2	2.0	1.9	– 5.3
Domestic natural gas production (bn kWh)	151.0	70.5	61.6	– 12.6
Natural gas imports[3)] (bn kWh)	982.9	1 237.2	1 773.2	–
Natural gas output[3)] (bn kWh)	1 133.9	1 307.7	1 834.8	–
Natural gas exports[3)] (bn kWh)	163.0	347.6	861.7	–
Storage net balance (bn kWh)	+ 6.9	+ 0.7	– 27.8	–
Natural gas consumption (bn kWh)	977.9	960.8	945.3	– 1.6
Natural gas sales (bn kWh)	970.2	943.0	927.3	– 1.7
Feed-in of biomethane into the grid (bn kWh)	0.1	9.3	10.0	+ 7.7
Number of homes supplied with natural gas heating (million)	19.3	20.6	20.7	+ 0.5
Network length (km)	419 293	482 410	484 500	+ 0.4
– low-pressure networks	142 020	157 816	158 000	+ 0.1
– medium-pressure networks	171 654	202 983	204 000	+ 0.5
– high-pressure networks	105 619	121 611	122 500	+ 0.7
Underground storage facilities				
– Number	47	49	47	–
– Capacity (million m^3)	20 272	24 269	23 078	– 4.9

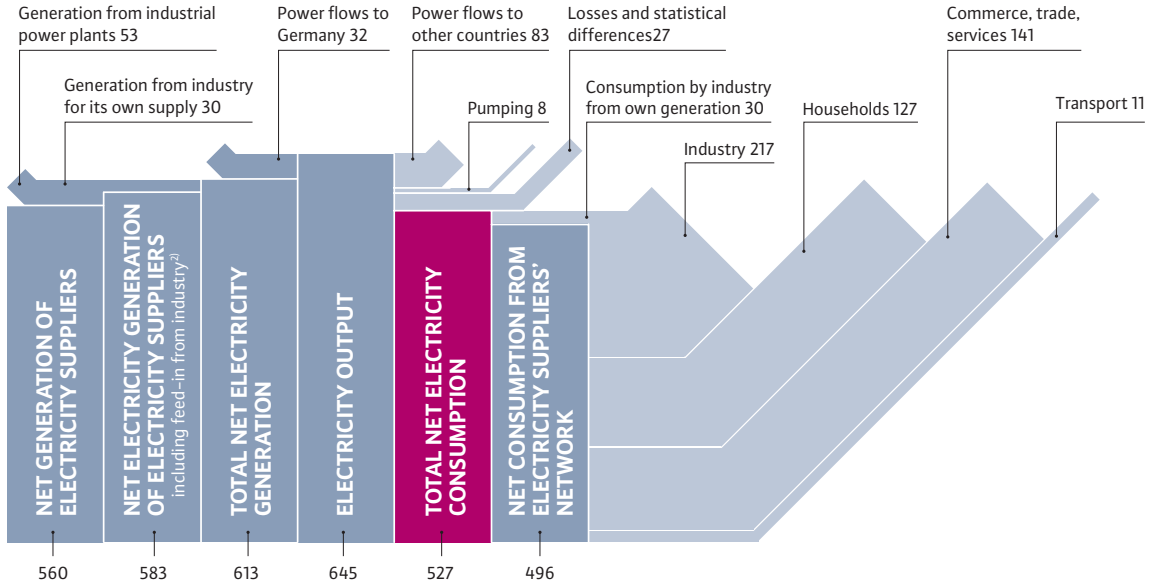
Sources: DESTATIS, BVEG, dena, LBEG, BDEW

1) Preliminary figures 2) Excl. VAT 3) from 2018, incl. all transit

ELECTRICITY FLOW

From generation to consumption

Electricity flow in 2018[1] in (bn kWh)



Source: BDEW

1) Preliminary figures 2) Including transmission through the networks for general supply

KEY DATA – ELECTRICITY

The most important figures at a glance

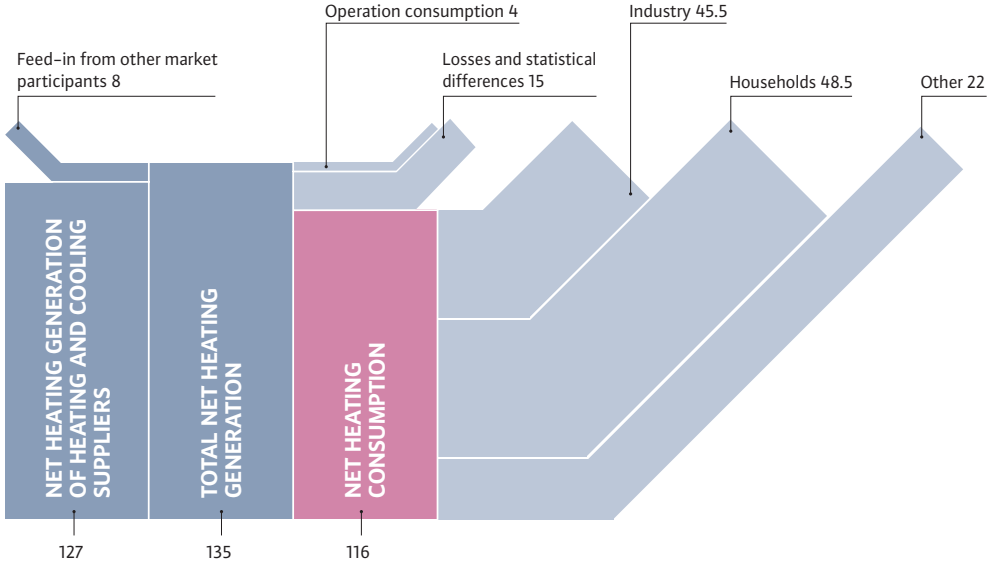
Electricity suppliers	2008	2017	2018[1)]	Change from previous year (per cent)
Employees (thousand)	132.3	132.5	135.0	+ 1.9
Revenue (€ bn) from electricity sales to end users[2)]	62.0	79.5	81.5	+ 2.5
Investment (€ bn)	7.8	11.3	9.1	– 19.5
Net capacity of power stations				
– total (GW)	149.5	216.0	219.7	+ 1.7
– general supply[3)] (GW)	139.0	205.3	209.0	+ 1.8
Net electricity generation				
– total (bn kWh)	601.1	619.1	613.1	– 1.0
– general supply[3)] (bn kWh)	555.5	566.3	559.8	– 1.1
Net eectricity consumption				
– total (bn kWh)	538.4	528.8	526.9	– 0.4
– general supply[3)] (bn kWh)	519.4	498.0	496.4	– 0.3
Physical flows (bn kWh)				
– from other countries	40.2	28.4	31.5	+ 11.0
– to other countries	62.7	83.4	82.7	– 0.8
– net balance of exchanges	– 22.4	– 55.0	– 51.2	–
Number of customers				
– Customers at tariff rates and those with special agreements (million)	44.7	45.5	45.5	+ 0.1
– Customers with special rates (million)	0.33	0.34	0.34	+ 0.0
Circuit lengths (million km)	1.74	1.84	1.85	+ 0.7

Sources: DESTATIS, BNetzA, BDEW

1) Preliminary figures 2) Excl. VAT and electricity tax 3) Excl. industrial power plants, incl. decentralised small plants

DISTRICT HEATING FLOW
From generation to consumption

District heating flow in 2018[1] (bn kWh)



Sources: DESTATIS, BDEW

1) Preliminary figures

KEY DATA – HEATING

The most important figures at a glance

Cooling and heating suppliers	2008	2017	2018[1)]	Change from previous year (per cent)
Employees (thousand)	14.4	15.4	15.5	+ 0.1
Revenue (€ bn) from heating sales to end users[2)]	7.5	8.3	8.1	– 2.7
Investment (€ bn)	1.0	1.2	1.2	+ 1.7
Net max. heating output				
– total (GW)	59.0	74.0	74.1	+ 0.1
– general supply (GW)	56.1	71.4	71.5	+ 0.1
Heating network feed-in (bn kWh)	141.9	138.3	134.9	– 2.4
– from CHP (bn kWh)	98.7	94.5	96.5	+ 2.1
– from separate generation in heating/CHP plants (bn kWh)	34.1	36.4	30.7	– 15.6
– from other market participants (bn kWh)	9.1	7.4	7.7	+ 4.1
Net heating consumption (bn kWh)	120.8	121.3	115.9	– 4.5
Number of households supplied with district heating (million)	5.0	5.8	5.8	+ 1.2
Length of pipelines (thousand km)	19.1	24.4	24.8	+ 1.8

Sources: DESTATIS, BDEW

1) Preliminary figures 2) Excl. VAT

LENGTH OF NETWORKS

The development of the energy supply networks at a glance

Length of suppliers' networks (km)

	2008	2018[1)]
Gas network operators		
Low-pressure networks	142 020	158 000
Medium-pressure networks	171 654	204 000
High-pressure networks	105 619	122 500
Total length of pipes	**419 293**	**484 500**
Electricity network operators		
Low voltage	1 131 181	1 202 100
Medium voltage	506 771	524 600
High voltage	76 946	85 500
Extra-high voltage	35 709	36 800
Total length of circuits	**1 750 607**	**1 849 000**
Heating and cooling network operators		
Heating networks	19 840	24 700
Cooling networks	60	100
Total length of pipes	**19 900**	**24 800**

Source: BDEW

1) Preliminary figures

Pressure levels of the gas network:

Low-pressure: up to and including 100 millibars
Medium-pressure: from over 100 millibars up to and including 1 bar
High-pressure: above 1 bar

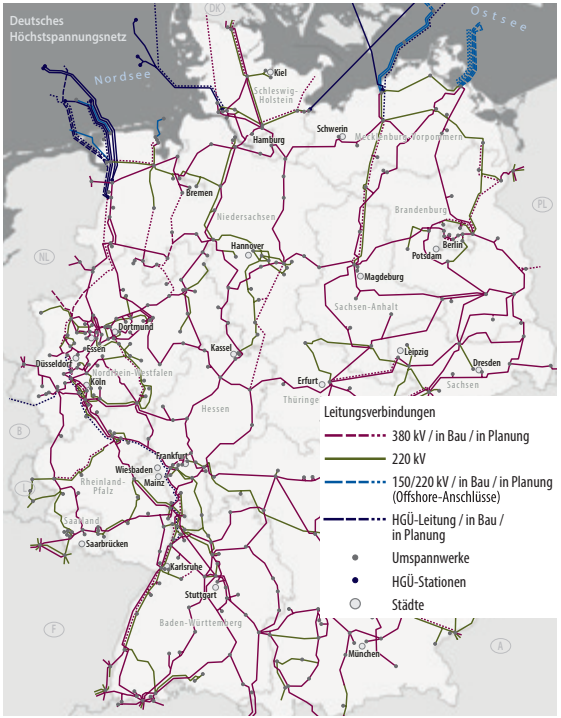
Voltage levels of the electricity network:

Low voltage: up to and including 1 kV
Medium voltage: from over 1 kV up to and including 72.5 kV
High voltage: from over 72.5 kV up to and including 125 kV
Extra-high voltage: over 125 kV

THE GERMAN EXTRA-HIGH VOLTAGE GRID

Grid development urgently required

Germany is served by a network of around 36 800 kilometers of extra-high voltage lines. This electricity network, operated at voltages of 220 and 380 kilovolts, forms the basis of a secure electricity supply. Further expansion is required in order to optimally integrate, in particular, the planned offshore and onshore wind farms and to ensure the transport of the electricity produced there to the centres of consumption. According to the German Federal Requirements Plan Act (Bundesbedarfsplangesetz, BBPIG), the intention is for the urgently required high-voltage direct current (HVDC) lines to transport electricity generated from wind power from the north to the centres of consumption in the south from 2025 onwards. However, numerous projects have been delayed by long planning and approval procedures or by already approved lines being called into question.

