

The Energy Transition in the Power Sector: State of Affairs in 2018

*A review of the major developments of
2018, including an outlook for 2019*

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Overview of Key Findings

1

In 2018, wind, sun and co. generated as much electricity as coal for the first time: renewables accounted for 38.2 percent of electricity consumption, the same amount as coal and lignite combined. This was made possible by a strong solar year in terms of expansion and generation. Wind power also increased, albeit significantly less than in previous years, while hydropower declined due to the drought. For the coming years, a significantly higher level of renewable energy expansion is necessary, combined with proactive sector coupling, in order to implement the 2030 energy turnaround targets in all sectors.

2

Germany's emissions fell by well over 50 million tonnes in 2018, but could rise again quickly in 2019. The main factors here were the mild weather in winter and the associated lower demand for heating, a slight drop in production levels in some energy-intensive industries and, at times, a sharp rise in oil prices.

3

Hard coal was squeezed out of Germany's energy mix: it fell to its lowest level since 1949 and now accounts for only ten percent of primary energy consumption. Thus in 2018 not only will the era of hard coal mining have come to an end, but with it the end of its contribution in power supply has become increasingly likely. The situation was different for lignite, which remained almost unchanged, accounting for 22.5 percent of German electricity generation. The Coal Commission, which is to make its recommendations in February 2019, will therefore have to propose clear regulations for lignite in particular.

4

The average annual CO₂-price reached its highest level in a decade, at 15 euros per tonne, with reforms of the EU emissions trading system adopted in 2018 beginning to have an impact. The decline in hard coal in the electricity sector is mainly due to higher CO₂ prices. In addition, the higher wholesale electricity prices resulting from the rise in CO₂ prices have made it possible to conclude the first purchase contracts for electricity from wind farms outside the EEG regime. This shows that stronger pricing of CO₂ can trigger significant climate protection effects on the market.

Key Aspects of the 2018 Power Market



Ten points on the power market in 2018

- 1. Renewable energies:** 2018 was again another record year for renewable energies. There was a recorded increase of 12.4 terawatt hours and renewables now cover 38.2 percent of electricity consumption. The below-average electricity production from wind turbines and hydroelectric power stations was offset by above-average solar electricity generation. In particular, the expansion of wind power is progressing much more slowly than in the previous year. The share of renewables in total primary energy consumption rose from 13 to 14 percent. However, this rise was not due to the expansion of renewable energies in the heating and transport sectors but rather due to a significant reduction in energy consumption. Without a substantial acceleration in the expansion of renewable energies, neither the 2020 targets nor the 65-percentage- target set by the German government for 2030 can be met.

Ten points on the power market in 2018

- 2. Conventional energies:** Due to power plant closures and higher CO₂ prices, the use of hard coal fell to a historic low since the beginning of collecting energy statistics in 1950. Hard coal still covers 10 percent of primary energy consumption and 12.8 percent of electricity consumption. Due to higher commodity prices and warm weather conditions, the use of mineral oil and natural gas also declined in 2018. By contrast, lignite use and nuclear power generation remain virtually unchanged. Nevertheless, the displacement of fossil fuels at the current rate is far too slow to achieve the German government's climate protection targets for 2030.
 - 3. Energy and electricity consumption:** While electricity consumption remains virtually constant, primary energy consumption is falling significantly by 5 percent. The main reasons for this are the mild weather, higher commodity prices and a slight decline in production in some energy-intensive industries. Since 2018 does not show any real trend reversal in energy efficiency either, the 2020 energy efficiency targets (a 20 percent reduction in primary energy consumption and a 10 percent reduction in electricity consumption compared to 2008) are unlikely to be achieved.
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Ten points on the power market in 2018

- 4. Climate protection:** Germany's greenhouse gas emissions fell significantly, by around 51 million tonnes or 5.7 percent compared to 2017 and are now 31.7 percent below the 1990 level at a total of 854 million tonnes. The reduction is attributable in particular to lower primary energy consumption in the industrial sector as well as due to the heating and transport sectors. Tepid growth in the energy-intensive industries and a decline in sales of natural gas, heating oil and diesel contributed to this development. The current gap to achieve the 2020 climate protection target of minus 40 percent compared to 1990-levels thus amounts to 103 million tonnes of CO₂ e. Due to the unique factors that led to the decline in 2018, it can be assumed that Germany will continue to fall well short of the 2020 climate target in its efforts to date. The result of the Coal Commission is therefore of central importance for the convergence towards the target.

Ten points on the power market in 2018

- 5. Electricity trading:** At 52.1 terawatt hours, the export balance in 2018 is about 8 terawatt hours below the balance from 2017. With slightly declining imports, this development is mainly due to lower electricity exports, which have fallen due to higher CO₂ costs and consequently higher electricity wholesale prices. This development was also a result of the separation of the bidding zone with Austria, whereby electricity exports to Austria declined significantly. The largest electricity buyers remain Austria (despite the division of the bidding zone), France and the Netherlands.

Ten points on the power market in 2018

6. Electricity prices and flexibility: In addition to higher gas and hard coal prices, the significantly higher CO₂ price led to a rise in average wholesale electricity prices. In the base tariff, forward deliveries for 2019 became more expensive, especially in the second half of the year, and cost, on an annual average, about 46 percent more than in the previous year. Prices for next-day deliveries average 44.5 Euros per megawatt hour. Medium household electricity prices are likely to rise in 2019 for the first time in three years, to almost 31 cents per kilowatt hour. Due to fewer extreme situations, the price surcharges on the electricity spot market declined again. The number of hours with negative or very high prices in 2018 was below the level of 2017. There was no perceived volatility in the intraday market. All this indicates that shortages have not yet affected the wholesale market significantly. The rising CO₂ price also contributed to the electricity price levels of coal and gas power generation.

Ten points on the power market in 2018

7. **Costs:** After years of declining results, the tender results for new wind and solar power will rise for the first time in 2018. The latest contracts are at 6.26 and 4.66 cents per kilowatt hour for onshore and offshore wind power respectively, and 4.69 cents per kilowatt hour for photovoltaics. Not enough approvals for onshore wind energy in addition to restrictive surface area for ground-mounted solar plants mean that, contrary to the international trend, the results of the tenders are rising in Germany.
8. **Grids:** While 45 percent of the projects under the Energy Pipeline Expansion Act (EnLag) have already been implemented, the implementation rate for the projects under the Federal Needs Planning Act (BBPlG) is just under three percent. This means that 6.720 of the 7.670 planned kilometres still need to be realised. However, in December 2018, the Federal Cabinet approved the draft law to accelerate the approval procedure for power lines (NABEG amendment) and accordingly an acceleration of grid expansion is to be expected.

Ten points on the power market in 2018

- 9. Perception of the general population:** At 93 percent, approval of the energy transition is still very high, although there is still dissatisfaction with its implementation. Among other things, the majority of respondents consider the progress of the expansion of renewable energies to be too slow. The most popular technologies are solar, hydro and wind power, whereas the vast majority would like to see less use of coal in particular, followed by less mineral oil. The high acceptance of the energy system transformation in general must not hide the fact that there are major challenges in the acceptance of the expansion of wind energy and the local power grids, which must be addressed politically.

Ten points on the power market in 2018

10. Outlook for 2019: In February, the recommendations of the Coal Commission are expected to be released, in particular on the further handling of lignite in Germany. The onshore wind expansion is facing a further decline due to delayed approvals. Since Philippsburg 2's licence to operate ceases only at on December 31, the amount of nuclear electricity will remain roughly the same in 2019, depending on the plants' availabilities. A further reduction in generation capacity is expected for coal: Two more lignite piles will be transferred to the security reserve in October 2019, and hard coal is still under economic pressure. With the planned adoption of a climate protection law in 2019, it will be possible to initiate concrete measures to ensure that the 2030 climate protection targets can be reliably achieved in all sectors.

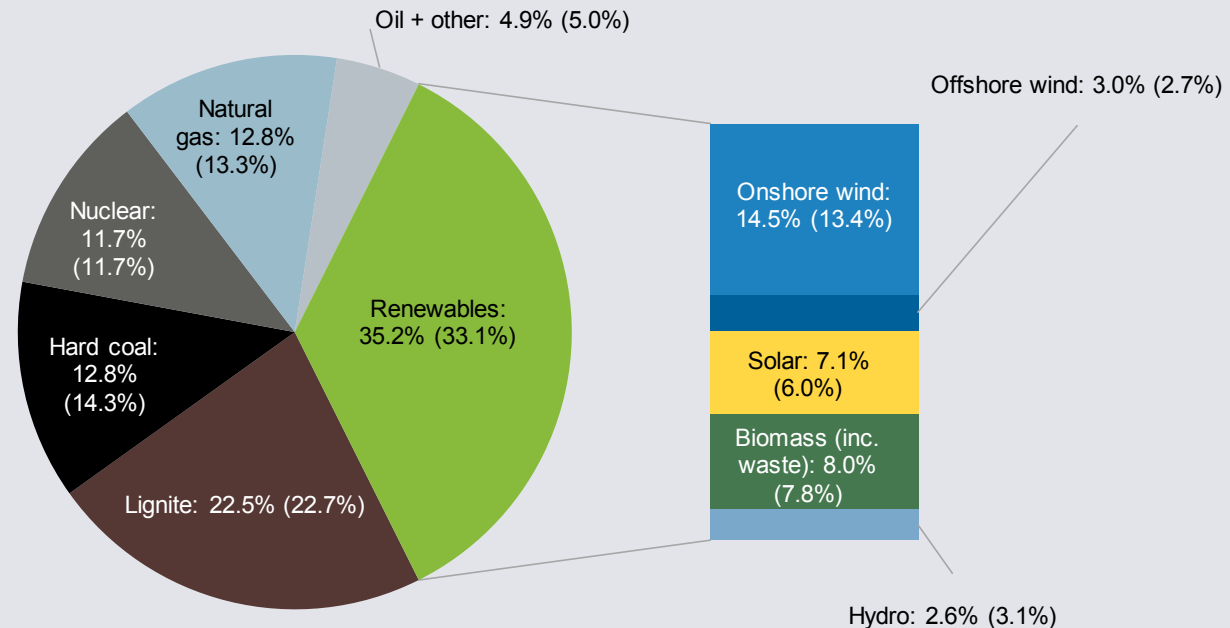
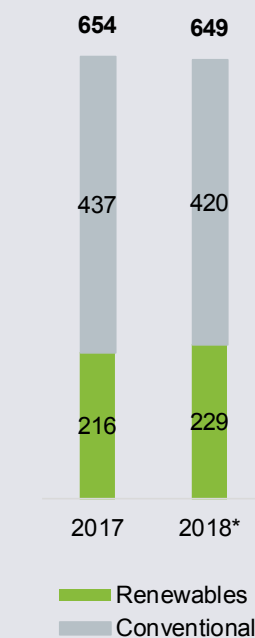
Power Generation in 2018



Electricity mix in 2018: Renewable energies are on a par with coal – each account for 35% of electricity generation

2018 power mix (2017 values in brackets)

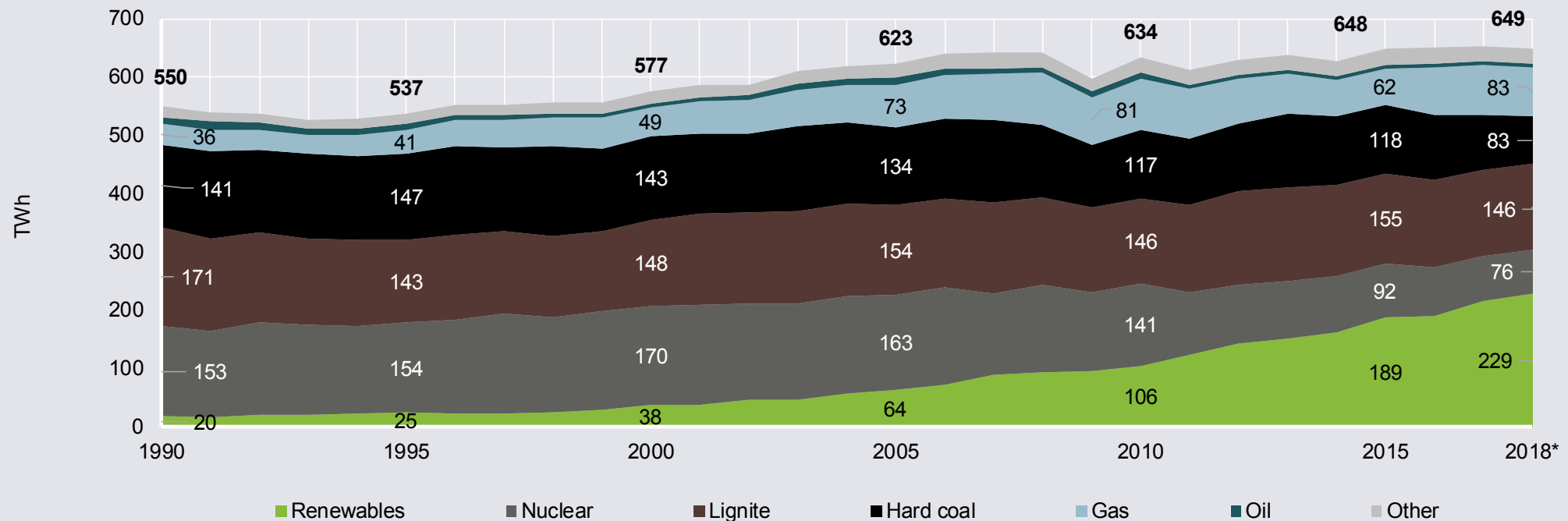
Gross power production (TWh)



AG Energiebilanzen (2018), * preliminary data, **includes biodegradable household waste

Power generation in 2018: New record for renewables, historic low (since 1949!) for hard coal

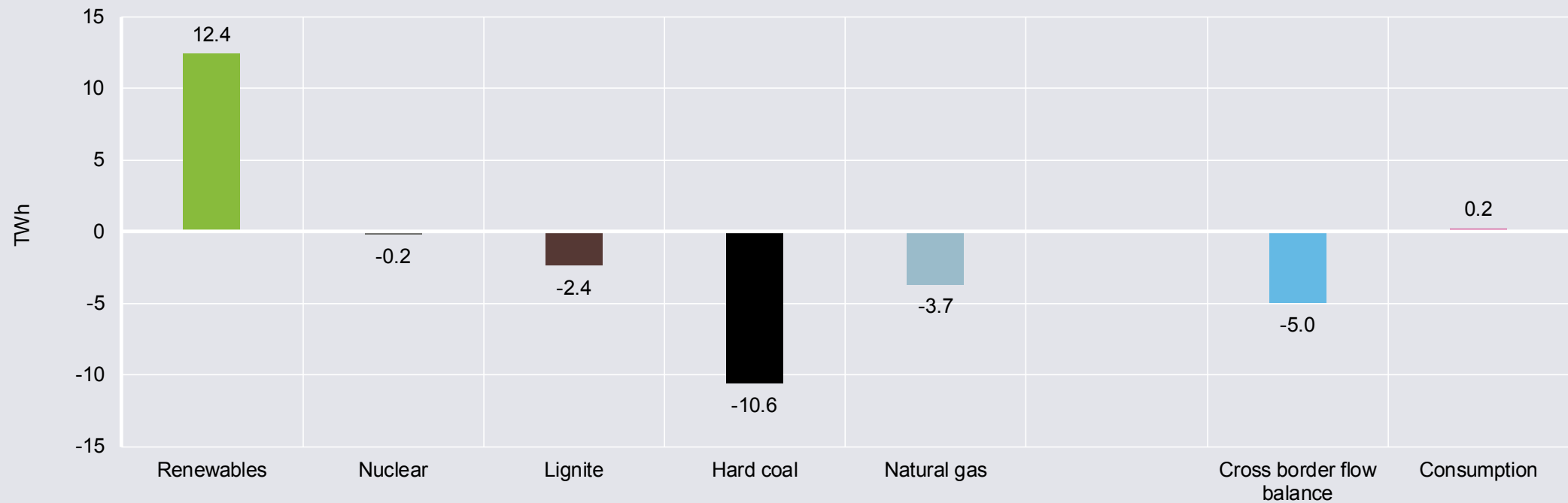
Gross power production, 1990–2018



AG Energiebilanzen (2018a), * preliminary data

Development of electricity volumes in 2018 compared with 2017: Growth in renewables, declines in all fossil energies – especially hard coal

