The energy transition in the power sector: State of affairs 2016

A review of the major developments in Germany and an outlook for 2017

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Key messages

Key Findings

1. **Natural gas was the winner in 2016, silently initiating a coal phase-out.** Thanks to sinking natural gas prices, power production from natural gas rose considerably. By contrast, coal-fired power production declined for the third year running, and a number of coal power stations are slated for closure in 2017. Should the 2016 trend continue, coal-fired power production in Germany will be eliminated by 2038.

2. **Renewable energy production and energy efficiency rose only slightly.** 2016 was a poor year in terms of weather for wind and sun, leading to a decline in power production from PV installations and onshore wind farms. But this decline was more than made up for by a sizeable increase in offshore wind power. Overall power demand dropped just somewhat, making it ever more unlikely that 2020 efficiency targets will be met.

3. **Harmful greenhouse gas emissions continued to rise.** The main reasons were strong economic performance and winter temperatures, which were somewhat colder than usual. The overall picture was not uniform, however. While emissions in the industrial, heating, and transportation sectors rose, they declined slightly in the electricity sector thanks to a drop in coal-fired power generation for the third consecutive year.

4. **Energy in all forms is cheap these days – save for household electricity.** 2016 saw sharp drops in the prices of coal, oil, and natural gas, even on spot markets. With an average of 26.6 euros per megawatt hour, energy hit a 10-year low. What is more, solar power went for 5.38 cents per kilowatt hour at the most recent PV auction, showing how inexpensive solar power can be. Yet low prices for natural gas, heating oil, gasoline, and diesel have not translated into more affordable household electricity, which remains elevated due to environmental levies and surcharges. In 2017, mains power is projected to rise to more than 30 cents per kilowatt hour

10 points on the 2016 power market

- **1. Renewables:** In 2016, power production from green energy rose slightly, from 187 terawatt hours to 191.4. Its share in total energy demand increased 0.8 percentage points, to 32.3 per cent. Given the hefty influx of new green energy facilities (especially in the wind sector), the increase in renewable power would have been greater were it not for 2016 being a below-average year for wind and solar power.
- **2. Electricity consumption:** German electricity use declined by 2.4 terawatt hours, from 595.1 to 592.7 terawatt hours, or 0.4 per cent. During the same year, the economy grew by 1.8 per cent, continuing its happy decoupling from electricity demand. Yet the process continues to be too slow. To reach the 2020 efficiency targets set by the German government – a 10-per cent reduction of electricity use relative to 2008 levels – eight fewer terawatt hours would have had to be consumed in 2016.

10 points on the 2016 power market

- **3. Conventional energy:** Conventional power plants produced 429.2 terawatt hours – three terawatt hours, or 0.7 per cent, less than in 2015. Hard coal power plants lost the most (7.7 terawatt hours, or 6.5 per cent), followed by nuclear power plants (6.9 terawatt hours, or 7.5 per cent), and lignite power plants (4.5 terawatt hours, or 2.9 per cent). By contrast, electricity production from gas-fired power plants increased by 16.5 terawatt hours, or 26.6 per cent.
- **4. Climate protection:** While total greenhouse gas emissions in Germany increased from 908 to 916 million tons (a 0.9-per cent bump), CO_2 emissions in the electricity sector dropped 5 million tonnes, or 1.6 per cent, to 306 million tonnes. This marks the third consecutive year that CO_2 emissions in this sector have fallen. By contrast, there is scarce evidence of climate protection in the industrial, heating, and transportation sectors.
- **5. Electricity trading:** In 2016, German electricity exports hit a new record: 55.5 terawatt hours, or 8.6 per cent of power production, were sold abroad. The main importing countries for German electricity were Austria, Switzerland, France, and the Netherlands.