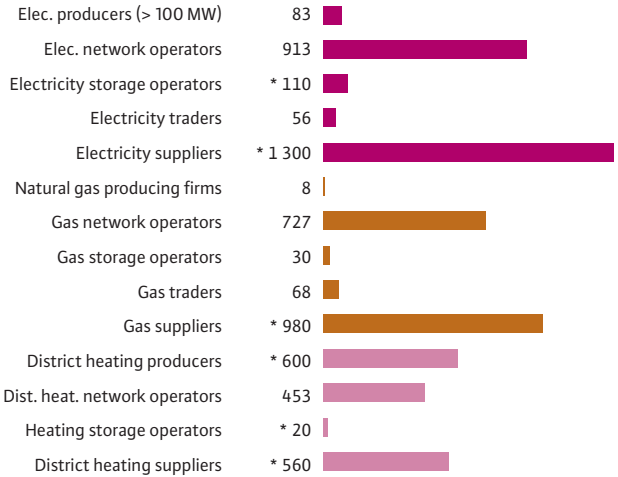


Source: VDE/FNN Status: 01/2018

UNIQUE DIVERSITY IN THE ENERGY MARKET

Around 2 200 companies involved in energy supply

Number of companies in the different market areas[1)]



1) Figures may not be summed as many of the companies are active in multiple sectors and at multiple levels of the value chain and have thus been recorded more than once; some figures rounded (*). In total, around 2 200 companies are active on the electricity/gas/district heating markets.

Sources: BDEW, BNetzA; Status: 03/2019

There is no other European country with as many energy supply companies as Germany. Alongside a number of major companies, there is a substantial number of small and medium-sized energy suppliers, the majority of which are in municipal ownership. Overall, they account for more than two thirds of all companies.

In total, there are around 2 200 companies active on the German energy market in 2019 – their fields of activity cover everything from the generation or production of electricity, heating and natural gas to the operation of energy storage facilities, power and pipeline networks and the supply to end-users on a local and regional level.

Despite many mergers, particularly at a regional level, the number of companies active in the German energy market today is considerably higher than prior to liberalisation in 1998. Suppliers mainly serving private customers are predominantly multi-utility companies who offer their customers a variety of product packages for natural gas, district heating, electricity and often also water.

SWITCHING SUPPLIERS ON THE ENERGY MARKET

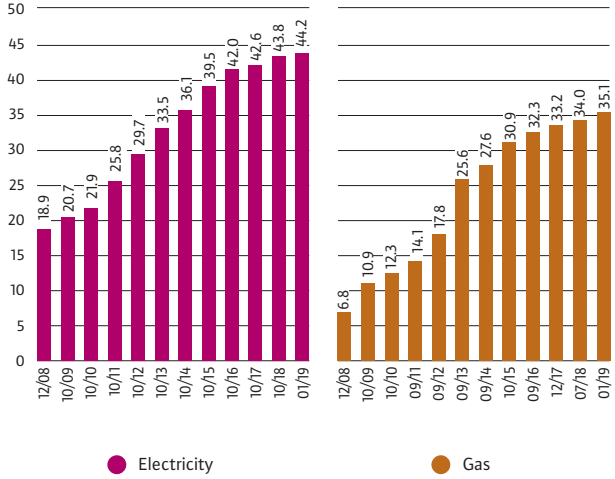
Cumulative rate of switching since liberalisation

Many new suppliers but also many established energy suppliers, now offer their products across multiple regions within Germany or even nationwide. This continues to contribute to slightly increasing year-on-year rates of switching. In this respect, since liberalisation of the market, over 44 per cent of all household customers had switched electricity supplier at least once by January 2019, with many of those switching multiple times.

Customers can usually choose from other options offered by their energy provider in addition to the general tariff. The range of products offered by the energy providers also often includes green energy tariffs. Therefore, in addition to switching to another supplier, there are many customers who switch to a lower cost tariff or to a green power tariff from their existing supplier.

Of the around ten million households who have a direct contractual agreement with their gas supplier, over 35 per cent have switched supplier at least once since liberalisation in 2007.

Switching of electricity and gas supply in homes (per cent)

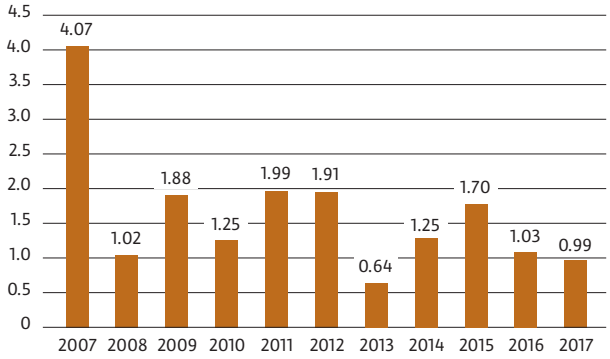


Sources: BDEW-Energietrends, BDEW-Kundenfokus; Status: 01/2019

RELIABILITY OF GAS SUPPLY

Secure supply with natural gas

Average duration of interruption of natural gas supply per customer per year (minutes)[1)]



Source: BNetzA; Status: 06/2018

1) Unplanned interruptions without exceptional events (force majeure)

For twelve years now, the BNetzA has been collecting annual data, in accordance with the German Energy Industry Act (Energiewirtschaftsgesetz, EnWG), from all gas distribution network operators regarding interruptions in supply. On the basis of this information, the SAIDI value (System Average Interruption Duration Index) – an average value across all end customers served – is determined. The SAIDI value reflects the average duration within a calendar year in which a customer is affected by an outage. All unplanned interruptions are included which are due to third party actions, reactions from other networks or other disruptions in the network operator's area.

In 2017, the SAIDI value was 0.99 minutes, which means that the supply of natural gas to German customers was interrupted on average for about one minute. As such, the reliability of the German gas supply remained at a very high level in 2017; the duration of interruption to the gas supply remained markedly below the multi-year median value of 1.7 minutes.

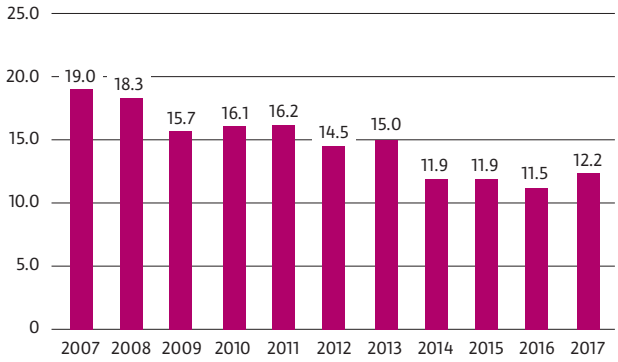
RELIABILITY OF EECTRICITY SUPPLY

Germany's electricity networks remain especially reliable

In 2017, the reliability of the German electricity grid was once more very high, with an average of just 12.2 minutes' interruption per customer. This is shown by the 2017 Disruption and Availability Statistical Report of the Forum Netztechnik/Netzbetrieb (Network Technology/Network Operation Forum) within the VDE (German Association for Electrical, Electronic and Information Technologies) (VDE|FNN). The key international standard indicator for the reliability of supply is the annual non-availability per electricity customer excluding interruptions due to force majeure. The extremely high level of reliability of supply in Germany must be viewed in light of a rapidly growing number of redispatch measures. This refers to short-term, unplanned interventions of network operators.

If electricity outages caused by force majeure are included – such as, in particular, adverse weather – the average annual interruption duration per electricity customer in 2017 was 20.0 minutes (2016: 12.1 minutes).

Average unavailability of the electricity supply per customer per year (minutes)



Source: VDE|FNN; Status: 02/2019

SECTOR COUPLING
Linking sectors and infrastructures

Key factors for sector coupling

Sector coupling is more than the electrification of heating and transport. BDEW sees sector coupling as referring to the linking of electricity, heating, mobility and industrial processes and their infrastructures in terms of energy technology and energy business. Sector coupling is a significant element within the implementation of the *Energiewende*:

- Integration of renewables
- Decarbonisation of all sectors
- Supporting security of supply

Specific examples of uses for sector coupling include heat pumps, power-to-gas (PtG) plants and power-to-heat (PtH) plants.

In Germany, there are currently over 35 PtG pilot and demonstration plants with an installed electrolysis capacity of between 100kwW and 6 MW, totally around 20MW. The hydrogen produced is either used directly or injected into the natural gas system. In some plants, there is an additional methanisation stage. The synthetic natural gas (SNG) produced can be injected without limitations into the gas network and used anywhere that normal natural gas is used.