Changes in electricity volumes, 2016–2018



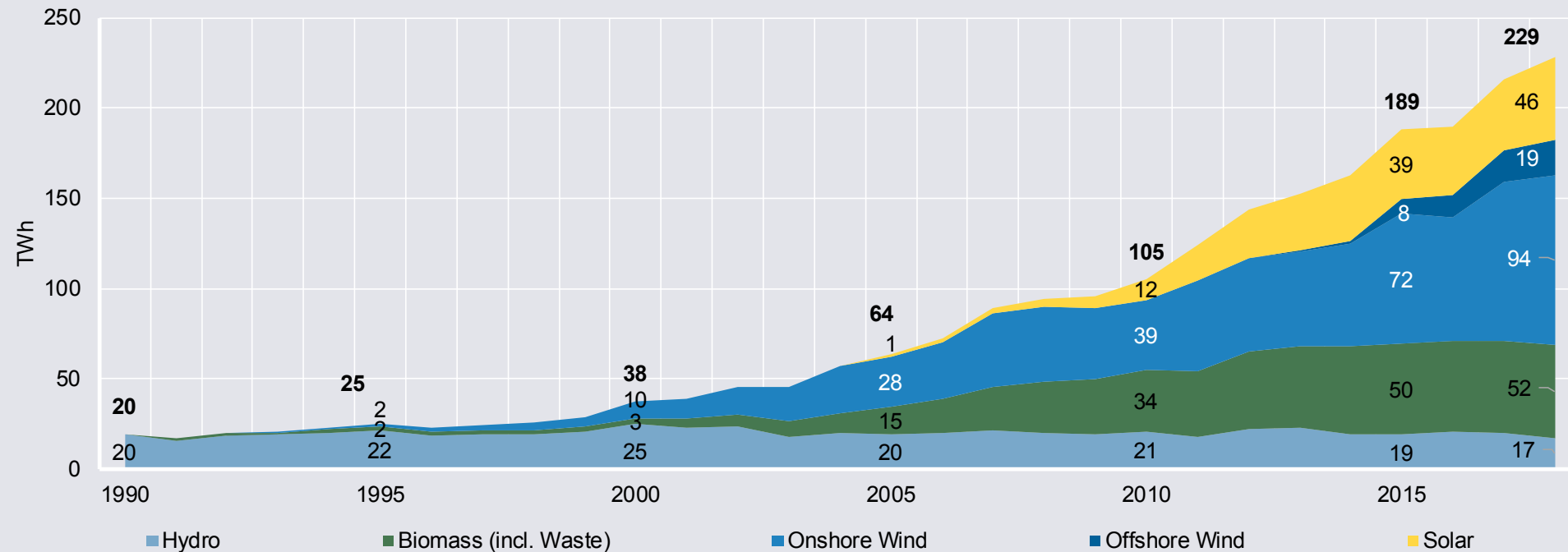
AG Energiebilanzen (2018), preliminary data

Renewables in 2018



Renewable energies in 2018: High solar power generation compensates for weak growth in wind and decline in hydropower

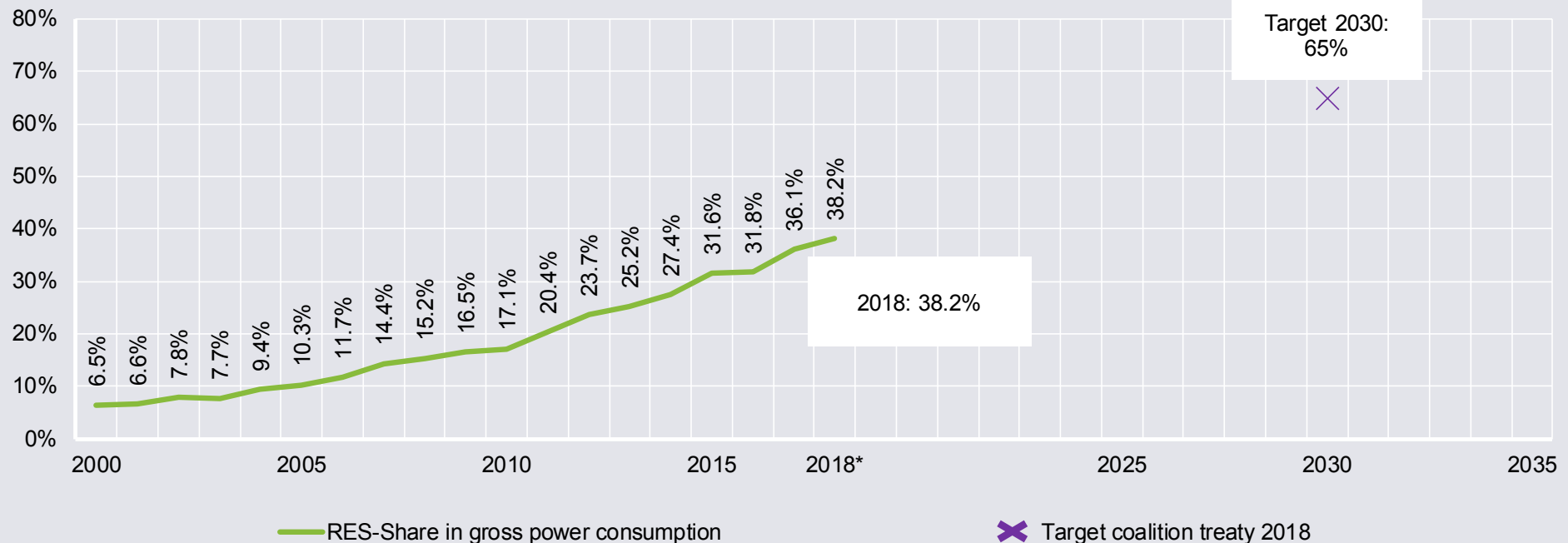
Power production from renewables, 1990–2018



AG Energiebilanzen (2018), *preliminary data

Renewables' share in electricity consumption rose to 38.2 percent in 2018, to reach the 65% target in 2030, the share must increase by 2.25% points annually

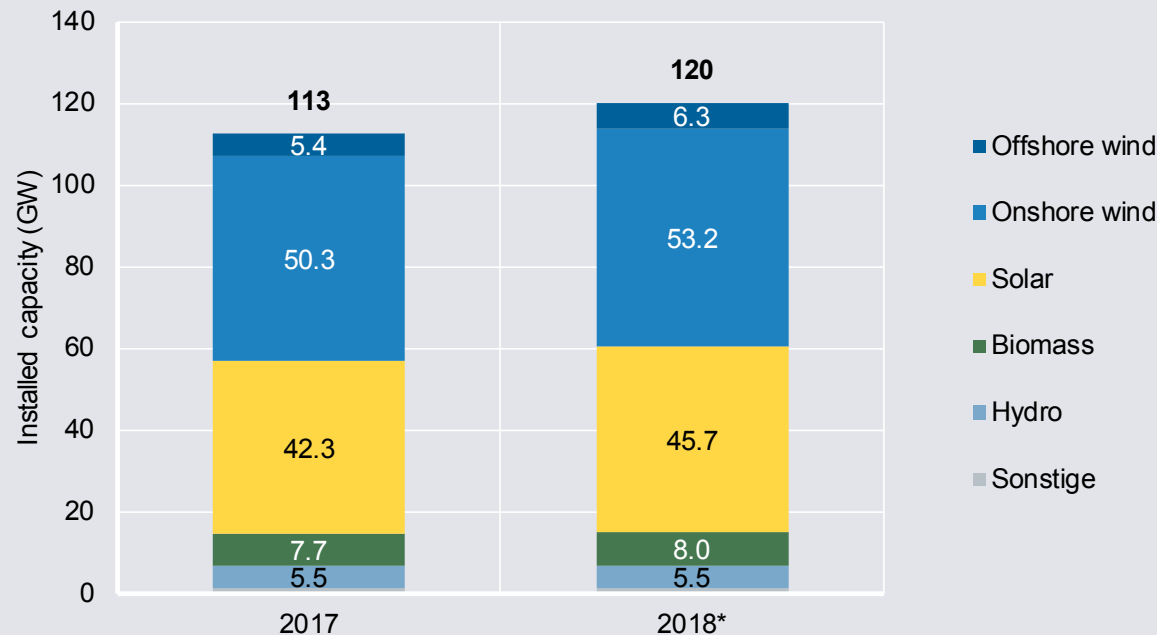
Share of renewables in gross power consumption, 2000–2018, together with the 2030 target



AG Energiebilanzen (2018), *preliminary data

Renewable energy systems in 2018: More than 2.5 gigawatts of photovoltaic power plant additions for the first time since 2013

Renewable capacity at the ends of the years 2017 and 2018



BNetzA (2018), *own calculations/estimations based on BNetzA (2018, as of 19.11.2018), Windguard (2018), Mittelfristprognose of transmission grid operators (2018)

Renewable capacities as of January 1st, 2018:

→ 113 Gigawatt

Expansion in 2018 (estimated)

- Onshore Wind: 2,9 Gigawatt
- Offshore Wind: 0,8 Gigawatt
- Solar: 3,4 Gigawatt
- Biomass: 0,3 Gigawatt

Renewable capacities as of December 31st, 2018 (estimated):

→ 120 Gigawatt

Necessary per-year-expansion to reach the 65-percentage-target in 2030:

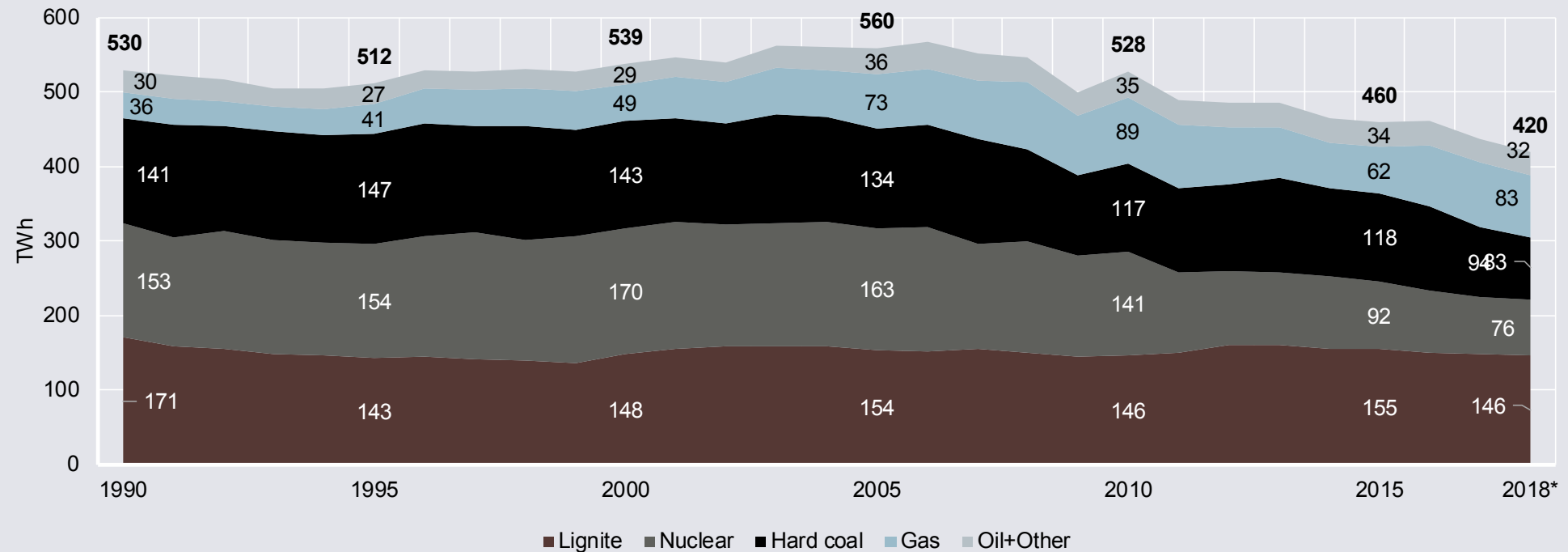
- Onshore Wind: 4 Gigawatt
- Offshore Wind: 0,8 Gigawatt till 2025, 1,7 Gigawatt from 2026
- Solar: 4 Gigawatt till 2021, 5 Gigawatt from 2022

Conventional Energy in 2018



Conventional power generation in 2018: Decline in all fossil fuels, especially hard coal, lignite still at the 2010 level

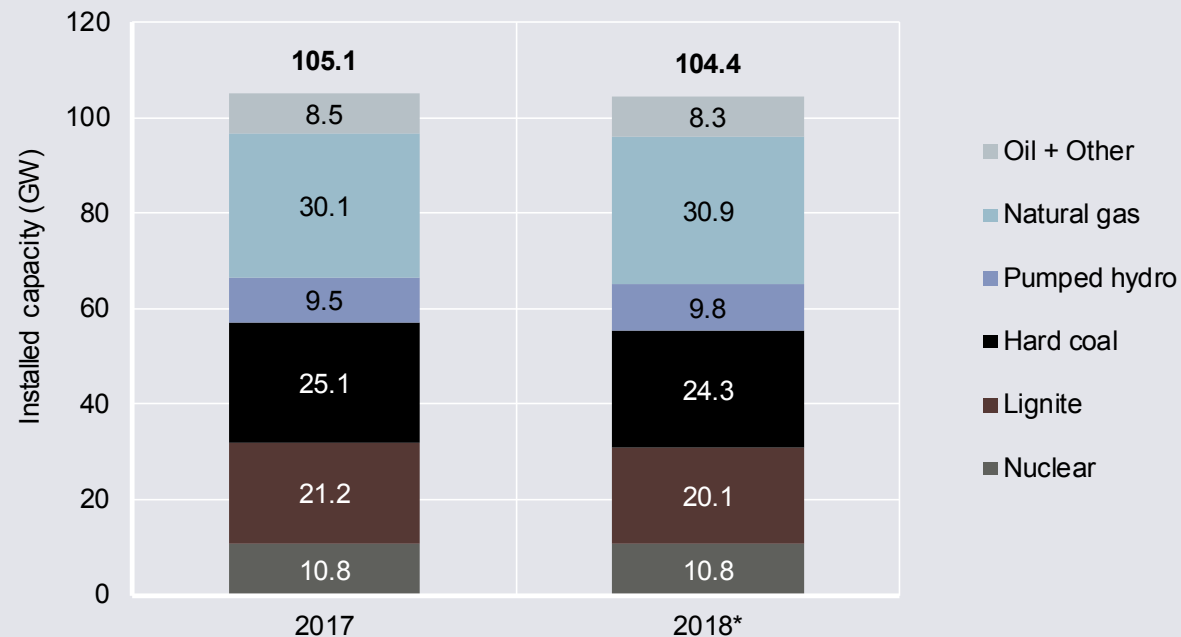
Gross power production from conventional energy sources, 1990–2018



AG Energiebilanzen (2018), *preliminary data

Conventional power plants in 2018: Slight shift from coal to gas

Conventional capacity at the ends of the years 2017 and 2018



Conventional power production as of January 1st, 2018:

→ 105 Gigawatt

Decommissioning in 2018:

- Hard coal: 0,7 Gigawatt
- Lignite: 1 Gigawatt (security reserve)
- Oil and other: 0,1 Gigawatt

Expansion in 2018:

- Natural gas: 0,8 Gigawatt
- Pumped hydro: 0,4 Gigawatt

Conventional power production as of December 31st, 2018:

→ 104 Gigawatt (geschätzt)

BNetzA (2018), *own calculations/estimations based on expansion and decommissioning numbers released by the Bundesnetzagentur (2018, Stand 19.11.2018)