10 points on the 2016 power market

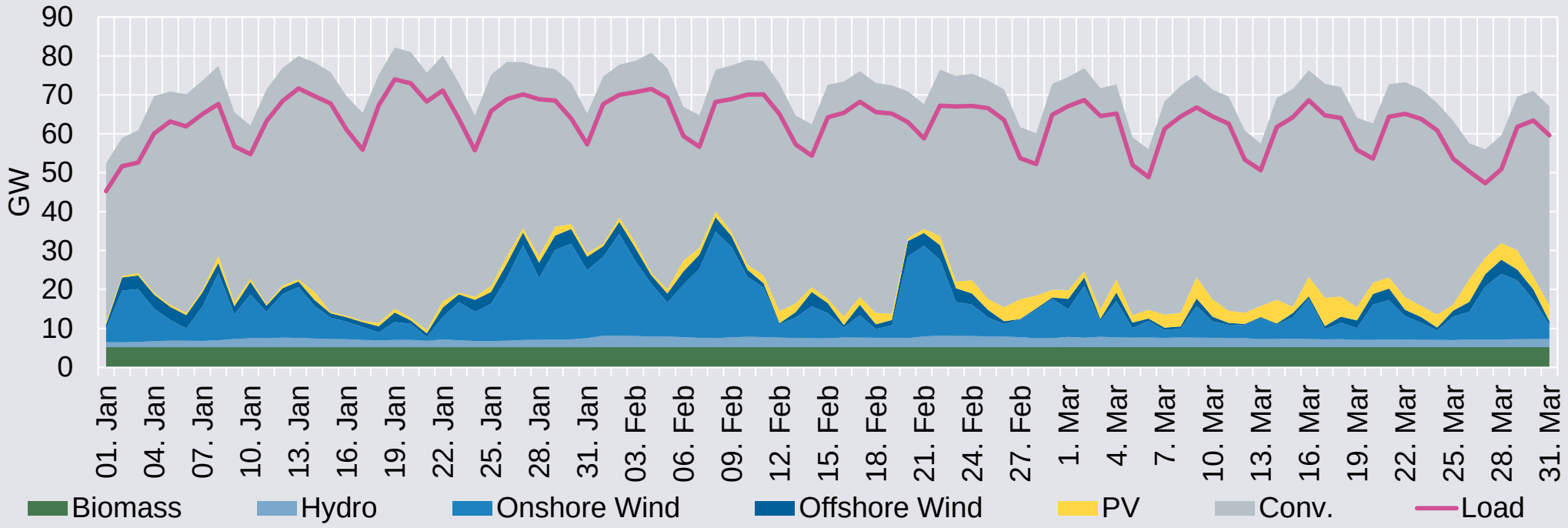
- **6. Electricity prices:** Electricity prices for future deliveries in 2017 dropped from 31 euros to 26.60 euros per megawatt hour. Next-day electricity prices on the spot market averaged 28.81 euros (versus 31.91 euros in 2015). By contrast, household electricity prices increased to 30 cents per kilowatt hour on account of higher levies and surcharges.
- **7. Flexibility:** Negative electricity prices on the German power market decreased, but were still lower than the previous year's. This indicates that participants in the energy market were able to respond more flexibly on the whole yet the number of conventional must-run power plants connected to the grid remained too many.

10 points on the 2016 power market

- **8. Record days:** On 8 May 2016 at 1 pm, 86.3 per cent of electricity demand was met by renewable energy, a greater share than ever before. Likewise, the lowest feed-in level of coal-powered electricity ever recorded – 7.6 gigawatts – occurred during the early morning hours of 27 March.
- **9. Mood:** Germans are firmly behind the transition to green energy. 93 per cent believe that it is “very important” or “important,” with the share of the former group rising from 50 per cent in 2015 to 57 per cent in 2016. Germany’s *Energiewende* hasn’t been this popular since 2012.
- **10. Outlook for 2017:** Several conventional power plants with a total output of four gigawatts will be shut down in 2017, reducing the excess capacity in Germany’s power plant fleet. The share of coal and nuclear energy in power generation will decline slightly while renewables are projected to keep rising. Due to the introduction of auctions for wind and biomass, the cost of adding renewables is expected to continue to fall.