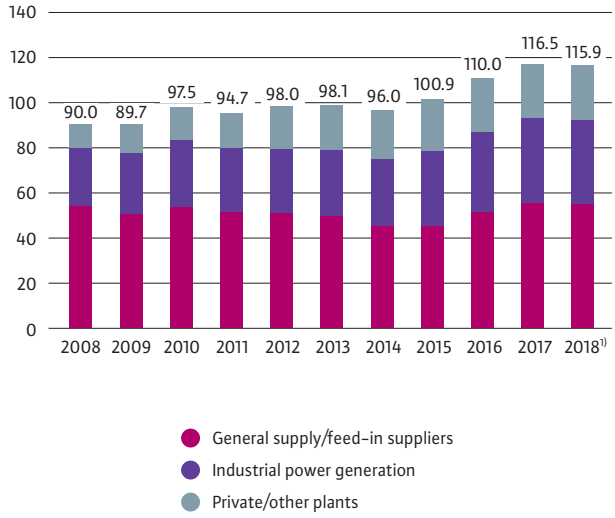
In addition, there are already 38 larger (> 2.5 MW) PtH plants with a total electrical capacity of around 640 MW across Germany today. The majority of those plants are integrated into CHP/heating network systems. Through the PtH module, they are then able to generate heating, for example from excess electricity from renewable energy sources. Shutting down the CHP plant whilst simultaneously starting up the PtH plant relieves the electricity grid and can avoid wind energy plants having to be disconnected. Excess heating can be “accommodated” in heating storage facilities and used later to supply district heating customers. This type of sector coupling makes an important contribution to the integration of electricity from renewables into the heating sector and thus to the environmentally friendly heating of buildings.

COMBINED HEAT AND POWER

Important component of the *Energiewende*

Combined heat and power (CHP) installations generate electricity and heating simultaneously. Aside from the smaller installations, most are integrated into a system comprising heating network, heating storage facilities and increasingly also power-to-heat installations. These flexible "heating network systems" supply many customers with heating while also making an important contribution to the security of supply and system security. In 2018, electricity generation from CHP plants in Germany was around 115.9 bn kWh. That meant that the volume of electricity from CHP fell slightly by 0.5% in comparison to 2017. CHP thus accounted for an 18.9 per cent share of net electricity generation. According to forecasts from the transmission system operators, operators of the installations claimed subsidies under the German CHP Act (*Kraft-Wärme-Kopplungsgesetz, KWKG*) for 38.9 bn kWh in 2018. The volume of electricity subsidised under the German KWKG thus decreased by almost 8.7 bn kWh compared to 2017. This can be attributed to several factors. Firstly, temperatures started to rise significantly as early as April 2018 and the summer-like temperatures continued as late as October, reducing the demand for district heating for building heating purposes and thus also reducing the operating times for CHP installations. Secondly, the expansion of CHP above the 250 kW level came to an almost complete standstill in 2018. A reform of the KWKG is intended to counteract that effect in the near future.

CHP electricity generation in Germany (bn kWh)



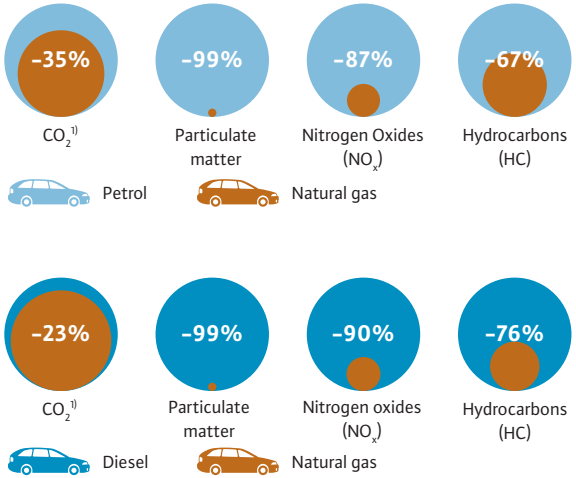
Sources: DESTATIS, AGEB, BDEW; Status: 02/2019

1) Preliminary figures

NATURAL GAS MOBILITY

Natural gas vehicles with almost zero particulate matter

Reduction in emissions – natural gas compared to petrol and diesel (Euro 6)



1) Taking into account the current biomethane share of 20 %
(see 3rd Interim Report of the 2015 dena Initiative for Natural Gas Mobility)

Source: Own representation from IAV data, 10/2015:
Euro 6 emissions standards, comparison using VW T5 CNG 2.0l

Road traffic causes almost 20 per cent of the greenhouse gas emissions in Germany. Alternative fuels could make a substantial contribution to reducing the emission of greenhouse gases and other pollutants (SO_2, NO_x, particulate matter). Natural gas and biomethane are important components of the future fuel mix. This can be seen, in particular, in the bottom line reduction in CO_2 emissions of around 25 per cent in comparison to petrol. If pure biomethane is used, CO_2 emissions can even be reduced by up to 97 per cent. Natural gas vehicles emit as good as no particulate matter.

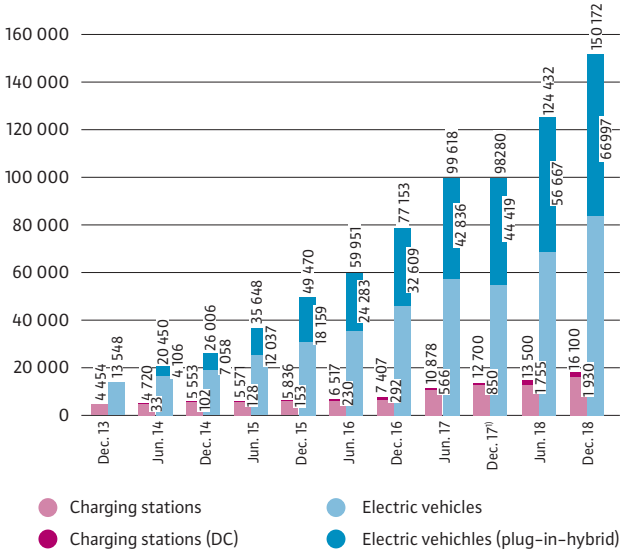
Today, 100 per cent biomethane is available at 102 natural gas filling stations. In addition, biomethane is added to the mix at many of the around 850 natural gas pumps in Germany.

As far as the number of natural gas vehicles on the roads, there was an increase of 5.3 per cent to a total of almost 96 531 vehicles of which 80 826 were gas powered cars.

The BDEW data collection on the status of the charging infrastructure recorded that 13 500 public charging points existed as of 30 June 2018 of which 1 755 were rapid charging points. As at 31 December 2018, there were 16 100 charging points in the Charging Station Register of which 1 930 were fast charging points. That represented an increase of just over 16 per cent and 10 per cent respectively. The leading cities in terms of the development of the public charging infrastructure are Hamburg (834), Berlin (779) and Munich (696). They are followed by Stuttgart (382), Düsseldorf (211) and Leipzig (168). Comparing German Länder, one finds that Bavaria (3 618) is in front, with North Rhine-Westphalia (2 739) and Baden-Württemberg (2 525) just behind.

According to the German Federal Motor Transport Authority (Kraftfahrtbundesamt), as of 1 January 2019, there were 83 175 purely battery-powered electric vehicles and 66 997 plug-in-hybrid vehicles registered in Germany (total: 150 172). That represents a year-on-year increase of 54.4 per cent and 50.8 per cent respectively. Statistically, that meant that the ratio of charging points to electric vehicles was one to almost nine, hence the current state of the charging infrastructure is adqeuate. In order to achieve the German Federal Government targets of one million electric vehicles and 100 000 charging points by 2020, a much steeper growth in the number of vehicles is needed to fully utilise the charging infrastructure.

Number of electric vehicles and publicly available charging points

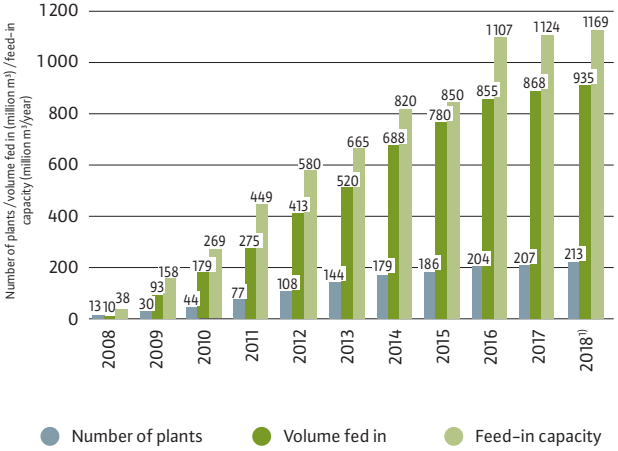


1) Due to the change in data collection in the BDEW Charging Station Register, the values for December 2017 can only be estimated.

Sources: BDEW Survey on Charging Infrastructure, number of registrations, KBA

BIOMETHANE
Renewable, storable and versatile

Feed-in capacities and volume of biomethane fed into the natural gas grid



Sources: dena, BDEW (own calculations); Status: 01/2019 1) Preliminary figures

As of December 2018, there were around 213 biomethane plants, with a capacity of around 1 169 million Nm³/a, injecting biomethane, upgraded to natural gas quality, into the natural gas grid. The injected volume of 935 million m³ (around 10 bn kWh) equates to just over one per cent of German natural gas consumption. More plants are currently under construction or at the planning stage.

Biomethane is the term for (raw) biogas which, after being cleaned and upgraded, has the same combustion properties as natural gas and can be injected into the natural gas network. It can be used for electricity production, in the heating market or as a fuel. Biomethane is renewable, storable and versatile.

In 2018, a total of 33 bn kWh of electricity was generated from biogas and biomethane, mostly from the around 9 200 plants with direct electricity generation. The electricity produced in this way supplied almost 5.5 per cent of gross electricity consumption. Together, biogas and biomethane provided around 16.7 bn kWh of heating and cooling in 2018. Natural gas vehicles consumed 0.5 bn kWh of biomethane last year.