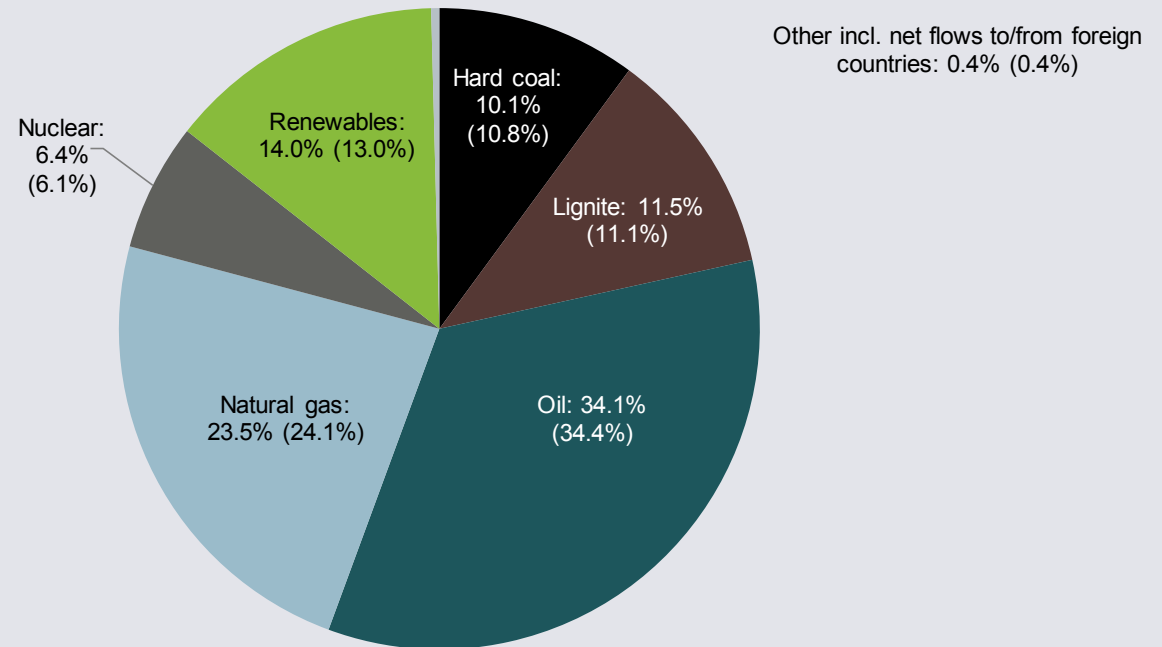
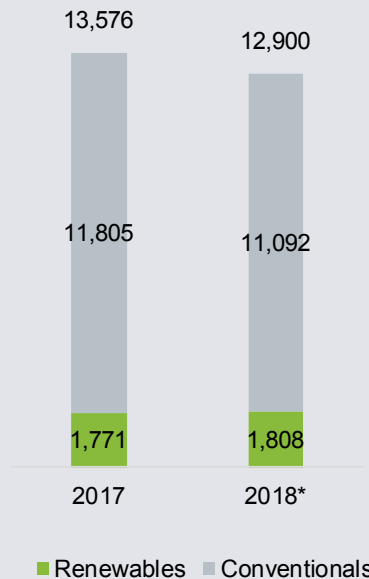
Energy and Electricity Consumption in 2018



Primary energy consumption in 2018: Significant decline in consumption means an increase in renewables share to 14 percent

Primary energy consumption mix in 2018 (values for 2017 in brackets)

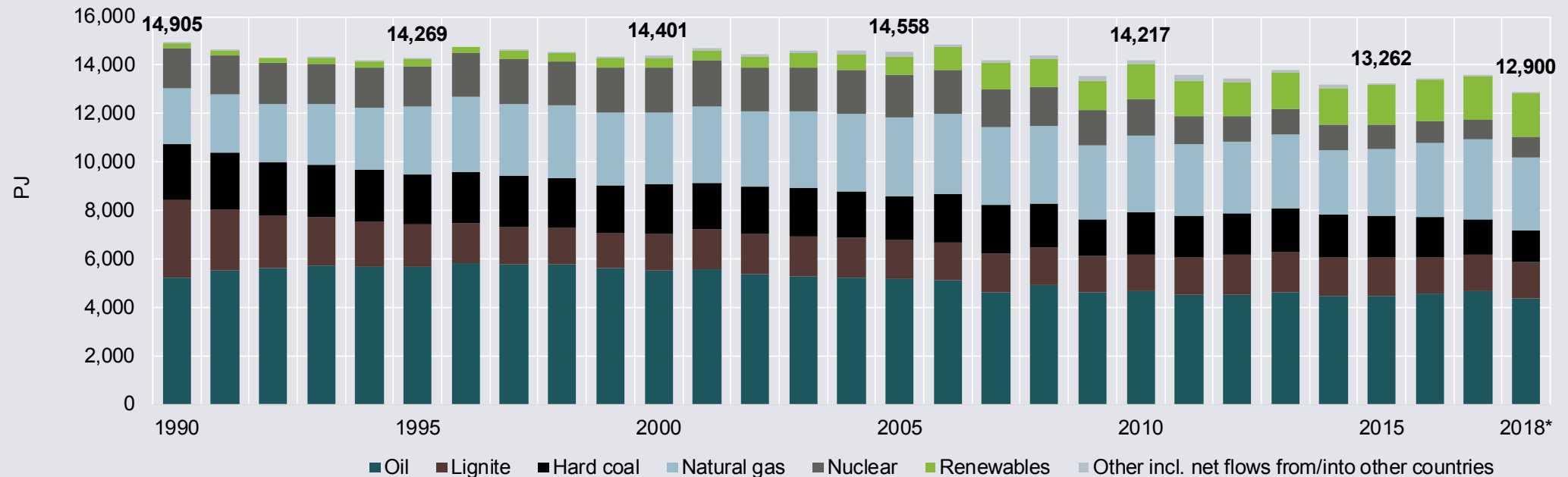
Primary energy consumption (PJ)



AG Energiebilanzen (2018), *preliminary data

Primary energy consumption in Germany: Lowest energy consumption since 1990, mainly due to mild weather and lower production by energy-intensive industries

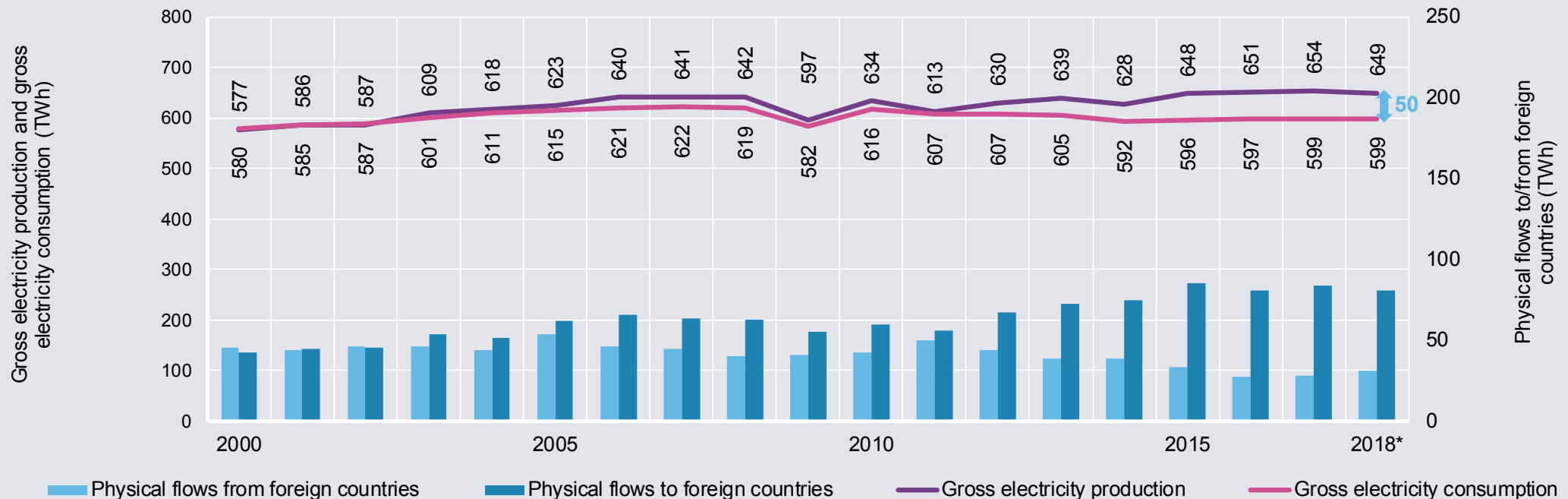
Primary energy consumption, 1990–2018



AG Energiebilanzen (2018), *vorläufige Angaben

Electricity consumption 2018: Constant electricity consumption and slightly declining electricity production

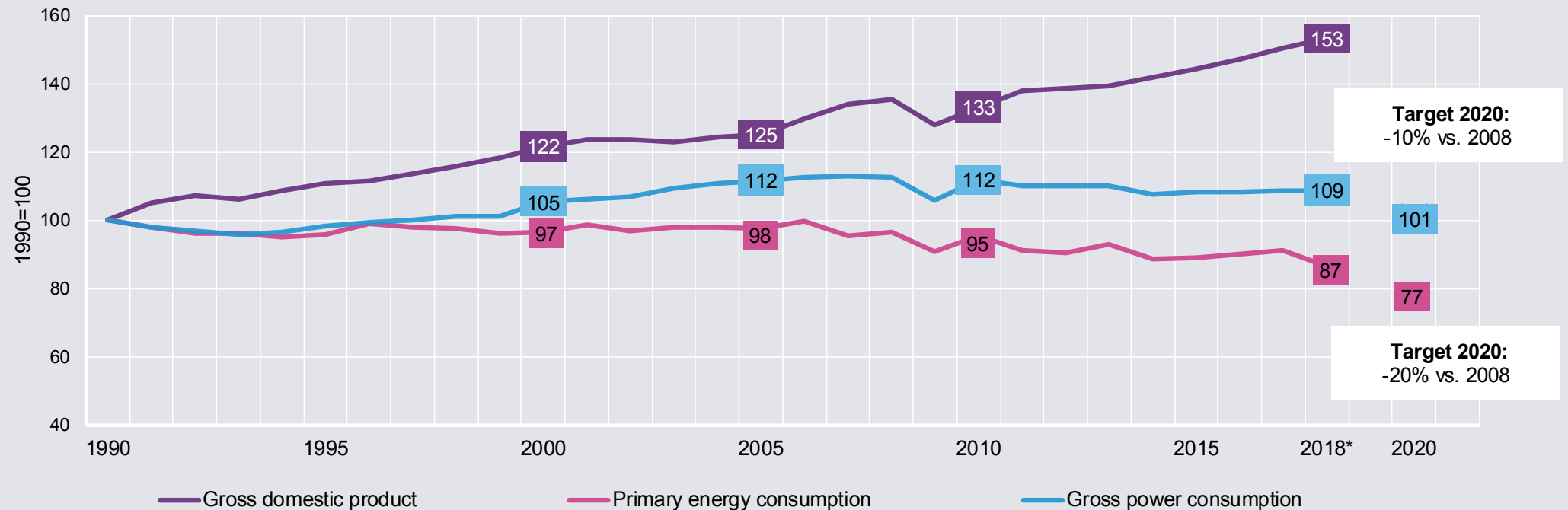
Power generation, power use, and load flows abroad, 2000–2018



AG Energiebilanzen (2018), *preliminary data

Energy efficiency in 2018: Mild temperatures and a slight decline in production in some energy-intensive industries lead to a decline in energy consumption despite an increase in GDP

Gross domestic product, primary energy consumption, and gross domestic electricity use, 1990–2018 (indexed, 1990=100)



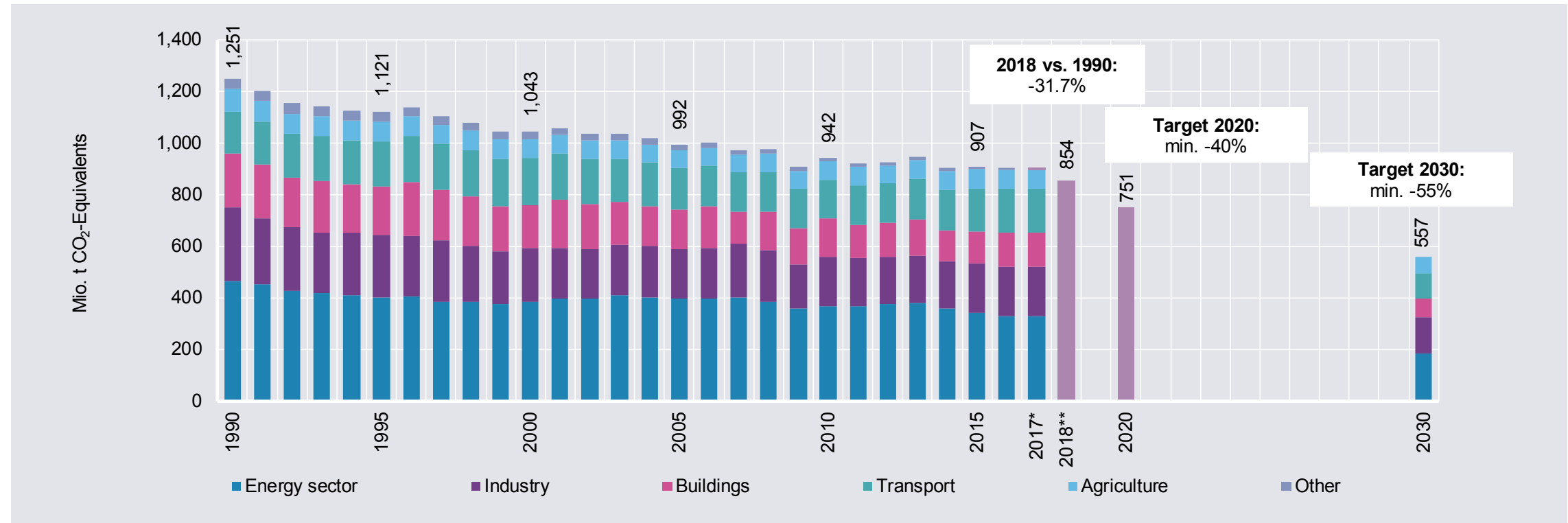
AG Energiebilanzen (2018), Statistisches Bundesamt (2018), Bundesministerium für Wirtschaft und Energie (2018),
 *preliminary data /own calculations

Greenhouse Gas Emissions in 2018



Climate protection 2018: CO₂ emissions fall by over 50 million tonnes, but the climate protection target for 2020 remains difficult to achieve

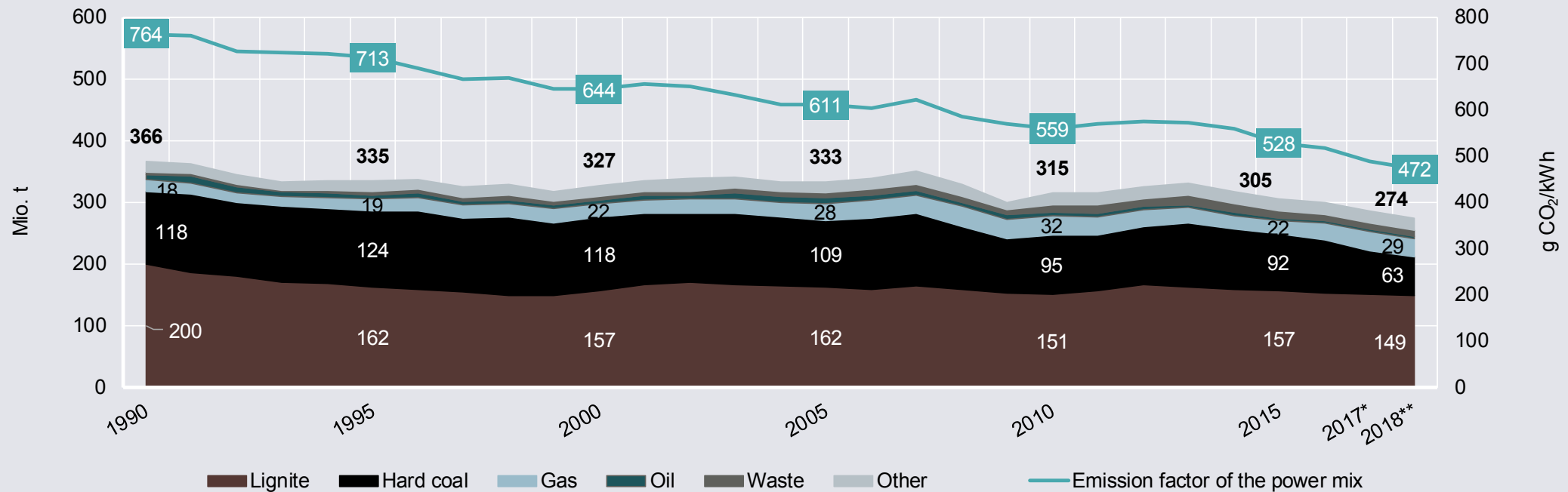
Greenhouse gas emissions by sector, 1990–2018, together with 2020 and 2030 targets