Power generation in Q1 2016:
Year begins with high demand and winter storms

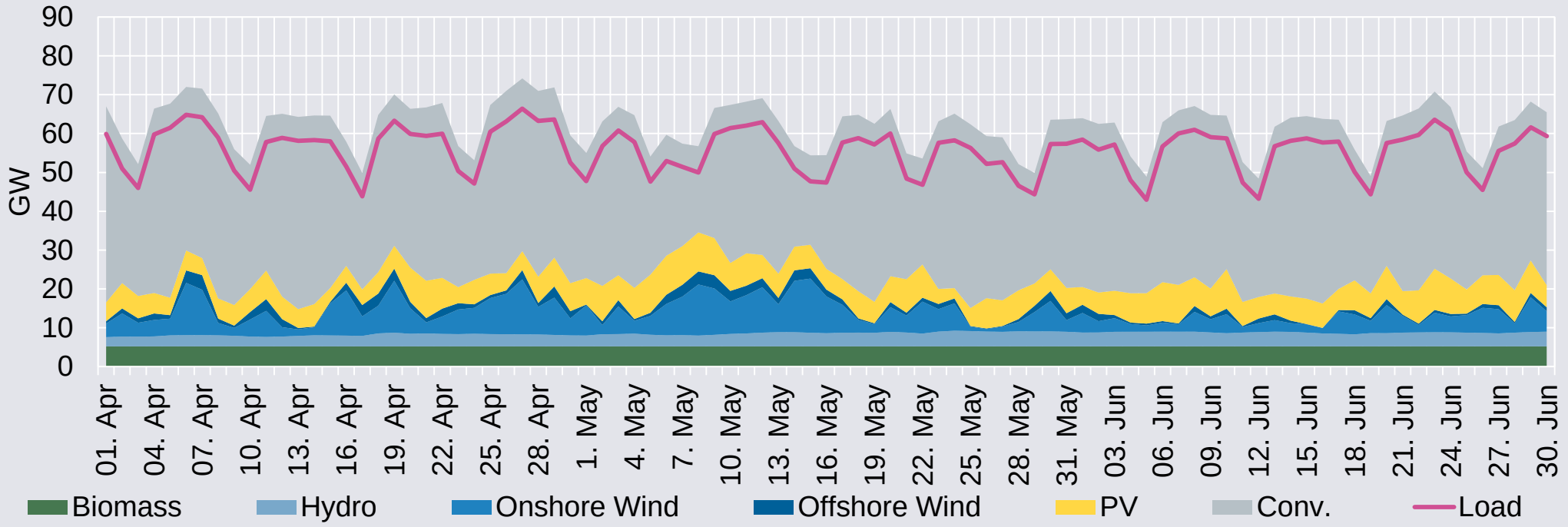
Power generation and demand in Q1 2016 (daily average)



Agora Energiewende 2017

Power generation in Q2 2016:
Wind yield and power demand decline; solar power generation increases