SOURCES OF DISTRICT HEATING

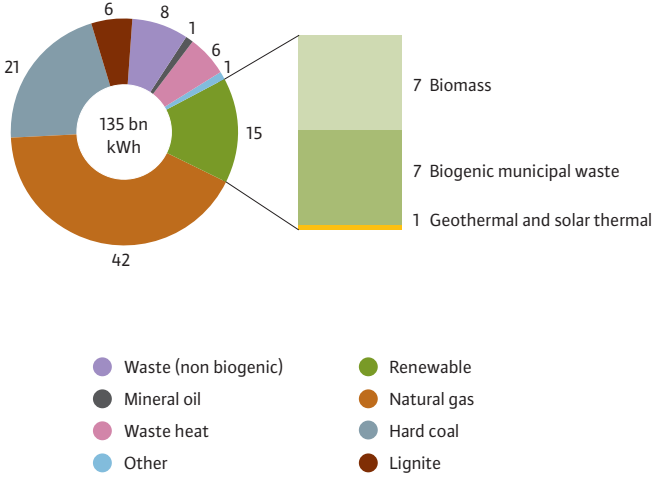
Natural gas out in front

In 2018, the net heating generation for grid-bound heating supply via the heating network systems in Germany was predicted to be around 135 bn kWh. At 57 bn kWh (42 per cent), the largest proportion of this local and district heating was generated from natural gas. Hard coal and lignite contributed 27 per cent (37 bn kWh) of the heating generated.

Heating from renewable energies, as the third largest source, accounted for a proportion of around 15 per cent or a volume of 21 bn kWh. In addition, biomass accounted for seven per cent (10 bn kWh) and biogenic municipal waste accounted for seven per cent (9 bn kWh). Heating from geothermal and solar thermal energy only played a minor role in grid-bound heating supply in 2018, at 0.8 bn kWh or 0.6 per cent.

Heating generation from non-biogenic waste totalled around 11 bn kWh (8 per cent) in 2018. The next largest proportion, at seven per cent and accounting for around 9 bn kWh, was waste heat recovery from industrial processes, from other market participants and external live steam recovery. The provision of heating from mineral oil only accounted for one per cent (1 bn kWh).

Net heating generation[1)] for grid-bound heating supply 2018[2)] (per cent)

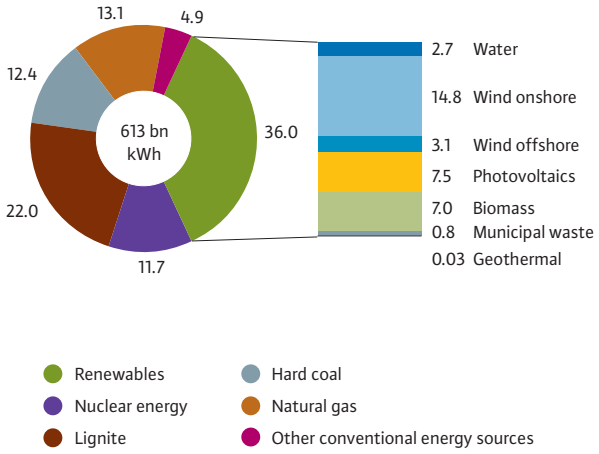


Sources: DESTATIS, BDEW; Status: 02/2019

1) Feed-in to heating network
2) Preliminary figures

ELECTRICITY GENERATION
Significant changes to energy mix

Net electricity generation 2018[1] (per cent)



Source: BDEW; Status: 03/2019

1) Preliminary figures

In 2018, (net) electricity generation in Germany amounted to 613 bn kWh. The largest proportion of that was supplied, as in previous years, from renewable energies.

The progress of the *Energiewende* is well illustrated by the hugely changed energy mix in electricity generation. The proportion of renewable energies has markedly increased over the last ten years, while electricity production from nuclear power is continuously decreasing due to the decision to phase out that energy source. The last of the seven electricity generating units will be taken offline at the end of 2022. Electricity generation from lignite and hard coal is similarly declining. In 2018, hard coal power plant units with a total capacity of 879 MW were closed. As of the end of the year, a further 1 973 MW of power plant capacity was in the lignite-standby pool.

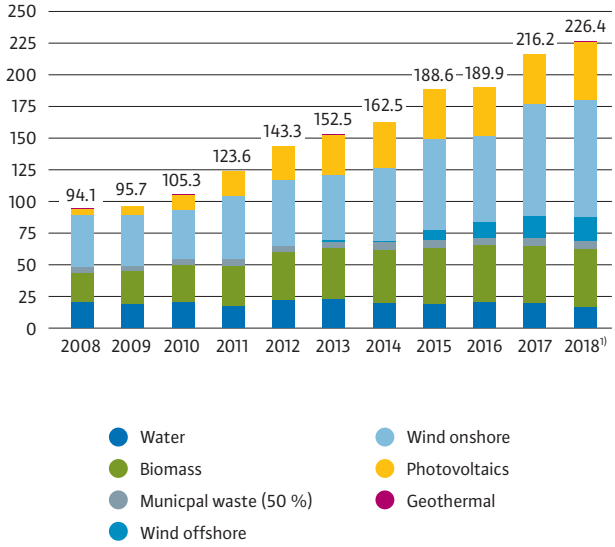
ELECTRICITY FROM RENEWABLE ENERGIES

Wind power provides the greenest electricity

In 2018, renewables-based electricity was already covering 38 per cent of German electricity demand. Wind and hydropower, biomass, municipal waste and photovoltaics delivered a gross figure of around 226 bn kWh of electricity. The payment guaranteed by the government for electricity generated from renewable energies was one of the reasons why green electricity generation has seen a more than 140 per cent increase over the past ten years.

Onshore and offshore wind power plants produced almost 112 bn kWh in 2018; this was almost three times the level of 2008. Electricity generation from biogenic energy sources (including the renewable share of waste) amounted to almost 52 bn kWh, hydropower plants delivered 17 bn kWh. Photovoltaic plants contributed 46 bn kWh to electricity generation in Germany. The first German power station using geothermal energy was commissioned in 2004. In 2018, 0.2 bn kWh came from this renewable source of energy.

Electricity generation by energy source (bn kWh)



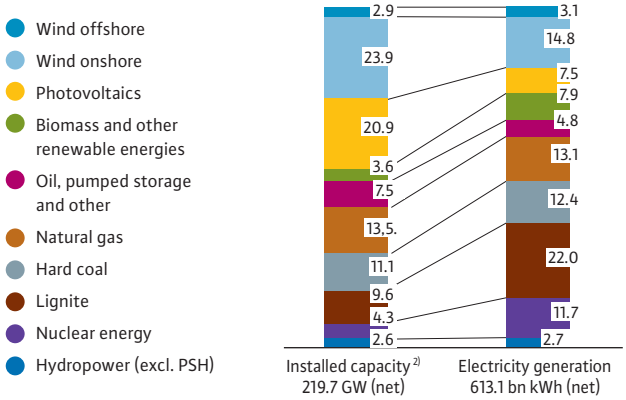
Sources: ZSW, BDEW; Status: 02/2019

1) Preliminary figures

CAPACITY AND GENERATION 2018

Not all power plants are the same

Installed capacity and generation of the overall electricity industry 2018 (per cent)[1)]



Source: BDEW; Status 03/2019

1) Preliminary figures
2) Installed capacity as at 31/12/2018

For reasons of cost, efficiency and availability, power plants are deployed for electricity generation in different ways. Nuclear and lignite-fired power stations currently generate, in the base load – i.e. electricity demand which remains constant around the clock – just over one third of the electricity in Germany. However, as a proportion of total installed capacity, such plants only make up just under 14 per cent of the generation fleet as they are characterised by a long utilisation period and a high rate of availability.

Generation from wind and solar is determined by fluctuating wind conditions and number of hours of sunshine. Photovoltaic energy contributes nearly 8 per cent to electricity generation, but accounts for 21 per cent of installed capacity. For periods when the sun is not shining or the wind is not blowing, appropriate capacity has to be available in reserve in plants which can be used in a plannable manner. In order to meet demand during short-term peaks in electricity consumption, or to compensate for rapid fluctuations in feed-in from renewable energies, gas-turbine power plants, heating oil power plants and pumped storage power plants are added. They are deployed less frequently but are essential in order to provide the volume of electricity demanded at any time.

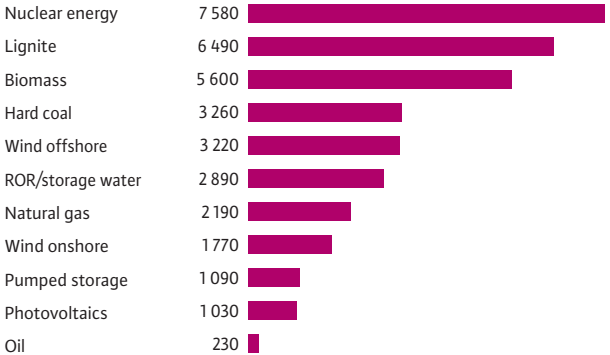
OPERATION OF POWER PLANTS

Nuclear energy has the highest capacity utilisation

The usage of the German electricity industry's power stations differs widely. Nuclear power stations, together with lignite-fired power stations, biomass plants and run-of-river power plants generate electricity for consumers almost around the clock. During the day, hard coal and natural gas-fired power stations are deployed to meet any additional demand. Oil-fired plants, storage facilities and pumped storage plants are normally only used to cover peaks in demand.

In addition, wind and photovoltaic installations today generate considerable volumes of electricity. Their capacity is, however, not available at all times. Their deployment depends on weather conditions and therefore cannot be scheduled in advance. Furthermore, their location plays a role: wind plants in coastal regions, for example, are usually utilised to a greater extent than those further inland. In order to demonstrate the large differences within the generating fleet, the "annual full load hours" are calculated. They show how many of the 8 760 hours of each year a power plant would have to be operated at maximum capacity to generate its annual output. The actual annual period of utilisation is usually higher as power plants are not always operated at full capacity.

Annual full load hours[1)2)] 2018
General supply



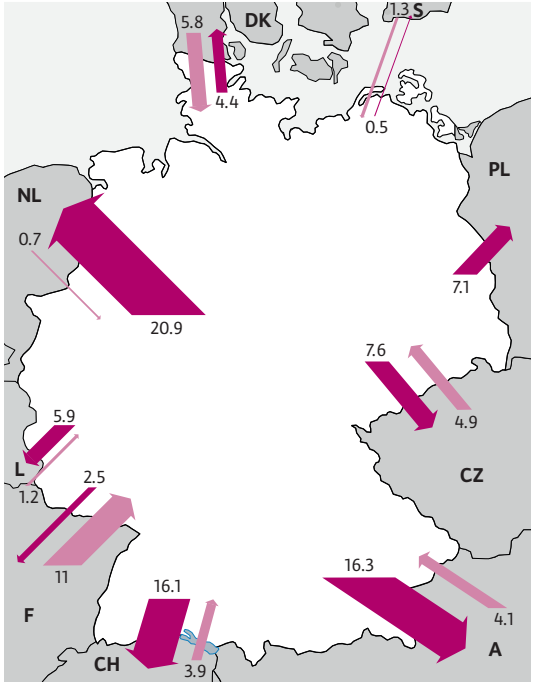
1) Preliminary figures
2) Significant changes in capacity during the period duly taken into account

Source: BDEW; Status: 03/2019

ELECTRICITY EXCHANGE WITH OTHER COUNTRIES

Germany is the European hub for electricity

Physical electricity exchanges between Germany and its neighbouring countries in 2018 (bn kWh)



With its central location in Europe, Germany is the hub for European electricity flows, directly exchanging electricity with nine neighbouring countries. A major part of these cross-border flows does not constitute contractually agreed deliveries but transit quantities and loop flows.