Umweltbundesamt (2018), own calculations, *preliminary data, **own estimation

Climate protection in the electricity sector 2018: CO₂ emissions from electricity generation fall to their lowest level since 1990 due to the decline in hard coal

CO₂ emissions from power production, 1990–2018



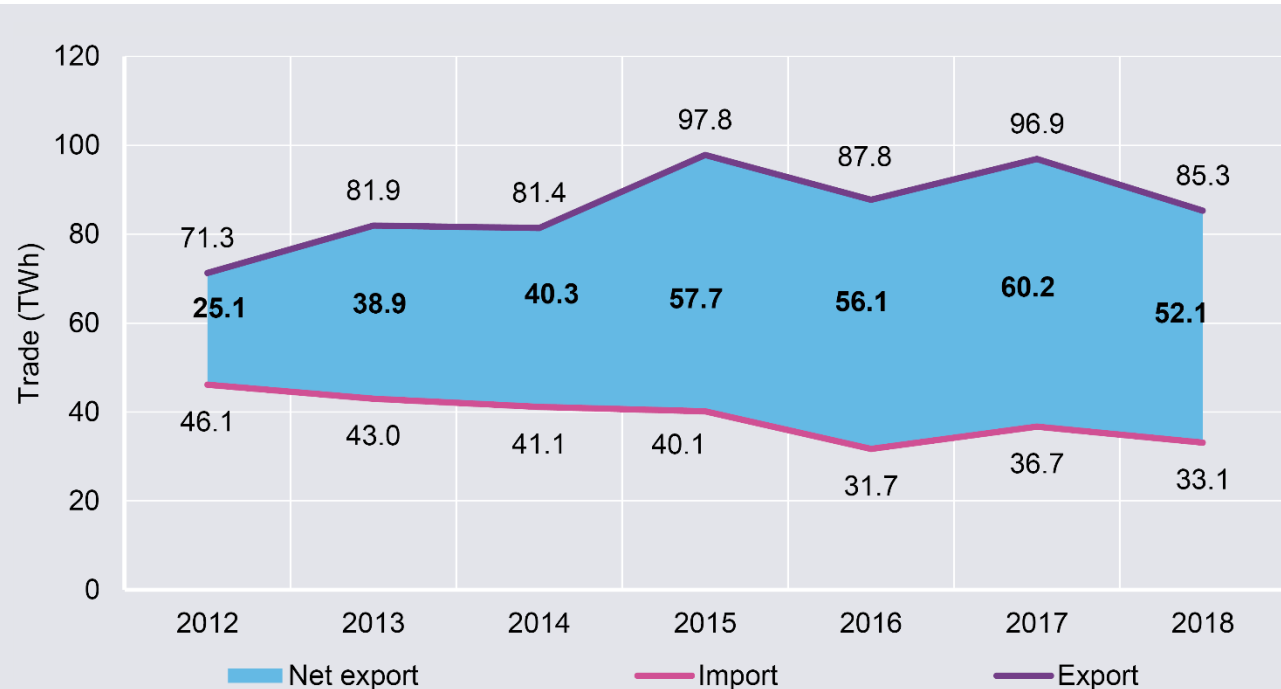
Umweltbundesamt (2018) (*preliminary data, **UBA estimation), ***own calculations

Electricity Trading and Price Developments in Europe 2018



Germany is an electricity export country: electricity exports remain high, but do not reach the record level of 2017

Cross-border electricity trade in Germany, 2012–2018



Own calculations based on ENTSO-E 2018 (as of 28.12.18); commercial electricity trade flows are shown

- At minus 12 terawatt hours, electricity exports fell much more sharply than electricity imports at minus four terawatt hours.
- The largest electricity consumers remain Austria (despite price zone separation), France and the Netherlands.
- The largest electricity suppliers are Sweden and the Czech Republic.
- Due to lower electricity prices and fully installed electricity phase shifters at the German-Polish border, Germany has become a net exporter for Poland in 2018, with an export balance of 0.9 terawatt hours.

Germany's electricity trade with its neighbours: The structure of trade flows remains similar, but the dimensions are changing

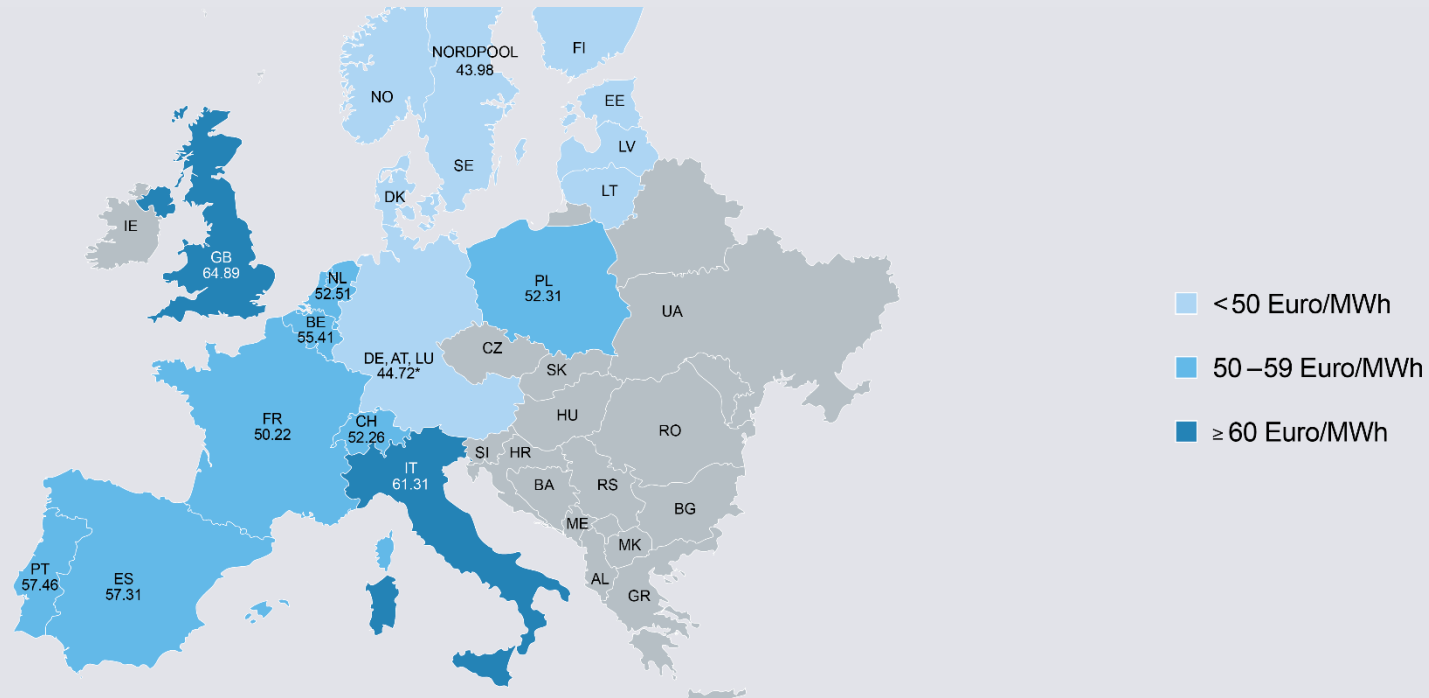
Comparison of foreign electricity trade with neighboring countries in 2017 and 2018

	TWh 2017			TWh 2018		
	Import from	Export to	Balance	Import from	Export to	Balance
Sweden	2.2	0.3	-1.9	1.2	0.3	-0.9
Austria	10.6	42.4	31.8	10.1	35.0	25.0
Switzerland	3.1	11.6	8.6	4.8	8.8	4.0
Czech Rep.	7.7	5.1	-2.5	6.5	4.9	-1.5
Denmark	6.3	3.9	-2.3	5.6	5.2	-0.4
France	3.8	17.5	13.7	3.8	12.7	8.9
Netherlands	1.2	10.7	9.6	0.4	13.0	12.5
Poland	1.9	0.8	-1.0	0.6	1.4	0.9
Luxembourg	0.1	4.5	4.3	0.2	3.8	3.7
Sum	36.7	96.9	60.2	33.1	85.3	52.1

Own calculations based on ENTSO-E 2018 (as of 28.12.18); commercial electricity trade flows are shown

Wholesale electricity prices in 2018: Germany has the second lowest wholesale electricity prices in Europe

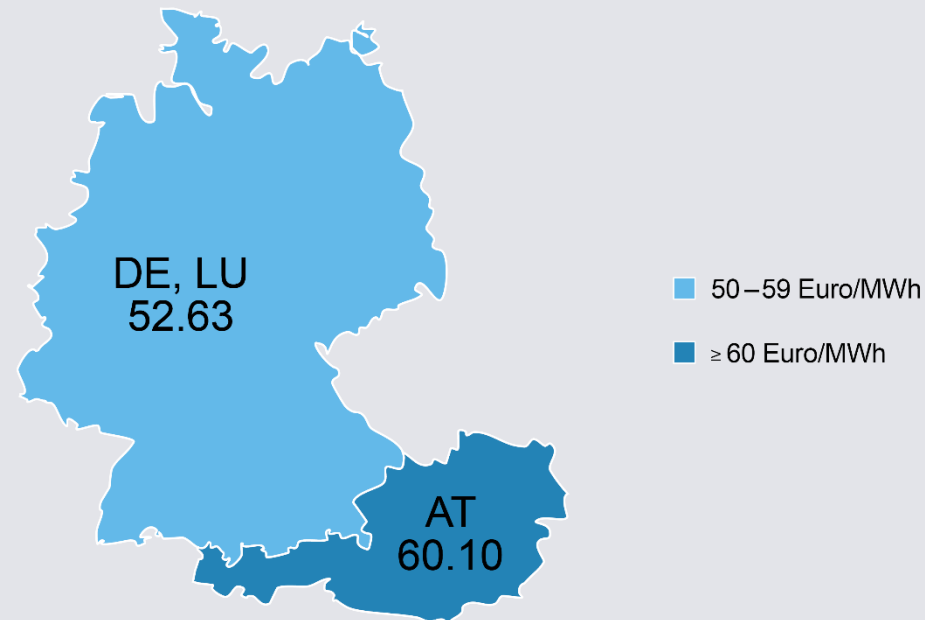
Comparison of wholesale power prices in selected European neighbouring countries



Own calculations based on EPEX-SPOT (2018a), Nordpool (2018), Belpex (2018), OMEL (2018), Mercato Elettrico (2018), APX (2018), POLPX (2018, Stand 28.12.18), *Calculation: Mean value of exchange electricity prices in the DE-LU-AT price zone in the first three quarters of 2018 and the total consumption-weighted exchange electricity prices in the DE-LU and AT price zones in the last quarter of 2018

Disbanding of the joint German-Austrian price zone : Austria's wholesale electricity prices are clearly moving away from those in Germany

Wholesale electricity prices after the separation of the uniform price zone DE-AT on October 1st, 2018



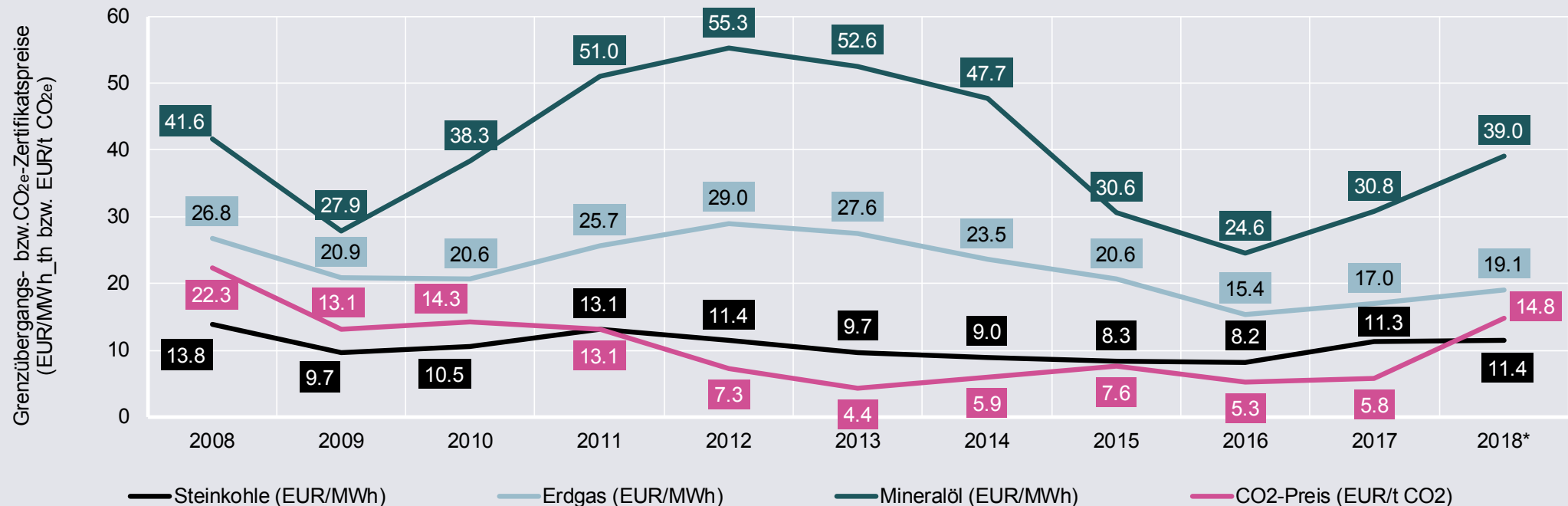
Own calculations based on EPEX-SPOT (2018), Mean values from October to December after price zone division (as of 28.12.18)

Electricity and Fuel Price Trends in Germany in 2018



Commodity prices in 2018: Prices of oil, gas and CO₂ certificates rose more sharply than in 2017

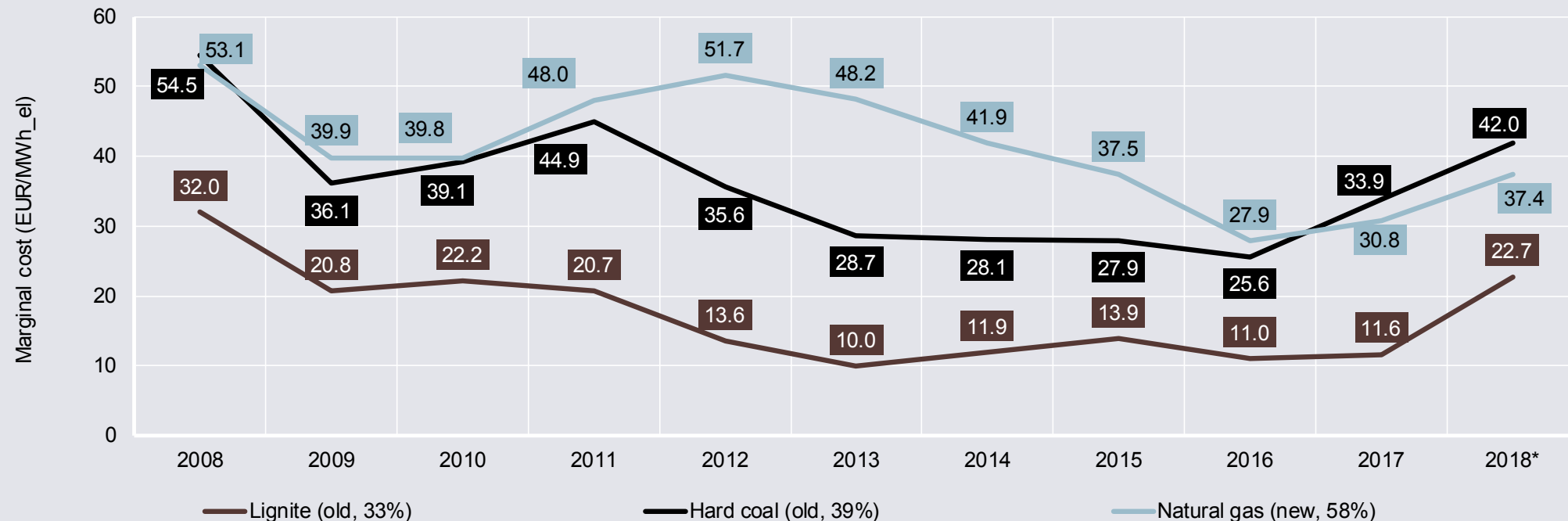
Import prices for natural gas, hard coal, and petroleum, as well as CO₂ certificate prices 2008–2018