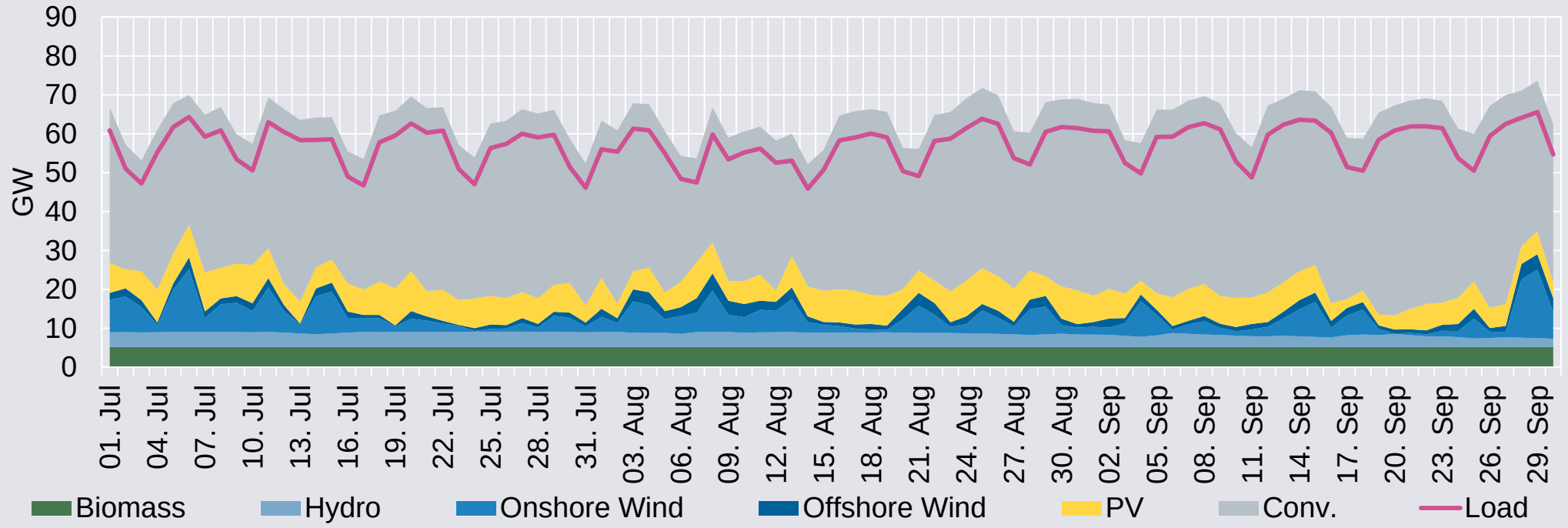
Power generation and demand in Q2 2016 (daily average)



Agora Energiewende 2017

Power generation in Q3 2016:
Summer brings much sun but little wind

Power generation and demand in Q3 2016 (daily average)



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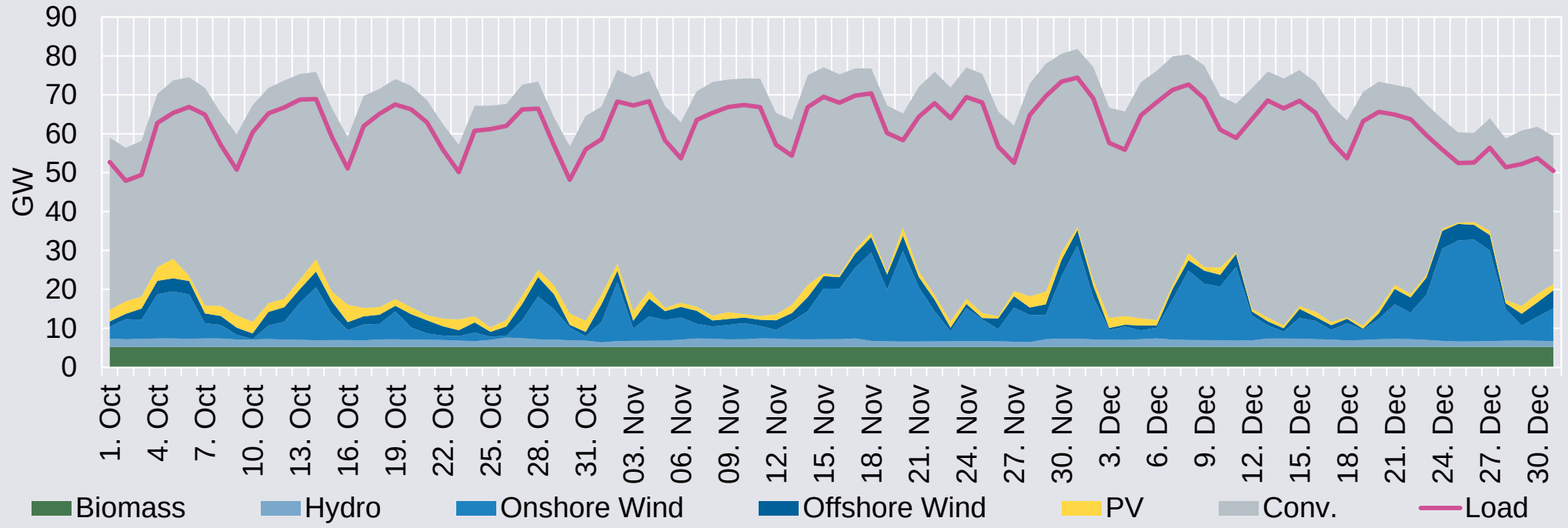
Power generation in Q4 2016:
Autumn sees little power from renewables – wind strong only over Christmas