- Exports 82.7 bn kWh
- Imports 31.5 bn kWh

Source: BDEW; Status: 02/2019

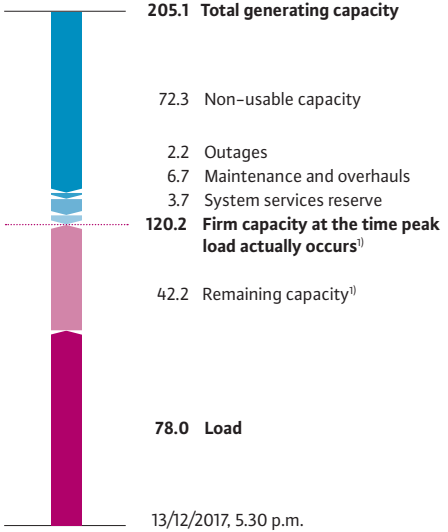
PEAK ELECTRICITY DEMAND

Consumer demand to be met by power stations

In 2017, the peak of electricity demand from consumers and thus the greatest challenge for power stations occurred on 13 December at 5:30 p.m. A proportion of the generating capacity is not available at all times. Reasons for this can include low water flow, lack of wind, little or no sunshine, the daily limits of electricity storage facilities, district heat extraction leading to a reduction of output or regulations imposed by public authorities.

At the time of the 2017 annual peak load, the remaining capacity was still relatively high as a relatively large volume of wind power was being fed-in at that time and conventional power plants were needed to a lesser degree. That is not always the case, however: in times of very cold weather, low wind levels and high electricity demand – as can be quite normal during the winter – the peak load would have been 81.6 GW and the firm capacity only 84.5 GW as then it would almost exclusively be conventional power stations available to meet the electricity demand.

Power balance of general electricity supply in Germany at the time of the 2017 annual peak load (GW)



1) Incl. grid reserve power plants/stand-by backup

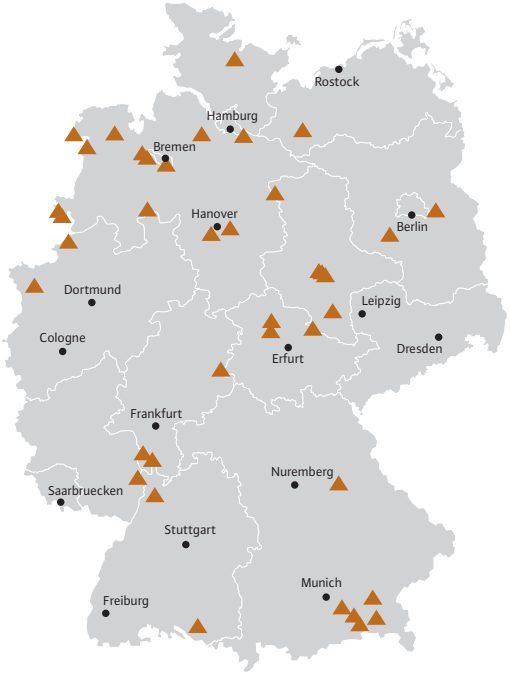
All capacity values are net values; rounding differences possible.

Source: Transmission network operators; Status: 01/2019

GAS STORAGE FACILITIES IN GERMANY

Secure natural gas supply

Locations of German underground natural gas storage



Sources: LBEG, BDEW; Status: 03/2019

The 47 German underground gas storage facilities, across 38 locations can store just over 23 bn m³ of working gas. This corresponds to around a quarter of the volume of natural gas consumed in Germany in 2018. The German gas industry thus has the largest storage volume in the European Union.

GAS SALES

Industry is the largest consumer of natural gas

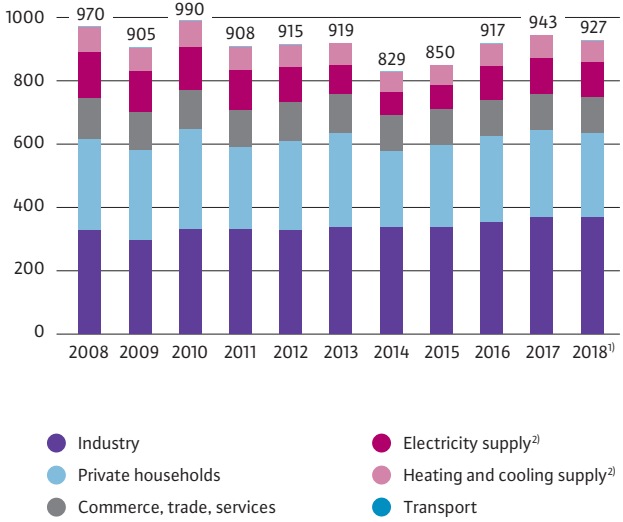
Natural gas sales in Germany amounted to 927 bn kWh in 2018. Industrial companies continue to account for the largest share, at 40 per cent. The proportion accounted for by households, which can vary greatly from year to year depending on the weather conditions, was 29 per cent.

Compared to the previous year, natural gas sales decreased in 2018 by 1.6 per cent. The main causes were a reduced use for heating purposes due to the milder temperatures and the slight economic slowdown from the end of the third quarter.

The continued increase in the numbers of natural gas heating systems could not compensate for that development. At the end of 2018, a total of 20.7 million homes were equipped with gas heating. That represents almost half of all homes in Germany. On the new-build market, natural gas heating systems (including biomethane) were installed in just over 39 per cent of homes. Just as relevant is the growth in households supplied with district heating since in 2018 42 per cent of district heating is generated from natural gas.

The trend in the consumption of natural gas over the last ten years has been characterised by the economic crisis in 2008/2009, different weather conditions in the heating periods as well as political influences such as the 2016 KWKG-Amendment.

Natural gas sales in Germany over time (bn kWh)



Natural gas sales does not include the own consumption of the gas industry.

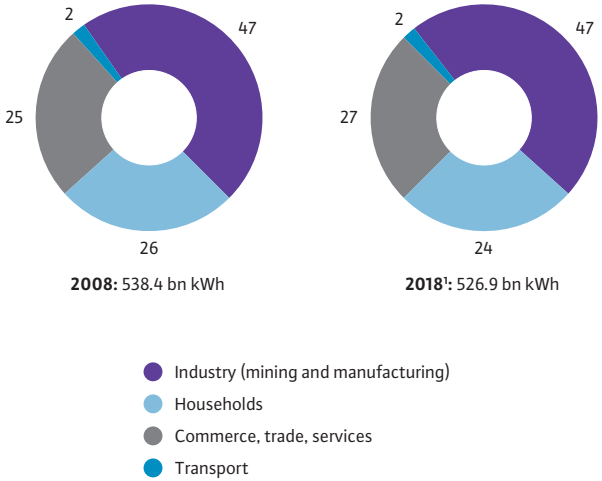
Source: BDEW; Status: 02/2019

1) Preliminary figures
2) Incl. CHP units < 1 MW

ELECTRICITY CONSUMPTION

Industry uses almost half of the electricity produced

Electricity consumption in Germany by consumer group 2008 and 2018[1)] (per cent)



2008: 538.4 bn kWh

2018[1)]: 526.9 bn kWh

Source: BDEW; Status: 02/2019

1) Preliminary figures

In 2018, net electricity consumption in Germany amounted to 527 bn kWh. It has been the case for years that industrial businesses have accounted for the highest proportion of electricity demand, at 47 per cent. The second largest proportion was from the sector commerce, trade and services (including agriculture). Almost a quarter of the electricity in 2018 was used by the just over 41 million households in Germany. As in the previous year, two per cent of consumption was accounted for by transport, which includes the operation of railways and electromobility.

Although electricity consumption in 2018 was just over 11 bn kWh below 2008 levels, the percentages accounted for by the individual groups of consumers have remained roughly stable over the past ten years, when looked at overall.

DISTRICT HEATING/COOLING SALES

Ever more households supplied with district heating

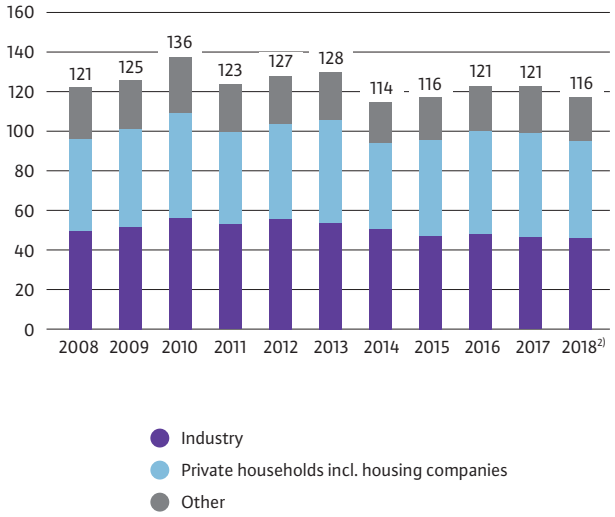
In 2018, grid-bound heating/cooling sales amounted to 116 bn kWh. 49 bn kWh of that was used by private households and for supplying residential buildings. Industrial consumers used 46 bn kWh of heating energy. The heating consumption of other consumers was around 22 bn kWh.

Whilst the proportion of district heating used by private households is strongly dependent on the weather and a steady construction of new homes heated by district heating, the proportion of consumption accounted for by commerce, trade, services and other consumers has remained more or less stable over time.

In private households, district heating is used for the most part for space heating. Heating consumption in industry tends to be more dependent on economic developments; manufacturing businesses tend to use district heating and cooling rather in industrial processes. In the commerce/trade/services sector, in addition to the use for space heating, use for the purpose of heating water and for other heating and cooling processes also plays a role.