Bundesamt für Wirtschaft und Ausfuhrkontrolle (2018), Deutsche Emissionshandelsstelle (2018), own calculations, *preliminary data

2018 electricity generation costs: Due to higher CO₂ prices, new gas-fired power plants are more competitive than old coal-fired power plants

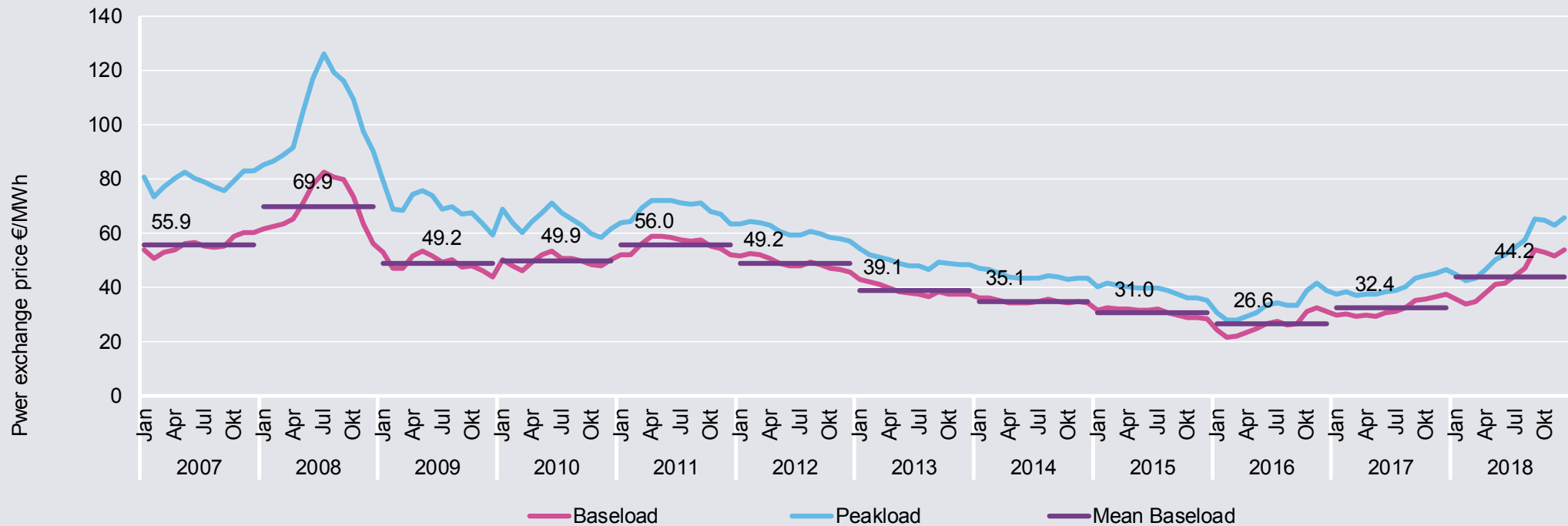
Marginal costs for new natural-gas power plants and old power plants fired with lignite and hard coal 2008–2018



Bundesamt für Ausfuhrkontrolle (2018), Deutsche Emissionshandelsstelle (2018/2006), Öko-Institut (2017), efficiency factor in brackets, *own calculations/preliminary data

Stock exchange electricity prices 2018: Significant price increase in stock exchange electricity prices in 2018 due to increased gas and CO₂ prices

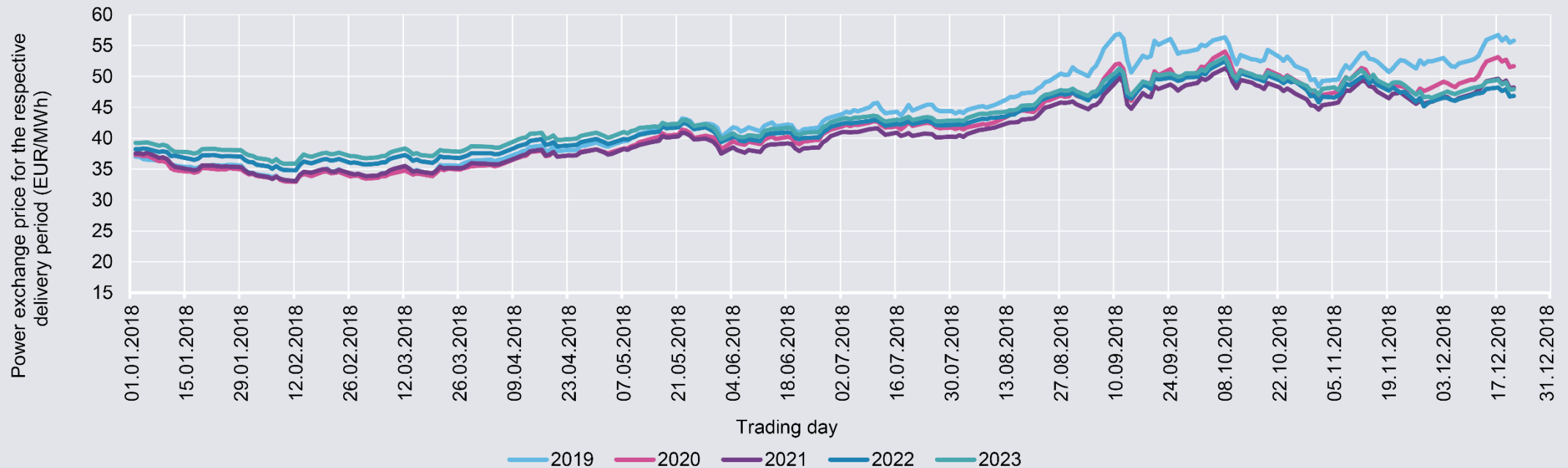
Rolling annual futures, 2007–2018



Own calculations based on EEX (2018, as of 28.12.18)

Power future prices 2019-2023: Electricity supplies in the future will cost around 50 euros per megawatt hour, but will become cheaper despite nuclear phase-out at later stages

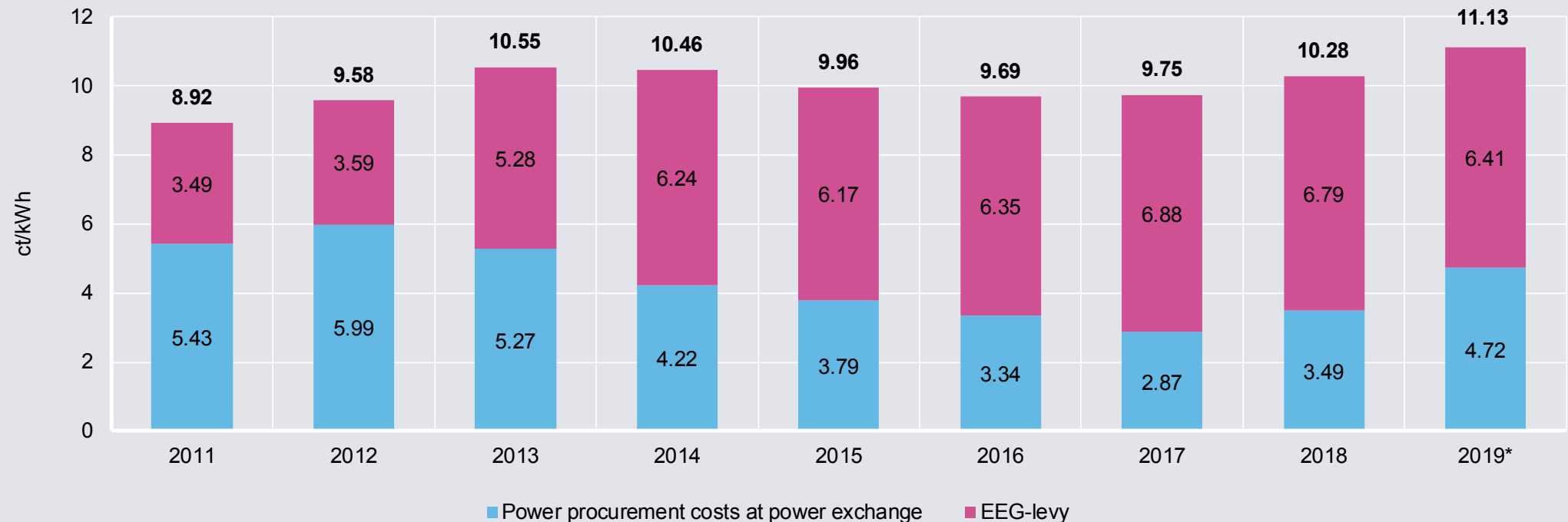
2018 future prices for power delivery in 2019–2023



EEX (2018, as of 28.12.18)

Electricity costs in 2019: EEG levy declines, but is overcompensated by significant increase in electricity procurement costs

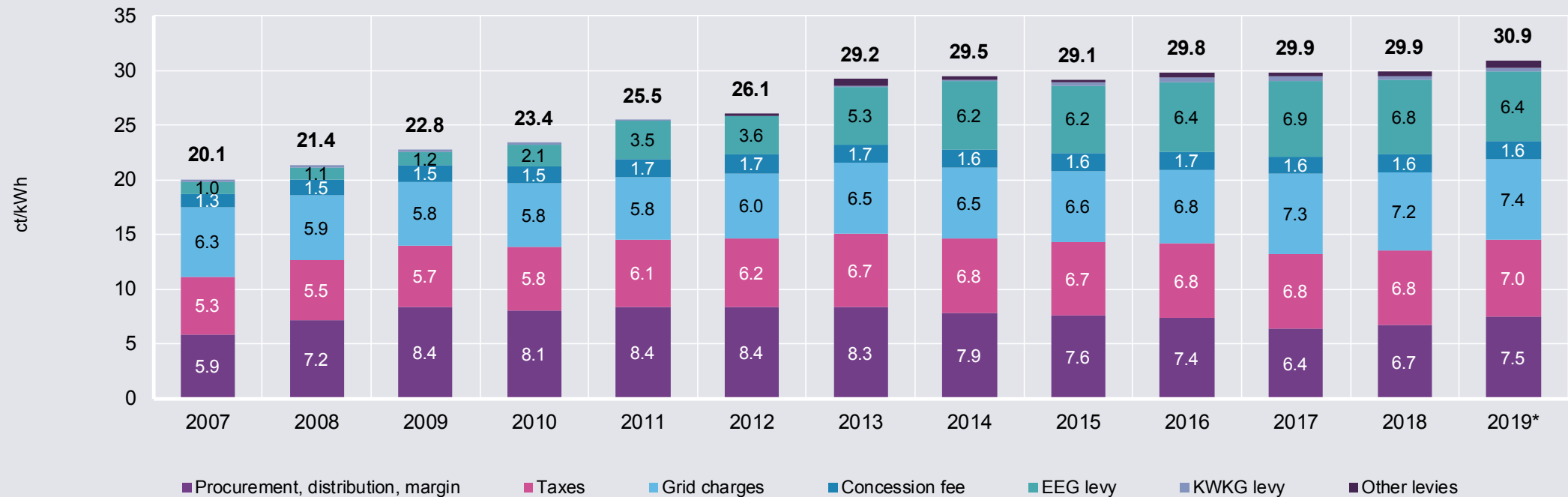
Electricity procurement costs and EEG levy, 2011–2019



EEEX (2018), Bundesnetzagentur (2018), *Estimation: 70 per cent one-year future (base), 30 per cent one-year future (peak) (as of 28.12.18)

Electricity costs in 2019: Electricity costs for private households are rising again for the first time in 3 years - by around 3 percent

Household power rates, 2007–2019 an annual consumption of 3,500 kWh



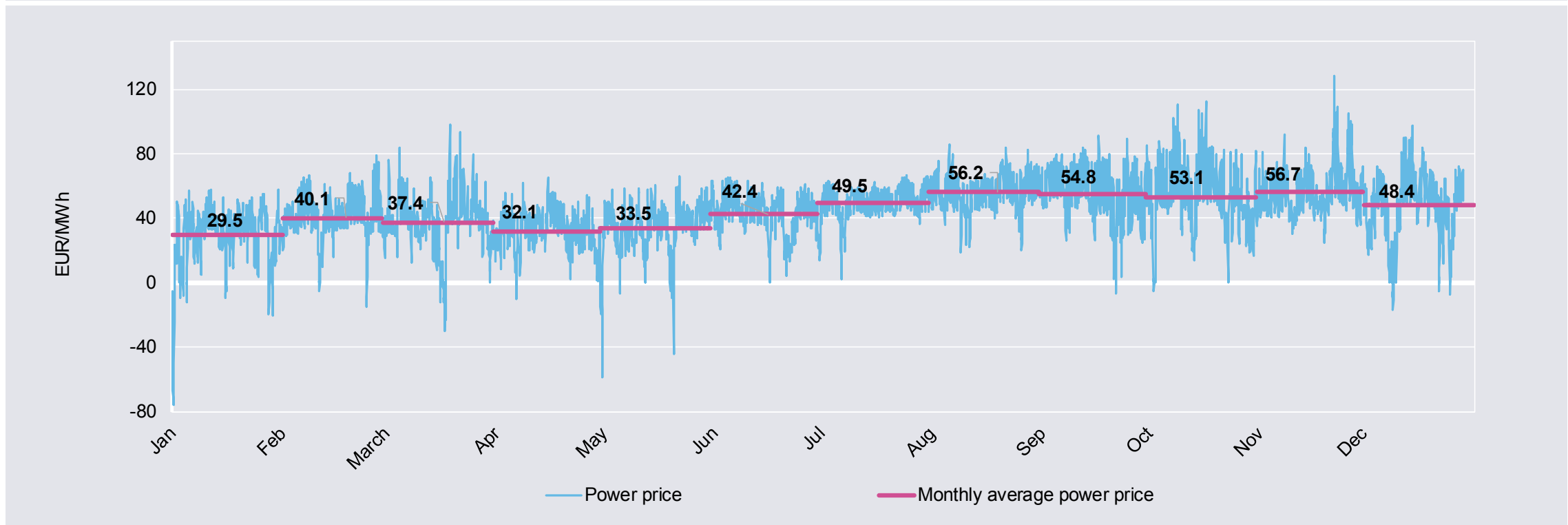
Bundesnetzagentur (2018), *own estimates based on Netztransparenz (2018)

Negative Electricity Prices and Power Market Flexibility in 2018



Hourly wholesale electricity prices over the course of 2018: Electricity prices have risen since June due to higher CO₂ and gas prices and weak wind production