Power generation and demand in Q4 2016 (daily average)



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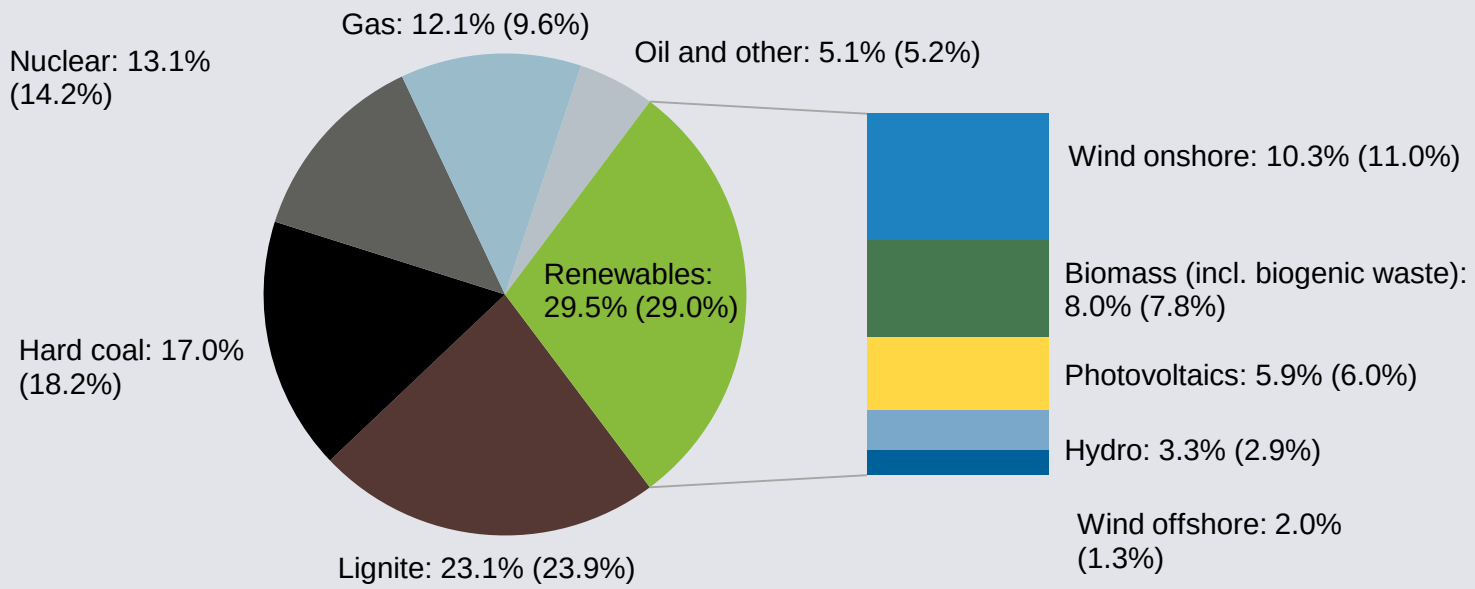
Electricity production and demand 2016

Power mix 2016: Renewables make up largest share; gas is the biggest winner, hard coal is the biggest loser