In 2018, the number of households supplied by (district) heating networks was 5.8 million and as such 16 per cent higher than the number in 2008 (5.0 million).

District heating sales[1] in Germany over time (bn kWh)



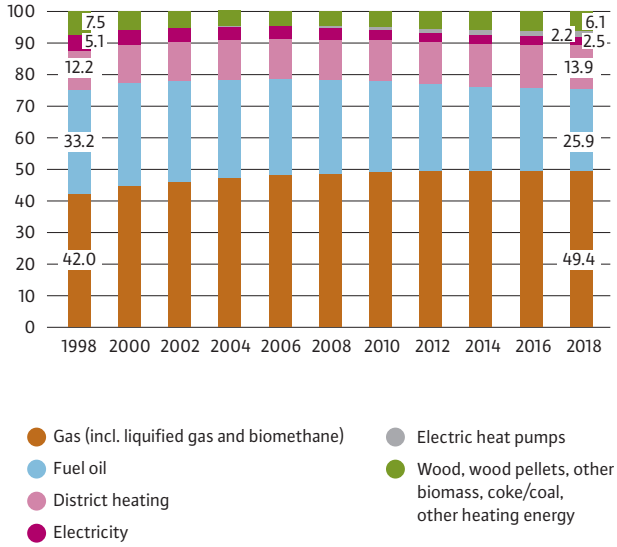
Sources: DESTATIS, BDEW; Status: 03/2019

1) Incl. district cooling
2) Preliminary figures

SPACE HEATING MARKET

Every second home is heated by natural gas

Heating systems in existing homes[1] in Germany by energy source over time (per cent)



Source: BDEW; Status: 01/2019

1) Number of homes in buildings with residential space; heating installed

The number of housing units heated by natural gas rose to 20.7 million in 2018. This corresponds to a market share of 49.4 per cent of the around 42 million homes. Nearly eleven million housing units (25.9 per cent) were heated by fuel oil. The share of housing units supplied with district heating rose to 13.9 per cent. Electricity was the energy source for heating in 2.5 per cent of dwellings.

The share of dwellings heated with electric heat pumps is climbing steadily (2.2 per cent). The share accounted for by other solid fuels (primarily wood and wood pellets) was unchanged at 6.1 per cent.

HEATING IN NEW-BUILD HOMES 2018

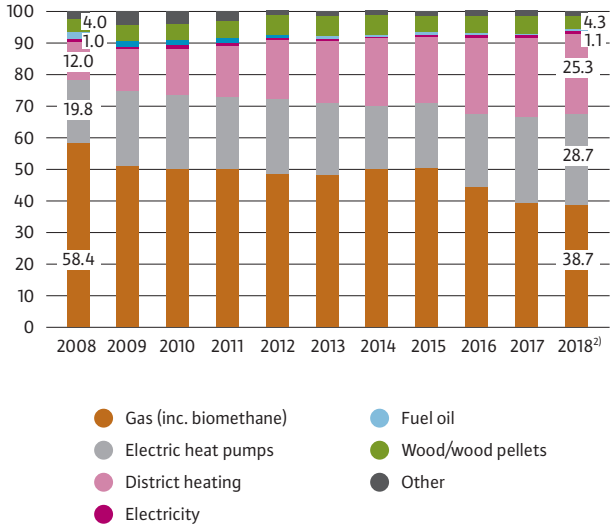
Natural gas remains most popular heating energy

In the new-build sector, natural gas (including biomethane) remains the most popular choice of heating energy. Natural gas heating systems were planned for nearly 39 per cent of new homes approved for construction in 2018. The proportion of planned new-builds to be heated with electric heat pumps is almost 29 per cent. Just over a quarter of planned homes are to be heated by way of district heating.

Electric heating is planned for one per cent of new homes for which permission has been granted. Wood and wood pellet heating systems have a market share of just over four per cent. Homes which are primarily heated with solar heating and passive houses account for just over one per cent. Heating oil accounted for a 0.5 per cent share of new builds in 2018.

In 2018, planning permission was granted for a total of around 302 800 new homes in new buildings to be constructed. Compared to 2017, that represents a rise of 0.8 per cent.

Heating systems in new builds[1] in Germany, proportions of energy sources over time (per cent)



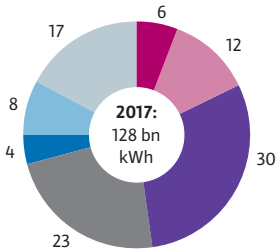
Sources: Statistical Offices of the German Laender, BDEW
Status: 03/2019

1) New-builds with planning consent; primary heating energy
2) Preliminary figures

ELECTRICITY CONSUMPTION OF HOUSEHOLDS

Nine per cent lower than 10 years ago

Electricity consumption by area of use (per cent)



- Heating
- Hot water heating
- Cooking, heating, ironing and other process heating
- Refrigeration and freezing appliances, other process cooling
- Mechanical household appliances
- Lighting
- Information and Communication

Source: AGEB; Status: 11/2018

Electronic entertainment devices and communications devices today account for a large share of electricity consumption in private households, namely 17 per cent.

Cooling and freezing appliances have become considerably more efficient in recent years. Currently, the proportion of energy used for cooling and freezing, as well as other process cooling applications, is 23 per cent.

The greatest share, however, is still accounted for by process heating. Included within this are all applications which require heat, such as induction hobs, tumble dryers and toasters but also hairdryers. The heating of water in washing machines and dishwashers is also covered.

At eight per cent, the proportion of electricity consumption accounted for by lighting is low. Today, LED lights in particular have established themselves as especially efficient and long-lasting alternatives.

Overall, despite the rising numbers of households, electricity consumption has fallen by nine per cent over the last ten years.

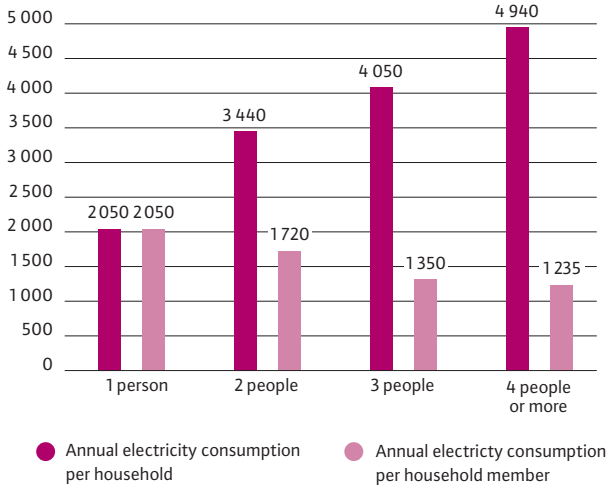
ELECTRICITY DEMAND FROM HOUSEHOLDS

Increasing number of one-person households raises electricity demand

Of the around 41.3 million German households, there are 17.3 million one-person households today, which amounts to 42 per cent. By way of comparison: in 1991 this figure was 34 per cent. The average household size shrank: in 1991, there was an average of 2.27 people per household compared to only 2.00 people in 2015. The rising number of people living alone increases the electricity consumption of German households. Someone living alone in Germany uses, on average, 2 050 kWh of electricity in a year. A two-person household uses around 3 440 kWh of electricity. The consumption per head is thus 1 720 kWh, a value which consistently decreases as the size of the household increases. For example, a family of three consumes an average of 4 050 kWh of electricity per year and a four-person household consumes 4 940 kWh.

These reference values can help households to identify potential savings in their own electricity use. It is important, however, also to consider regional differences. For example, households in the east of Germany use on average around 20 per cent less electricity than those in the west. The key reasons for this are a smaller average size of dwelling and lower numbers of electrical appliances and devices.

Electricity use[1)] per household by size of household on average



Sources: BDEW, HEA

1) Excluding heating in kWh

NATURL GAS IMPORT PRICES

Border prices in 2018 lower than ten years ago

**BAFA border prices for natural gas –
figure for first month in each quarter (cents/kWh)**

Source: BAFA; Status: 02/2019

The statistical average price of all imports by gas suppliers into Germany reached a peak level at the end of 2008. It fell continuously from 2012 to 2016. Since mid-2016, prices have been rising again slightly.

The main influences on the trend in prices are factors such as the worldwide demand for energy, especially in fast-growing economies like China or India, and the availability of unconventional natural gas, in particular in the USA.

The average values given here do not enable a direct conclusion to be drawn on the underlying contracts concluded between the natural gas importers and foreign natural gas producers. Different durations and conditions are stipulated in these contracts so that the import prices actually paid may, in some cases, deviate considerably from the average price.

NATURAL GAS PRICES FOR HOUSEHOLDS

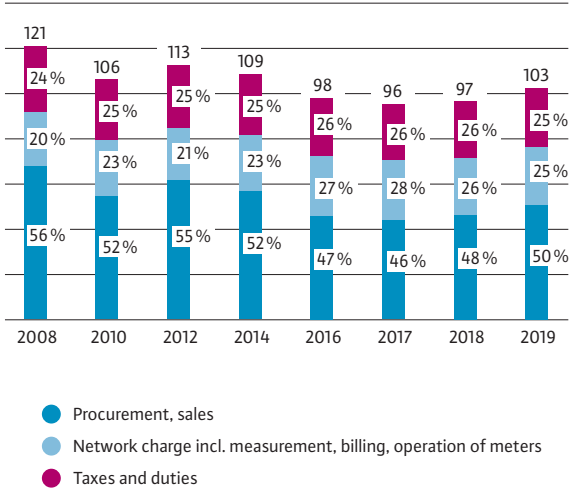
Remain at a low level

The natural gas price for households has risen in the past year by 6 per cent, primarily due to the increased cost of gas for suppliers, however it remains over 15 per cent lower than 2008 levels. A household that was paying over 120 euros per month for a single-family home with natural gas heating then, pays only around 103 euros today.

Within that bill, natural gas procurement and sales now account for half of the sum. Network charges, taxes and duties each account for a quarter of the natural gas price.

The largest element within the taxes and duties is value added tax, at just over 16 euros per month. In addition, there is natural gas tax (0.55 cents per kWh) at just over 9 euros per month as well as the concession fee at 50 cents per month. Heating gas customers are generally special-rate customers. Therefore, they only have to pay the reduced concession fee in the amount of 0.03 cents per kWh.