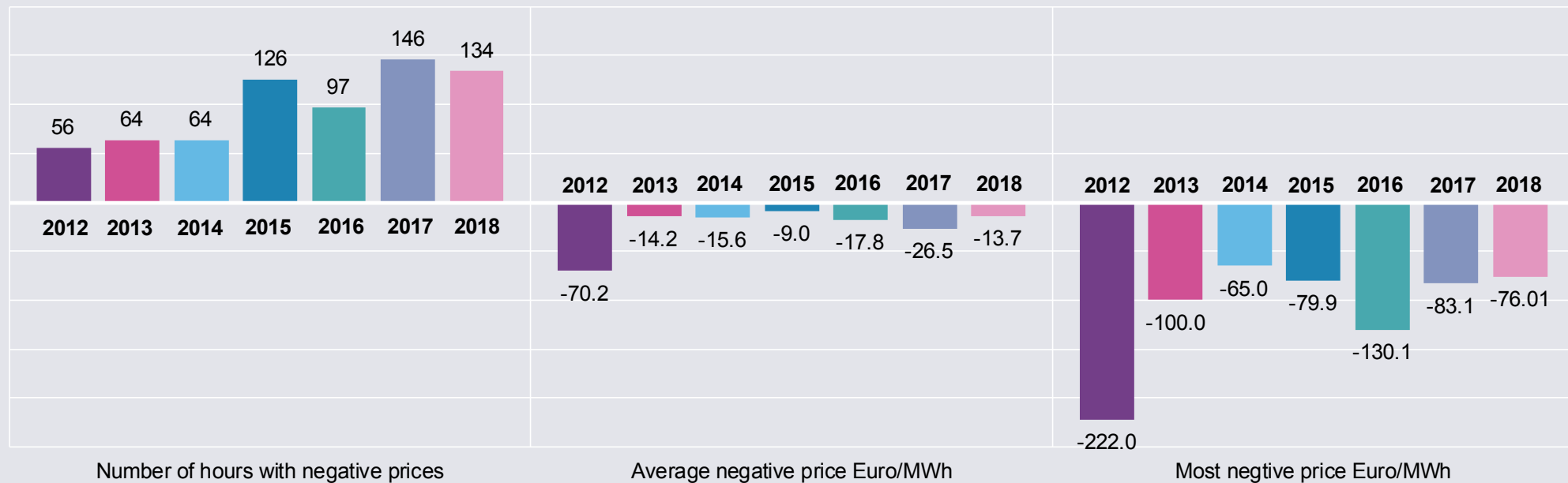
Hourly wholesale power prices (*Day-ahead*) in 2018



EPEX-SPOT (2018, as of 28.12.18)

Negative electricity prices in 2018: Number and extent of hours with negative electricity prices decreased in 2018

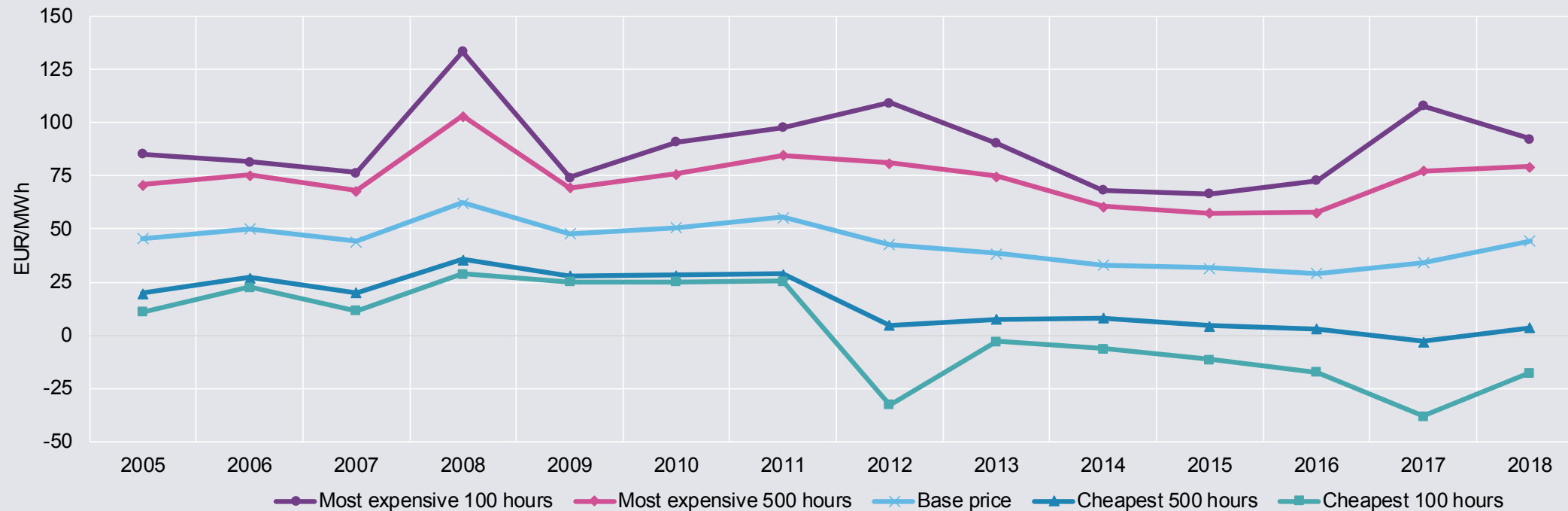
Number of hours with negative electricity prices in 2018



EPEX-SPOT (2018, as of 31.12.18)

Flexibility of the electricity market: High renewable energy production was not a problem for the electricity market, fluctuations in electricity prices on the spot market have decreased

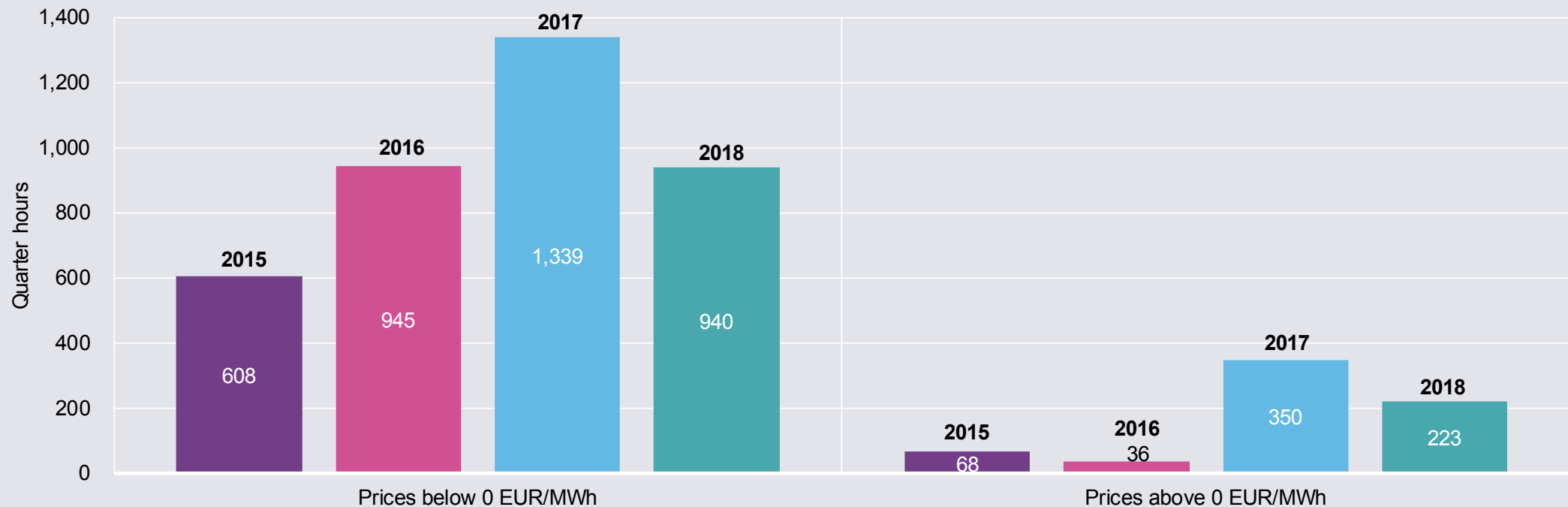
Cheapest and most expensive hours on wholesale markets in 2018



EPEX-SPOT (2018, as of 28.12.18)

Flexibility on the electricity market in 2018: Volatility in intraday electricity trading has also fallen slightly

Number of quarter hour increments with prices less than 0 or more than 100 Euro per megawatthours in 2018



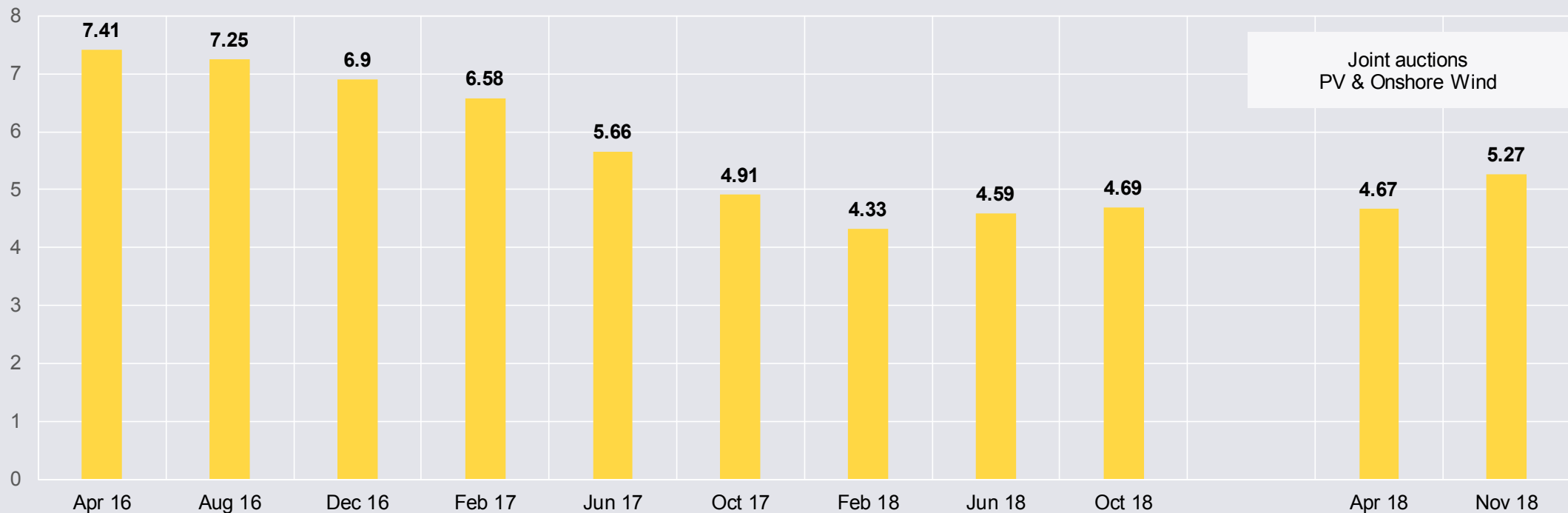
EPEX-SPOT (2018, as of 28.12.18)

Renewables Auctions and EEG Costs in 2018



Renewable energy auctions in 2018: After two years of continuous declines, remuneration for solar electricity slightly increased

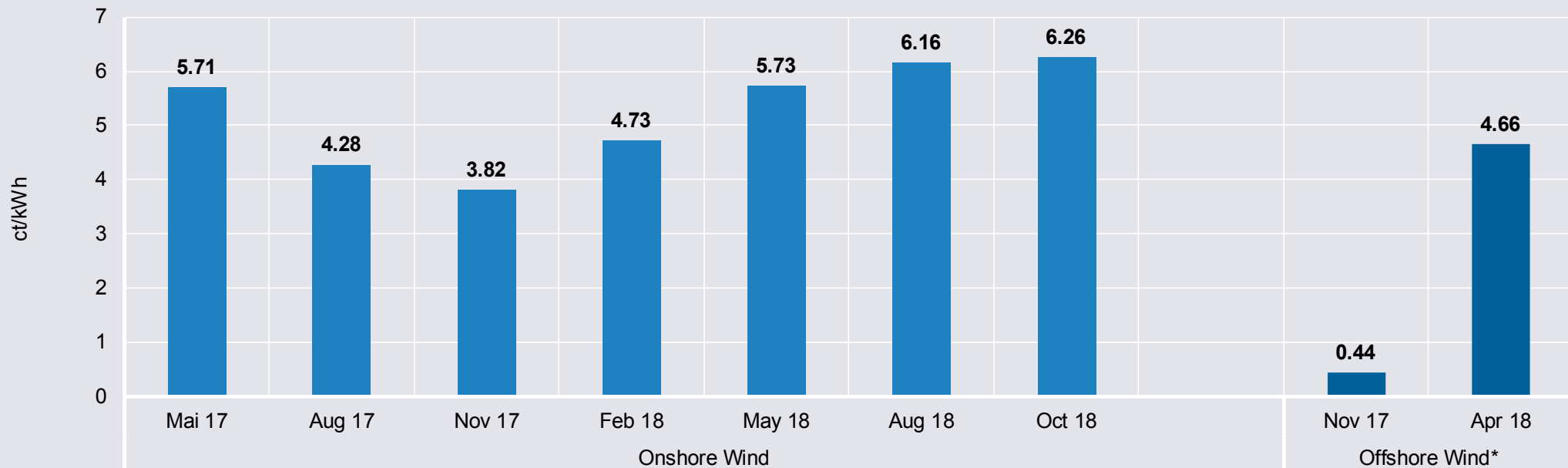
Average auction results for PV systems, 2016–2018



Bundesnetzagentur (2018)

Renewable Energy Auctions 2018: Due to low market volume and more expensive approval processes, auction results have risen

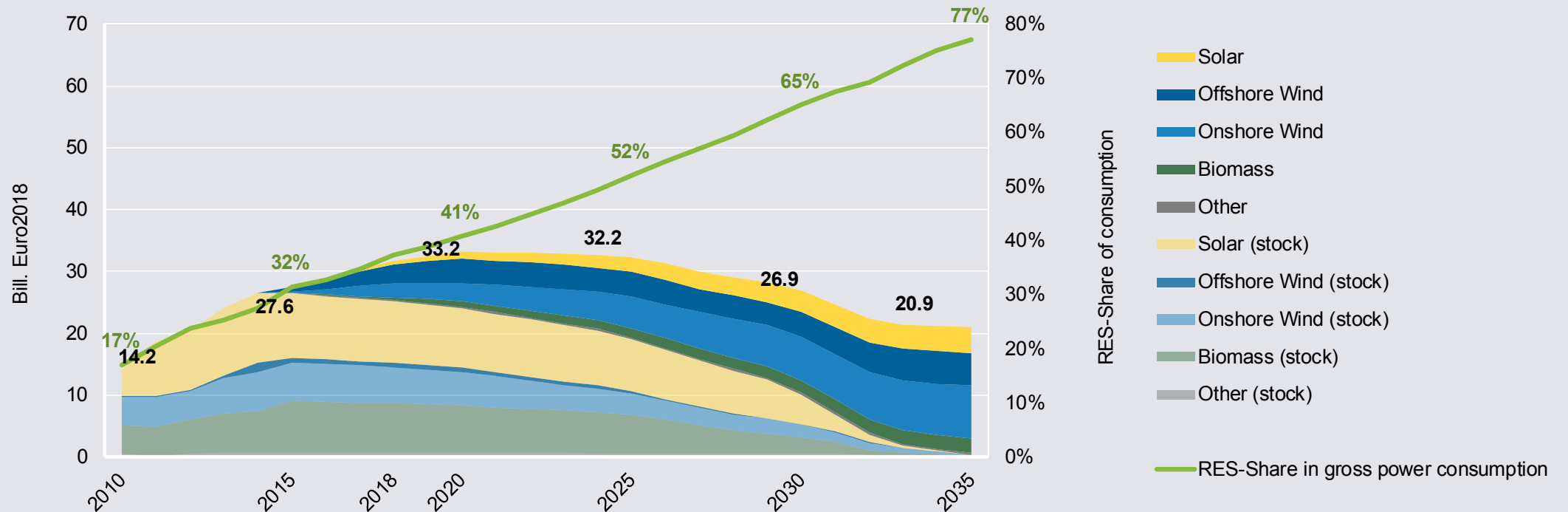
Average auction results for wind power, 2016–2018



Bundesnetzagentur (2018), * excluding grid connection costs (about 3 ct/kWh)

Costs of renewable energies: The peak of the cost hill has almost been reached, payments for renewables will decrease from the beginning of the 2020s