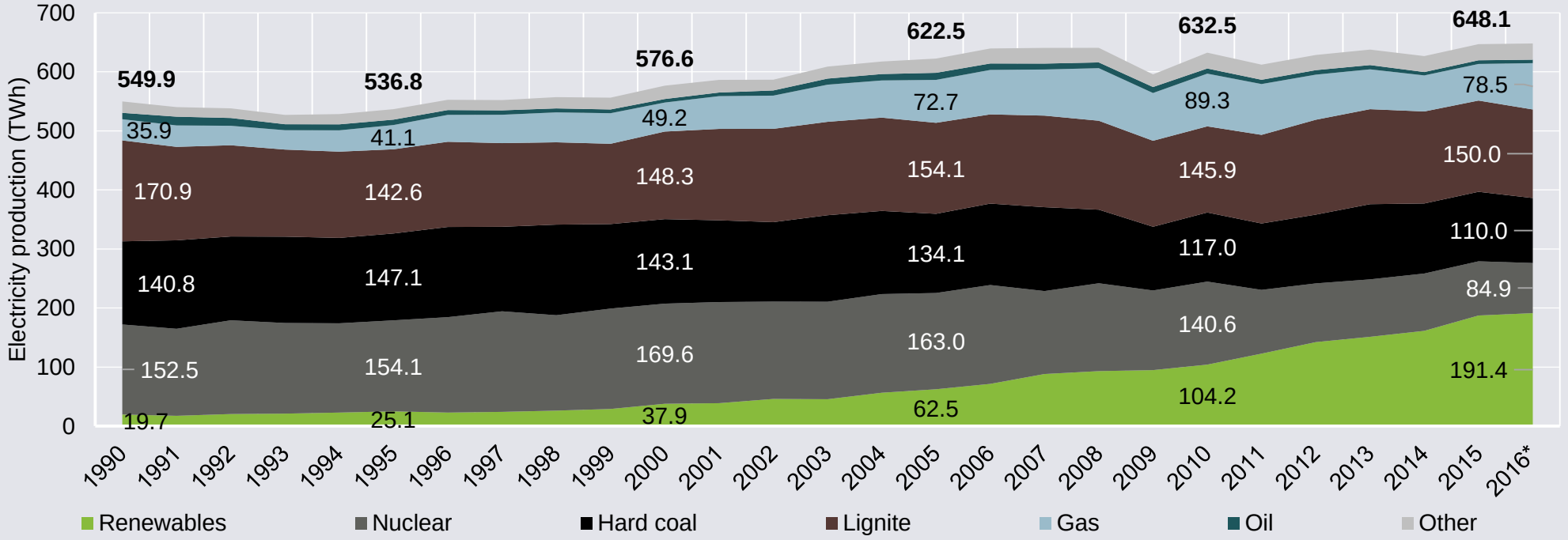
2016 power mix (2015 values in brackets)



AG Energiebilanzen 2016a

Power production, 2000-2016: Renewables quintuple; nuclear power falls by half; the sum of fossil fuel energy sources (coal, gas) remain constant