Average monthly bill for a single family household (euros)
Single family house, natural gas central heating with hot water heating, annual consumption 20 000 kWh

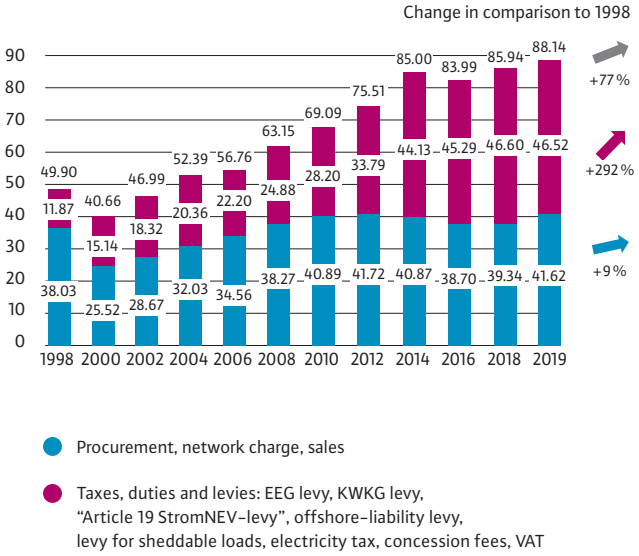


Source: BDEW; Status: 01/2019

ELECTRICITY PRICES FOR HOUSEHOLDS

53 per cent are taxes, duties and levies

Average electricity bill for a household with an annual consumption of 3 500 kWh (euros)



Source: BDEW; Status: 01/2019

In 2019, an average household pays just over 88 euros per month for electricity. This represents an increase of 2.6 per cent year on year. The pure electricity price – before taxes, duties and levies – is almost 42 euros per month and is only slightly higher than 1998 levels. Around 20 euros of that amount is for electricity procurement and sales, almost 22 euros is for network charges.

The state charges remained approximately unchanged in 2018. The EEG-levy continues to represent the largest proportion of such charges, at 6.41 cents per kWh. Since 1998, the monthly amount paid by the average household for taxes, duties and levies has increased from 12 euros to almost 47 euros, meaning it has almost quadrupled. These governmental charges currently account for 53 per cent of the electricity bill of an average household (1998: 24 per cent).

ELECTRICITY PRICES FOR INDUSTRY

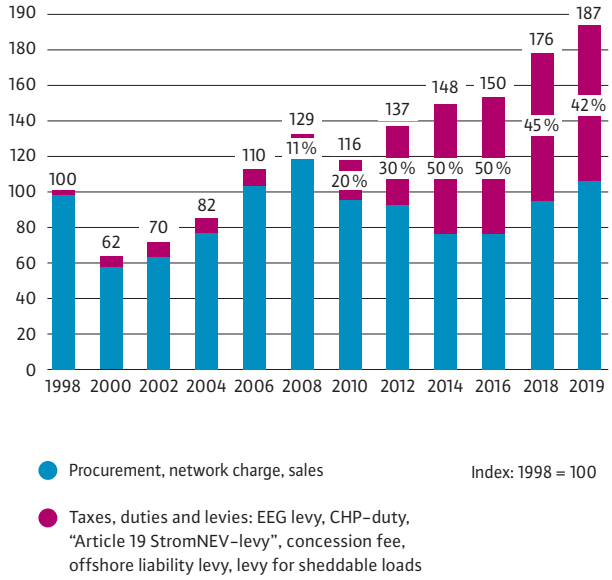
Taxes, duties and levies remain high

The liberalisation of the German electricity market in 1998 triggered a drive towards optimisation and efficiency in the electricity industry and initially led to a Germany-wide price reduction.

However, the growth in worldwide energy demand led to a considerable price increase up to autumn 2008. As a result of the economic crisis in 2009, electricity prices for industrial customers initially fell. However, the downward trend in prices was countered by the rise in burdens imposed by the state: the taxes and duties on one kilowatt hour of electricity for an industrial business under the EEG, KWKG, the levy under Article 19 of the Network Charges Ordinance ("Article 19 StromNEV-levy"), the offshore network levy, the concession fee and the levy for sheddable loads remained high in 2019 at around 7.4 cents per kWh. Their share of the industrial electricity price has fallen to 42 per cent, however it remains far higher than in the first ten years after liberalisation.

In addition, there is an electricity tax, although this is partly reimbursed to industrial enterprises.

Trend in industry electricity prices[1)]



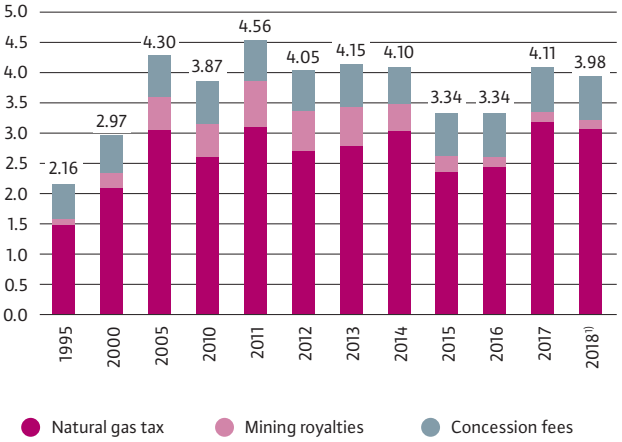
Sources: VEA, BDEW; Status: 01/2019

1) Supply from the medium-voltage level, not incl. electricity tax and turnover tax

TAXES AND DUTIES ON NATURAL GAS

State charges amount to almost 4 bn euros

Fiscal burden on natural gas in Germany (bn euros)



Sources: BDEW, BMF, BVEG; Status: 04/2019

1) Preliminary figures

State revenues from taxes and levies on natural gas increased considerably after 2000, amounting to over four billion euros in past years. However, in 2015 and 2016, federal tax revenues from the energy tax on natural gas, as well as from mining royalties experienced a temporary decline before reaching the four billion euro mark again in 2017 and 2018. The gradual increasing of the natural gas tax since 1999 in the course of the introduction of the eco-tax has led to a steady rise in the state burden imposed on the fuel, natural gas, for consumers.

Since early 1999, the natural gas tax rate has trebled from 0.18 cents per kWh to its current level of 0.55. As a result, revenues from the natural gas tax have considerably increased. Whilst revenues from concession fees have remained largely stable for many years now, receipts from the mining royalty for the production of natural gas have been falling since 2012 as a result of decreasing domestic gas production.

TAXES, DUTIES AND LEVIES ON ELECTRICITY

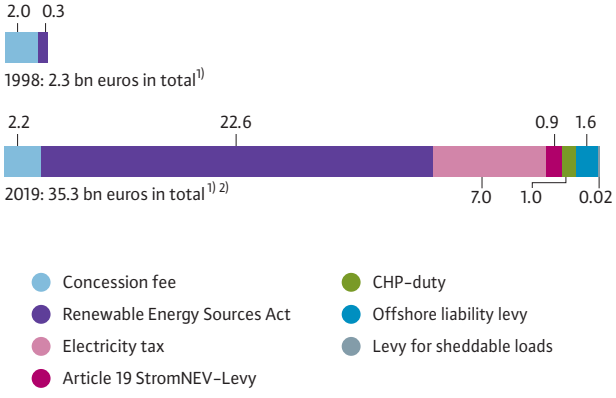
15-fold increase in charges on electricity prices

The government also earns revenues from electricity sales: in the past few years, taxes, duties and levies on the price of electricity have considerably increased. Since 1998 – the beginning of competition with massive price reductions – the burden of taxes, duties and levies for all electricity customers (including commerce, trade, services, industry and households) has increased fifteen fold. In 2019, it is predicted that consumers will pay more than 35 bn euros for electricity taxes, duties and levies.

The largest single factor is the subsidisation of renewable energies, which will cost electricity customers almost 23 bn euros in 2019 (see p. 44). In addition to that, there is the electricity tax, totalling seven bn euros. The concession fee will be just over two bn euros. The simultaneous, environmentally friendly generation of electricity and heating is subsidised by the government through the KWKG. Costs to the consumer were around one bn euros.

The Article 19 StromNEV-levy, with which network fee exemptions are financed, amounts to almost 0.9 bn euros. The offshore network levy will be almost 1.6 bn euros in 2019, the levy for sheddable loads 24 million euros. The value added tax revenues from electricity sales in the amount of around eight bn euros are not shown.

Extra charges imposed by the government on electricity prices in 1998 and 2019 (bn euros)



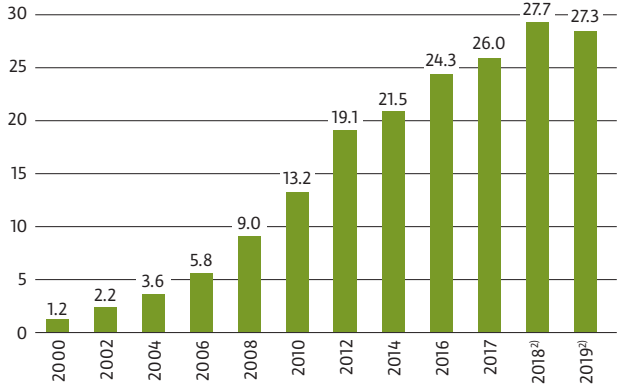
Source: BDEW; Status: 01/2019

1) Excl. VAT
2) Rounding differences

PROMOTION OF RENEWABLE ENERGIES

Renewable Energy Sources Act: 2019 forecast 27.3 bn euros

Payments to plant operators[1] under the Renewable Energy Sources Act (EEG) over time (bn euros)



1) Payment under the EEG, remunerated PV own consumption, market premium and flexibility premium
2) As per EEG forecast

Sources: BDEW and publications of transmission system operators
Status: 04/2019

The total annual payments to power plant operators under the EEG increased more than twenty fold, from 1.2 bn euros to 27.7 bn euros between 2000 and 2018. In 2019, it is estimated that total payments will amount to around 27.3 bn euros*. 37 per cent of that sum goes to operators of photovoltaic installations, with payments totalling 10.2 bn euros. The next largest proportion goes to biomass, for which a quarter of payments are allocated. Background: the legislator promotes the generation of electricity from renewable energies under the EEG. The producers are guaranteed a purchase price which is usually above the market price. The difference between the purchase price and the market price is paid, in the form of the EEG levy, by the consumer through their electricity bill. The rest is covered by the marketing of EEG electricity on the electricity exchange. The additional costs for consumers will, according to the EEG forecasts of the transmission network operators, amount to almost 23 billion euros.