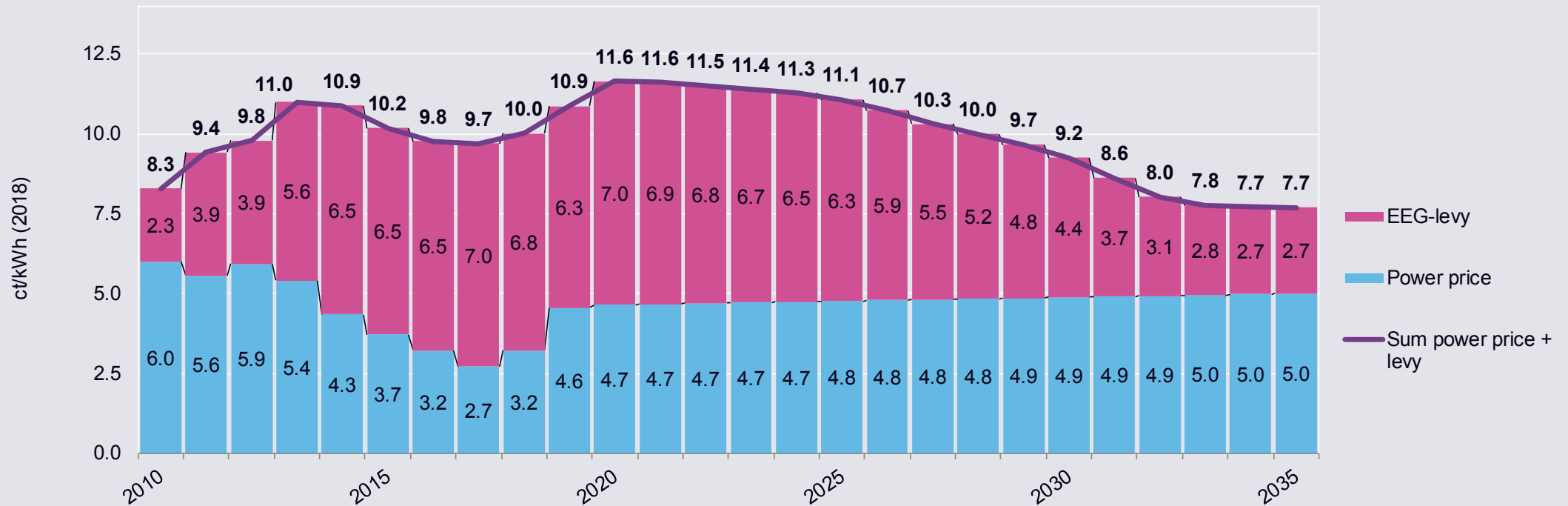
Guaranteed remuneration for renewable power plant owners, 2010–2035



Own projection based on Öko-Institut (2018), assuming that the 65 % target is reached

Electricity costs: The total of wholesale electricity prices and EEG levy should have reached the peak at the beginning of the 2020s

Electricity price (rolling annual future price for base load) and EEG levy, 2010–2035



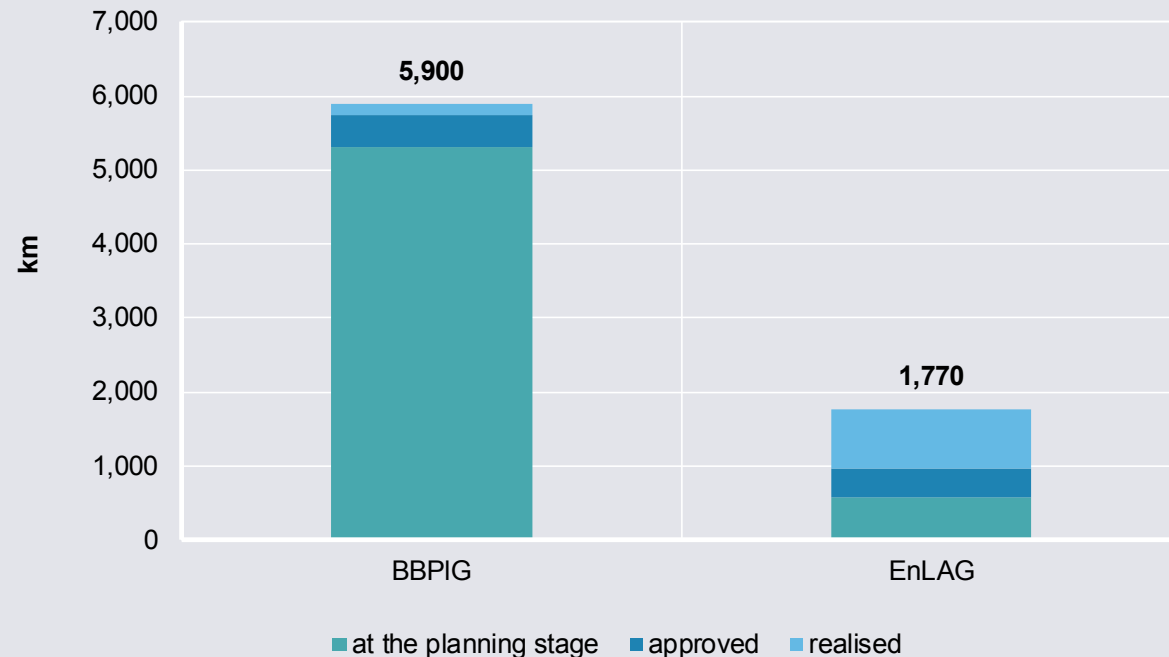
Own projection based on Öko-Institut (2018)

Grid Expansion in 2018



Of the planned 7,670 kilometres of power lines, 950 kilometres have been built to date

Status of grid expansion in the third quarter of 2018



Bundesnetzagentur (2018)

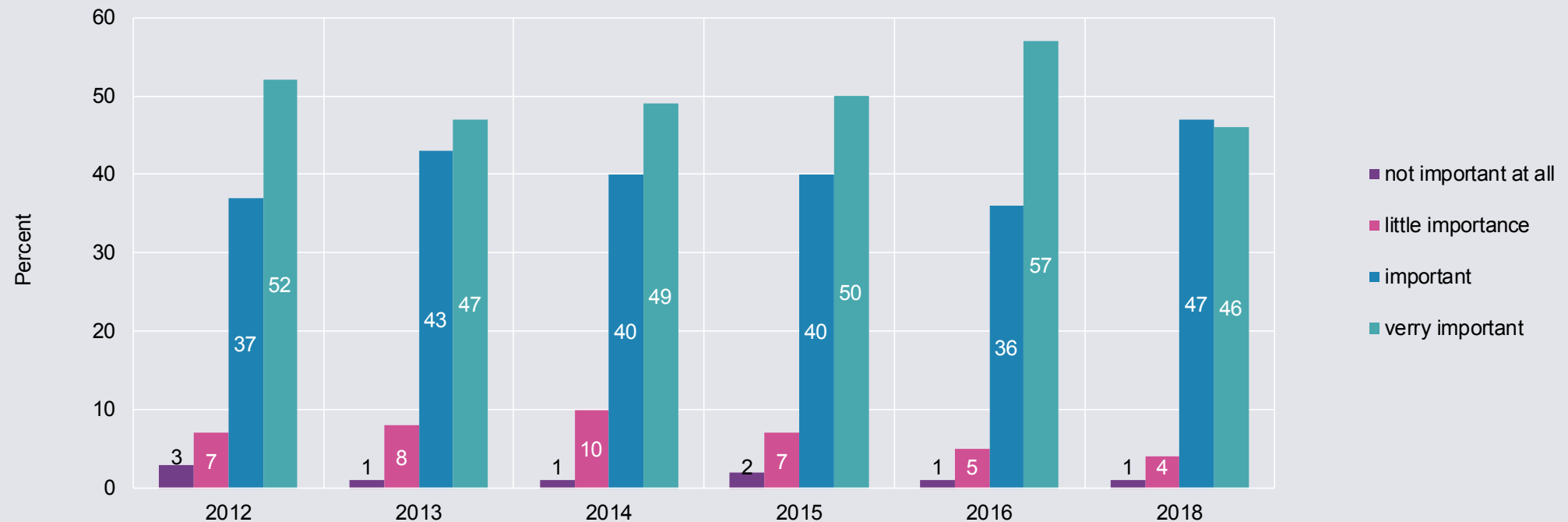
- A total of 6,720 of the planned 7,670 kilometers of power lines are missing.
- 45 percent of the projects under the Energy Line Expansion Act (EnLAG) have already been implemented.
- The implementation rate for the projects under the Federal Requirements Planning Act (BBPIG) is less than three percent.

Public Opinion on the Energy Transition in 2018



The population's attitude towards the energy transition in 2018: More than 90 percent of the population consider the energy system transformation to be important or very important

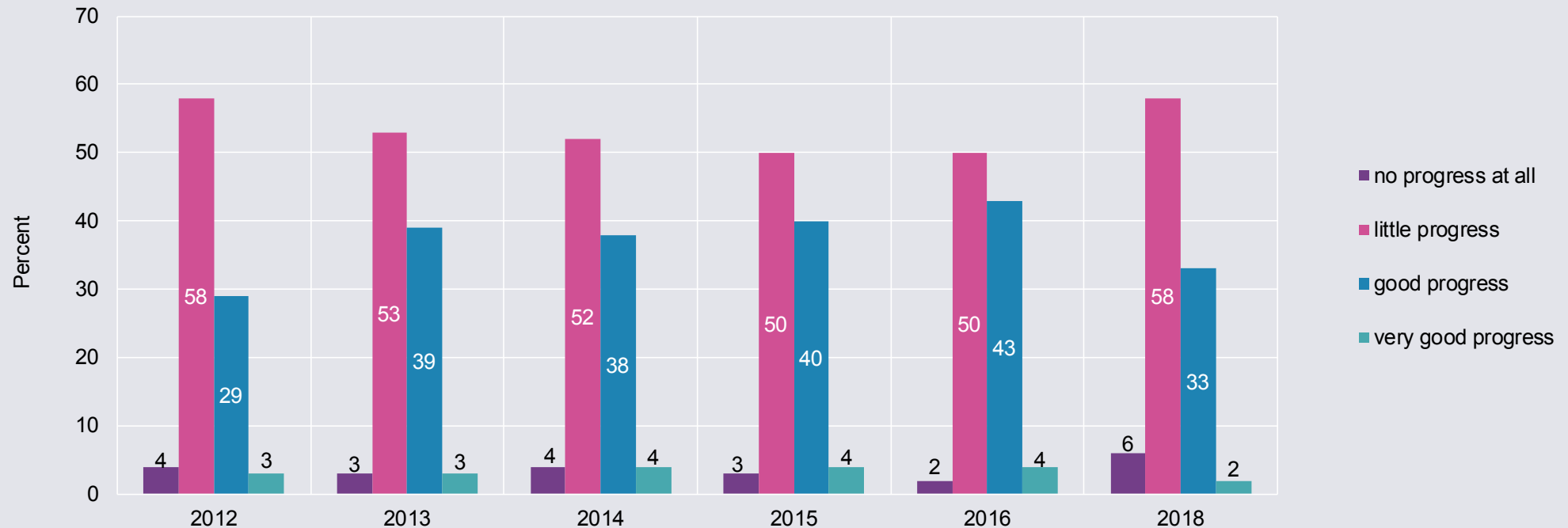
„The energy transition is...“



Bundesverband der Energie- und Wasserwirtschaft e.V. (2018), totals do not add up to 100 due to rounded values

The population's attitude towards the energy transition in 2018: Only 35 percent of the population are satisfied with the implementation of the energy transition

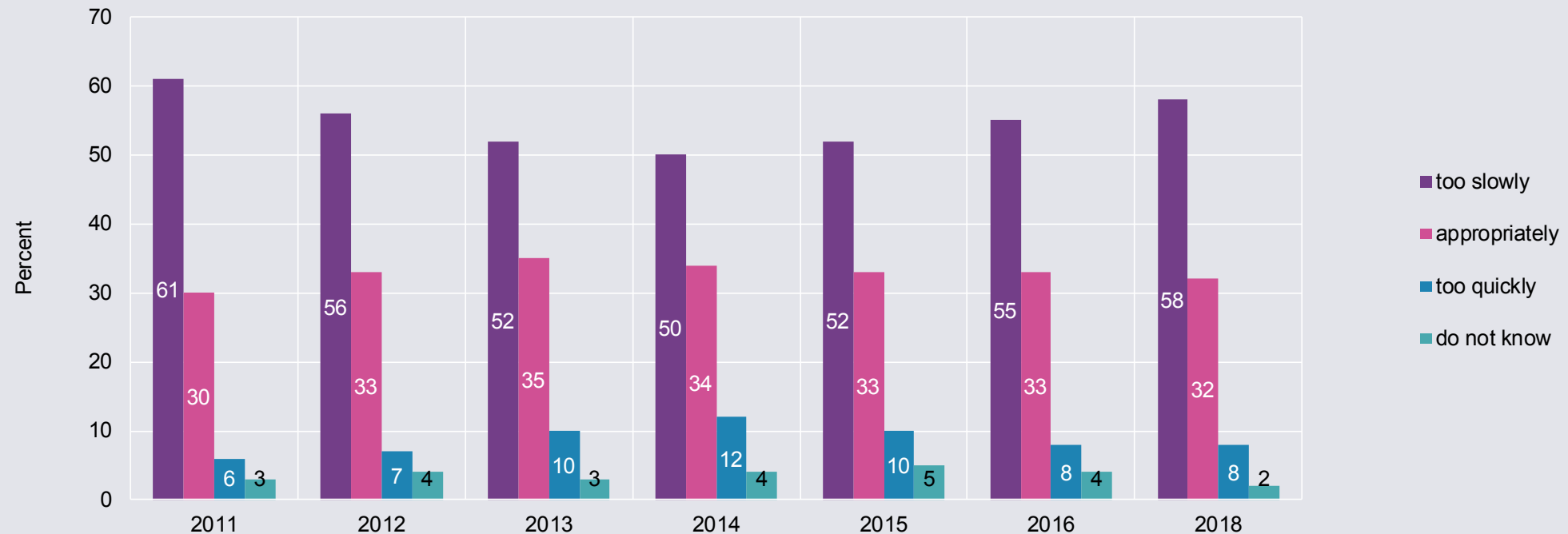
"The energy revolution in Germany is making ..."



Bundesverband der Energie- und Wasserwirtschaft e.V. (2018), totals do not add up to 100 due to rounded values

The population's attitude towards the energy transition in 2018: For 58 percent of the population, the renewables expansion advances too slowly

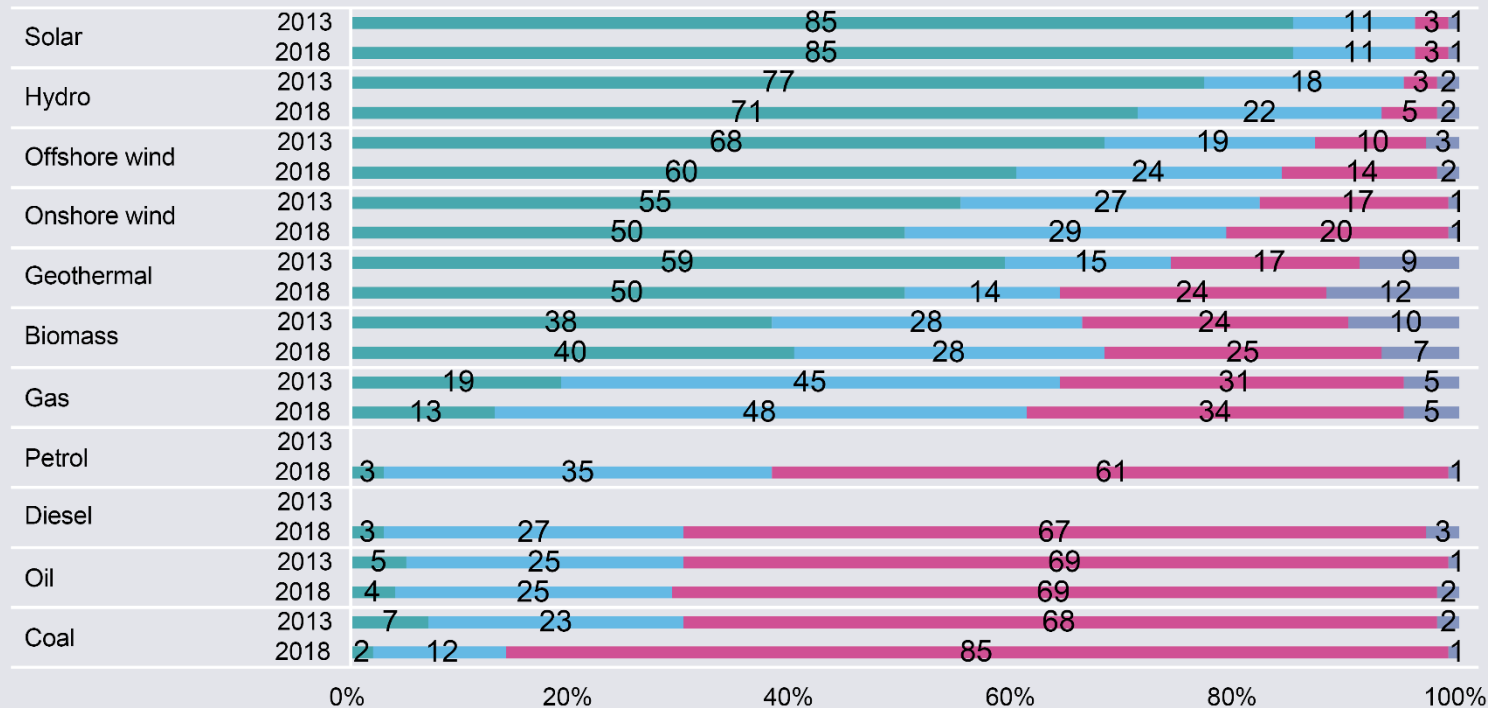
"The expansion of renewable energies is progressing..."



Bundesverband der Energie- und Wasserwirtschaft e.V. (2018), totals do not add up to 100 due to rounded values

The population's attitude towards the energy transition in 2018: 85 percent of the population would like to see more solar energy and less coal-fired power

"Which source of energy should be used more?"



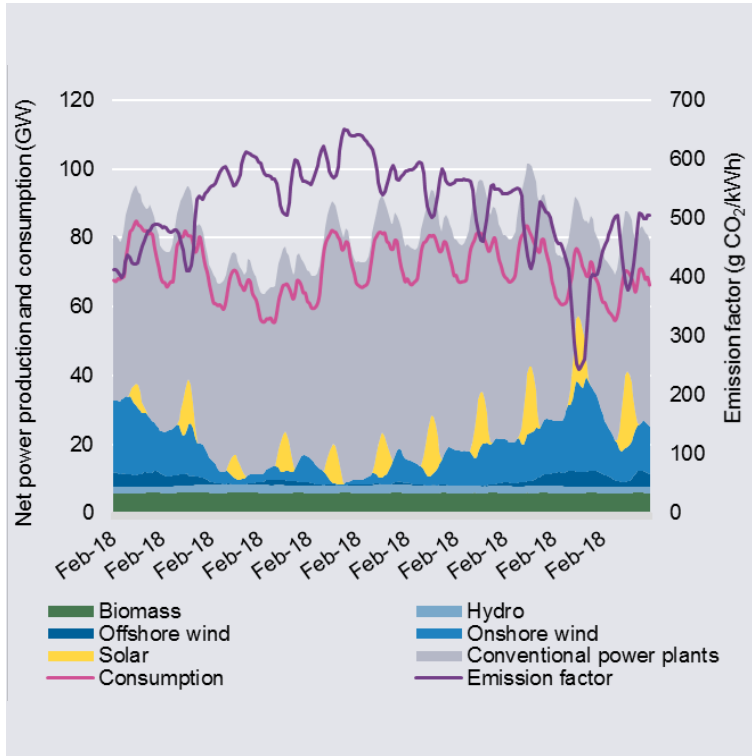
Bundesverband der Energie- und Wasserwirtschaft e.V. (2018), totals do not add up to 100 due to rounded values

Notable Events in 2018



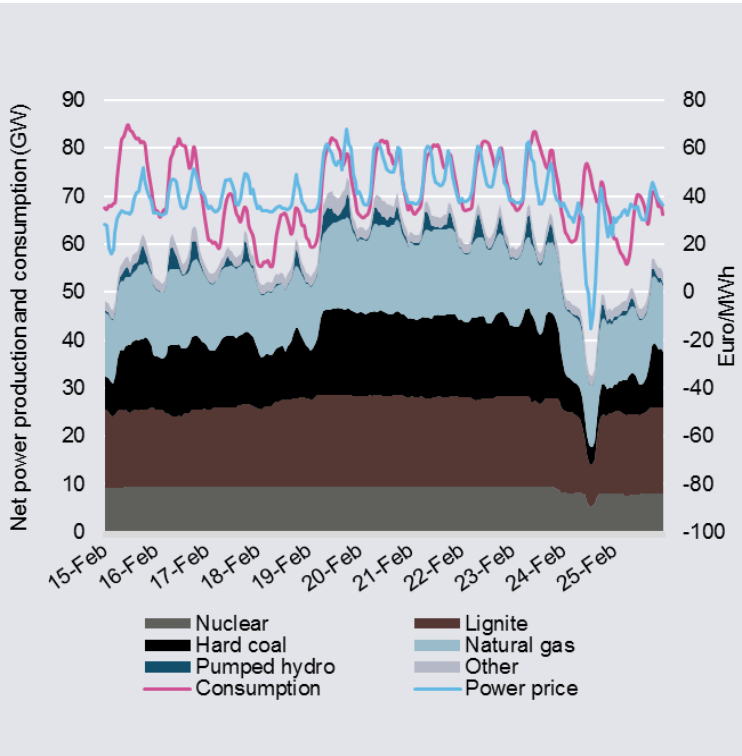
The cold period in February 2018: Renewables supply only 11 percent of electricity demand at times, but Germany still exports to its neighbours

Net electricity generation and consumption and emission factor (15-25 February)



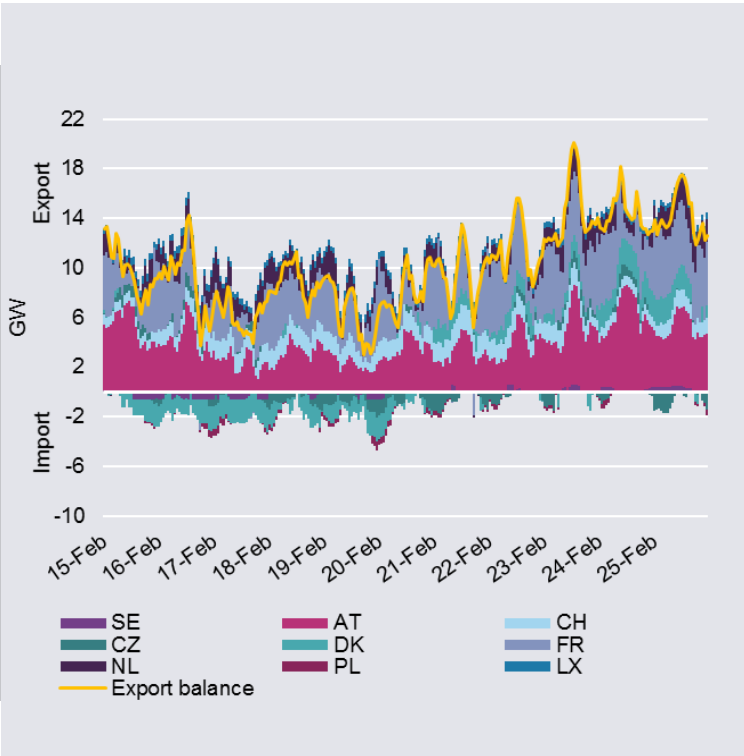
Agora Energiewende (2018)

Net electricity generation and consumption and power price (15-25 February)



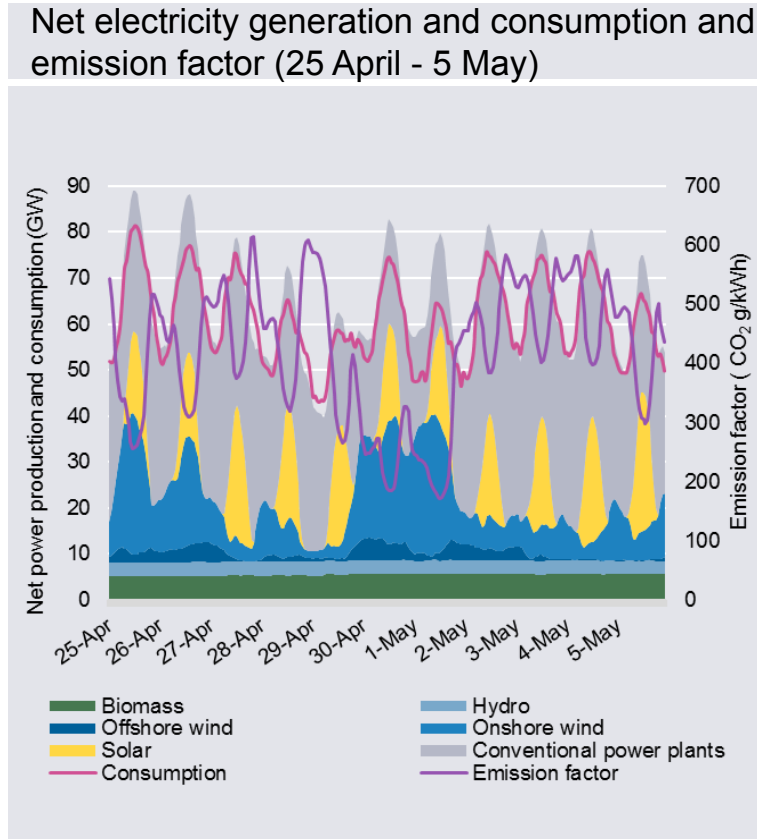
Agora Energiewende (2018)

Trade flows and export balance (15-25 February)

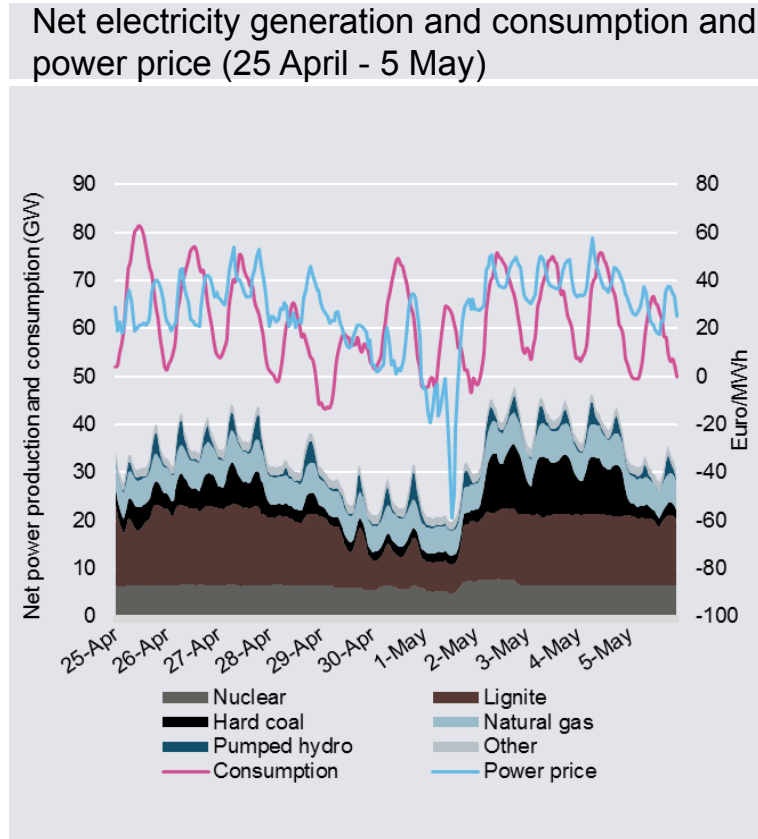


Agora Energiewende (2018)

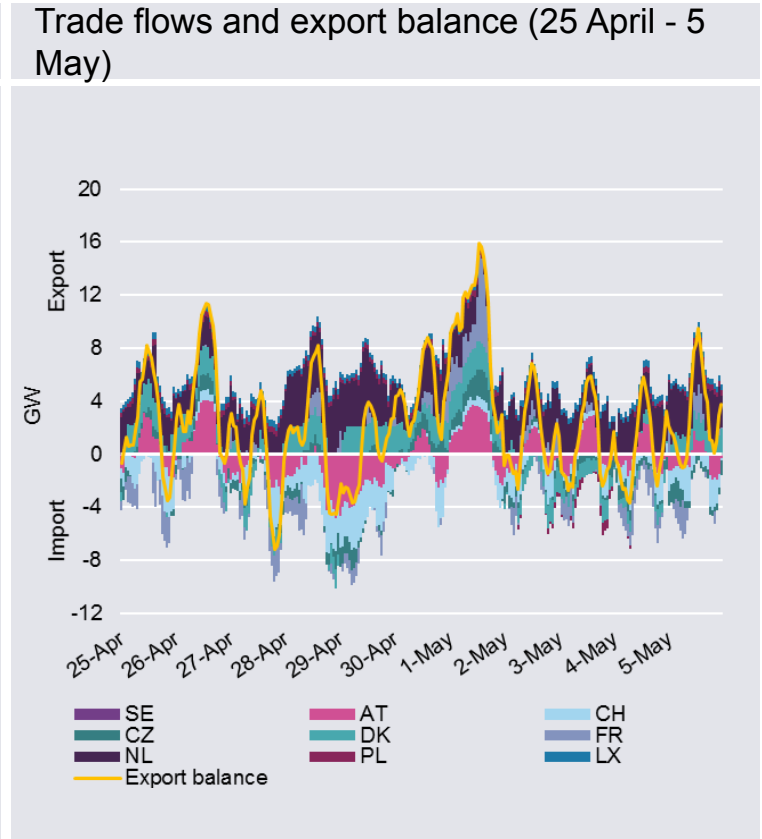
The day with the highest share of renewable energies in net electricity demand in May 2018: Wind and solar power cause negative electricity prices, since nuclear, lignite and gas CHP plants continue to operate at the same time



Agora Energiewende (2018)



Agora Energiewende (2018)



Agora Energiewende (2018)



Outlook 2019

Outlook for the year 2019 – Trends in the electricity sector

- **Energy consumption:** Following the sharp drop in primary energy consumption in 2018, an increase is more likely in 2019, as the special factors in 2018 (mild weather, high oil prices, decline in production in some energy-intensive industries) may change again quickly. Electricity consumption is expected to remain constant in 2019.
- **Renewable energies:** Sluggish approval procedures for onshore wind energy will result in further declines in new capacity (after 5 GW in 2017 and 3 GW in 2018 probably only 2 GW in 2019). In the case of solar energy, on the other hand, an increase of more than 3 gigawatts should take place in 2019, as in 2018. At 1.4 gigawatts, wind offshore will receive a new boost from old EEG plants before no new connections are expected in 2020/2021.
- **Conventional power plants:** Several shutdowns of conventional power plants are expected in 2019: 800 megawatts of lignite will be transferred to safety readiness, one gigawatt of old hard coal will be shut down, 800 megawatts of temporary shutdowns of gas-fired power plants have been announced and the Philippsburg 2 nuclear power plant (1 GW) will be closed on 31 December 2019.

Outlook for the year 2019 – Climate and energy policy

- **Climate Protection Act:** The coalition agreement stipulates that a legal framework for safe compliance with the 2030 climate protection targets is to be adopted. A corresponding bill is expected from the Federal Environment Ministry in spring.
- **Coal phase-out:** In February, the Coal Commission will present its recommendations, which will then be implemented by the Federal Government and the Bundestag.
- **Renewable energies:** A reform of the Renewable Energy Sources Act (EEG) is necessary for 2019 to secure the necessary expansion for the 65% target of 2030 and to focus on increasing acceptance for the construction of new wind farms on land.
- **Climate protection for transport and buildings:** So far, there are hardly any measures that ensure compliance with the climate protection sector targets for transport and buildings in 2030. These would have to be adopted in 2019 in order to take timely effect. This includes in particular a CO₂-oriented, revenue-neutral reform of taxes, existing levies and levies on energy.

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Thank you for your attention.

Do you have questions or comments? Please contact me:

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