* The difference between the sum which consumers contribute through the EEG-levy in 2019 (see p. 43), and the sum of the payments to EEG plant operators comes from market revenues, the offsetting of liquidity reserves and reimbursements from 2018 etc.

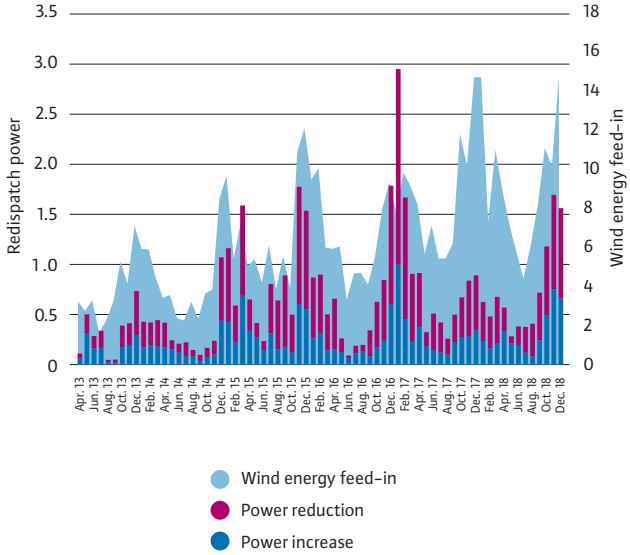
REDISPATCH IN GERMANY

Feed-in of wind energy not the only driving factor

Redispatch refers to intervention, requested by a transmission system operator, in the market based schedules of the power plants in order to shift feed-in and prevent power overloads in the electricity grid (preventive redispatch) or remedy them (corrective redispatch). In this process, the feed-in of electricity is reduced "in front of" a bottleneck (negative redispatch) and increased "after" a bottleneck (positive redispatch). In order to counteract bottlenecks in the electricity network, it is not the volume of electricity fed in which is altered but merely its regional distribution.

The trend in redispatch volumes is underscored by its increase over recent years. In this context, the redispatch volume increased from approx. 3 bn kWh in 2013 to approx. 9.3 bn kWh in 2018. Especially in the winter months, there is a high usage of redispatch measures. Extreme peaks occurred, for example, in December 2016 and January 2017. In comparison to the year with the most redispatch interventions so far, 2017, the total volume of redispatch has fallen. That resulted from, among other things, the South-West Interconnector coming online at the end of 2017, the installation of phase shifters at certain points and the optimisation of redispatch processes.

Redispatch and wind energy feed-in (bn kWh)

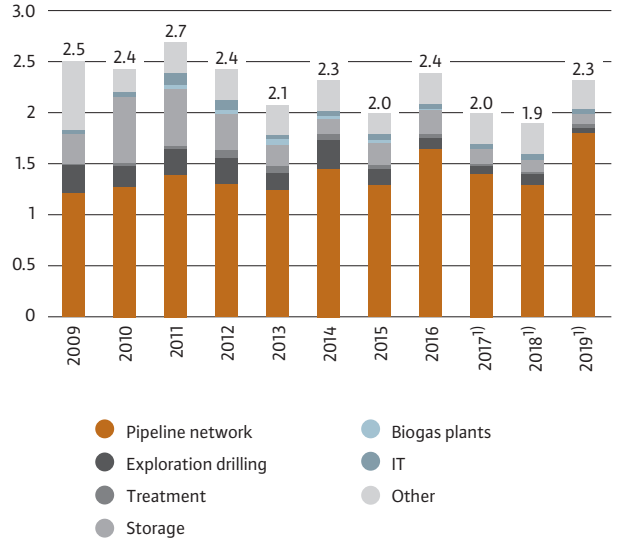


Source: BDEW; Status: 03/2019

INVESTMENT OF THE GAS INDUSTRY

Billions in investment for security of supply

Investment by the German gas industry (bn euros)



Source: BDEW; Status: 03/2019

1) Planned

On average, annual investment in the German gas industry amounts to just over two billion euros. Around two thirds of the total investment is spent on the expansion and maintenance of the pipeline network. The remaining proportion is used for exploration drilling, gas treatment, gas storage and other applications.

An increase in investment has been seen since 2009. The underlying reasons for this were plans for sizeable investments in the construction of gas pipelines, in particular to connect the German pipeline network to international pipelines as well as to expand the underground storage facilities in Germany in order to improve the security of gas supply.

INVESTMENT OF THE ELECTRICITY INDUSTRY

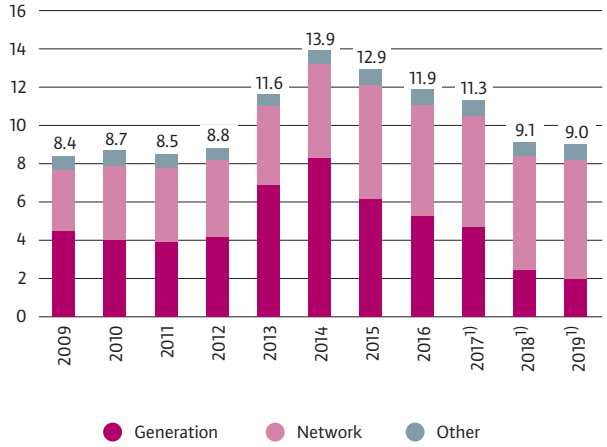
On average, 12 billion euros every year since 2013

The electricity industry is among the most significant investors in Germany. With billions in annual investment, the industry makes an important contribution to the attractiveness of Germany as an industrial location, especially due to the high degree of security of supply in comparison to other European countries.

The investment in plants by the companies within the electricity industry in Germany is currently at a high level. Considerably more money is being invested now than was the case ten years ago. In the years from 2013 to 2017, German electricity suppliers made on average 12 billion euros of investment every year.

The conditions for investment are becoming ever more difficult due to harsher economic conditions and acceptance problems for major projects among the population. Lengthy planning and approval procedures have a further inhibiting effect on investment.

Investment by German electricity suppliers (bn euros)



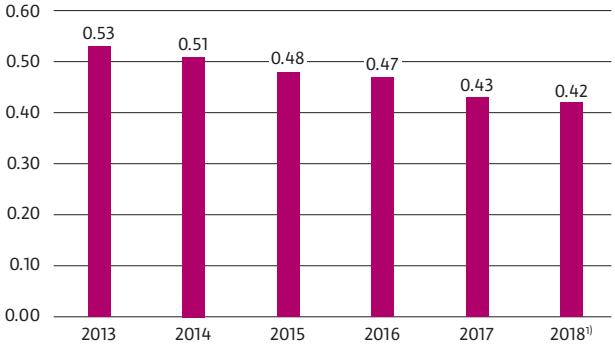
Source: BDEW; Status: 03/2019

1) Planned

CLIMATE RELEVANT CO_2 EMISSIONS OF ELECTRICITY GENERATION PLANTS

CO_2 emissions fall further

Specific CO_2 emissions of the general electricity supply (kg CO_2 per kWh net)



Source: BDEW; Status: 03/2019

1) Preliminary figures

The specific net CO_2 emissions from electricity generation from general supply power plants fell, according to BDEW's calculations, in 2018 compared to the previous year by four per cent to 0.42 CO_2 per kWh. The reduction has been driven primarily by the expansion of renewable energies along with a simultaneous reduction of electricity generated from hard coal and to a lesser extent also from lignite.

For the energy industry as a whole, 2018 figures revealed, in the sectoral breakdown of the Federal Government's climate protection plan according to information from the German Federal Environment Ministry, a reduction in greenhouse gas emissions by 33 per cent compared to 1990.

Power

1 kW	=	1 kilowatt	=	1 000 Watt
1 MW	=	1 megawatt	=	1 000 kW
1 GW	=	1 gigawatt	=	1 000 MW

Energy (legal unit)

1 J	=	1 joule		
1 MJ	=	1 megajoule		
1 PJ	=	1 petajoule	=	1 quadrillion J

Energy (normally used in the energy sector)

1 kWh	=	1 kilowatt hour	= 1 000 Wh	= 3.6 MJ
1 MWh	=	1 megawatt hour	= 1 000 kWh	
1 GWh	=	1 gigawatt hour	= 1 000 MWh	= 1 million kWh
1 TWh	=	1 terawatt hour	= 1 000 GWh	= 1 billion kWh

Weight

1 kg	=	1 kilogram		
1 t	=	1 ton	=	1 000 kg

1 m^3	= 1 cubic metre
1 Nm^3	= 1 normal cubic metre
k	= thousand
m	= million
bn	= billion

CO_2	= carbon dioxide
NO_x	= nitrogen oxides
SO_2	= sulphur dioxide

Laws

EEG	Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz = German Renewable Energy Sources Act)
KWKG	Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung (Kraft-Wärme-Kopplungsgesetz = German Combined Heat and Power Act)

EXPLANATORY NOTES
Units of measurement and abbreviations

AGEB	Arbeitsgemeinschaft Energiebilanzen e. V. (Working Group on Energy Balances)
BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Office for Economic Affairs and Export Control)
BMF	Bundesministerium der Finanzen (Federal Ministry of Finance)
BNetzA	Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen (Federal Network Agency)
BVEG	Bundesverband Erdgas, Erdöl und Geoenergie e. V. (Federal Association for Natural Gas, Petroleum and Geoenergy)
dena	Deutsche Energie-Agentur GmbH (dena) (German Energy Agency)
DESTATIS	Statistisches Bundesamt (German Federal Statistical Office)
HEA	HEA – Fachgemeinschaft für effiziente Energieanwendung e. V. (Professional Community for the Efficient Use of Energy)
IAV	IAV GmbH Ingenieurgesellschaft Auto und Verkehr (Automotive Engineering)
KBA	Kraftfahrt-Bundesamt (Federal Motor Transport Authority)
LBEG	Niedersächsisches Landesamt für Bergbau, Energie und Geologie (Lower Saxony State Authority for Mining, Energy and Geology)
VDE|FNN	Forum Netztechnik/Netzbetrieb im VDE (Network Technology/Network Operation Forum within the German Association for Electrical, Electronic and Information Technologies)
VEA	Bundesverband der Energie-Abnehmer e. V. (German Federal Association of Energy Users)
ZSW	Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research Baden-Württemberg)

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