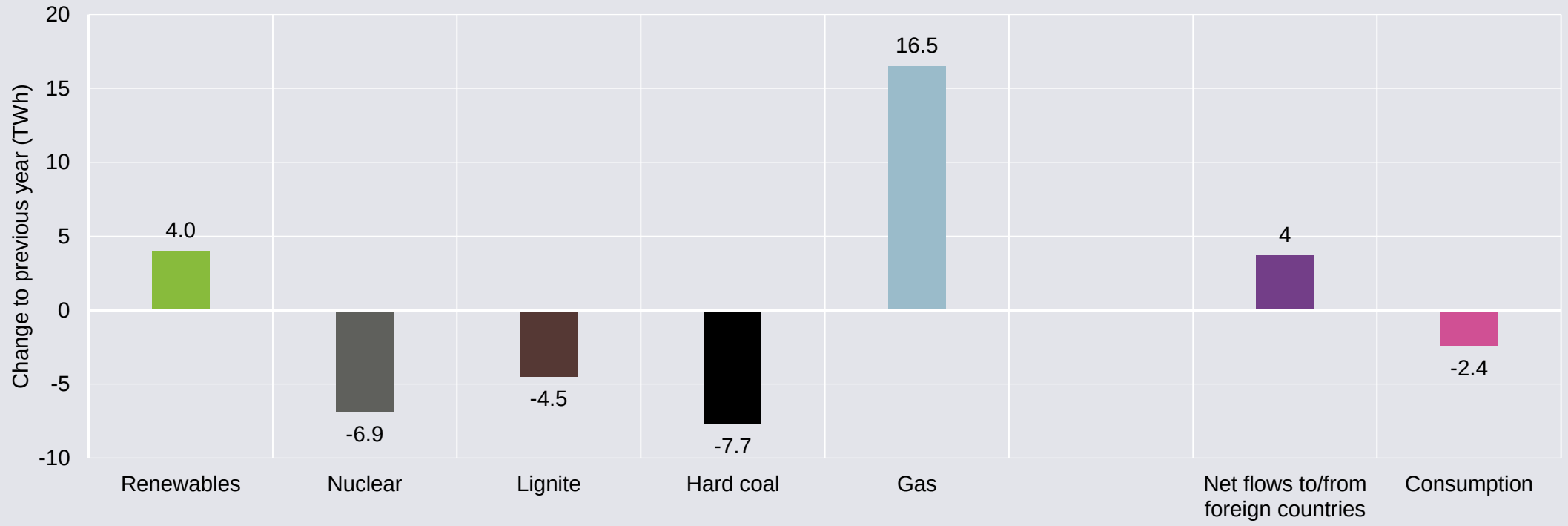
Power production, 1990-2016



AG Energiebilanzen 2016a

Changes from 2015 to 2016: Increases in renewables, but primarily in natural gas; decreases in coal, nuclear power and demand

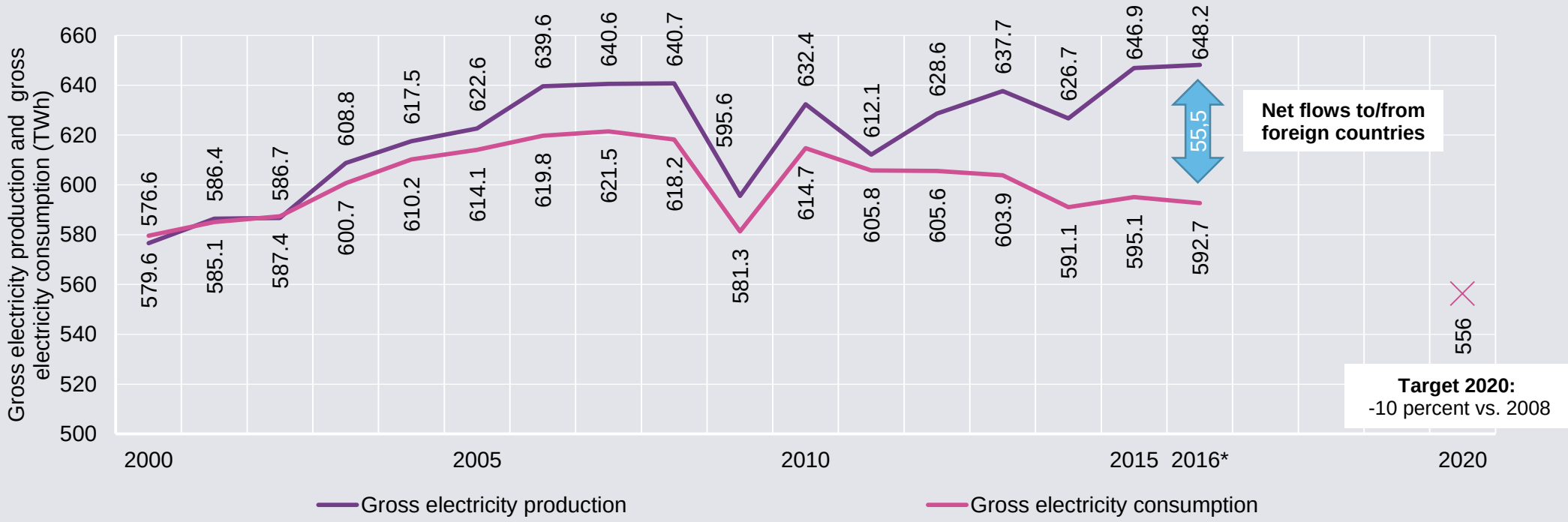
Changes in electricity volumes, 2015–2016



AG Energiebilanzen 2016a

Power production soars to new heights while consumption declines: 8.6% of electricity in 2016 goes to neighbouring countries; exported electricity primarily from hard coal

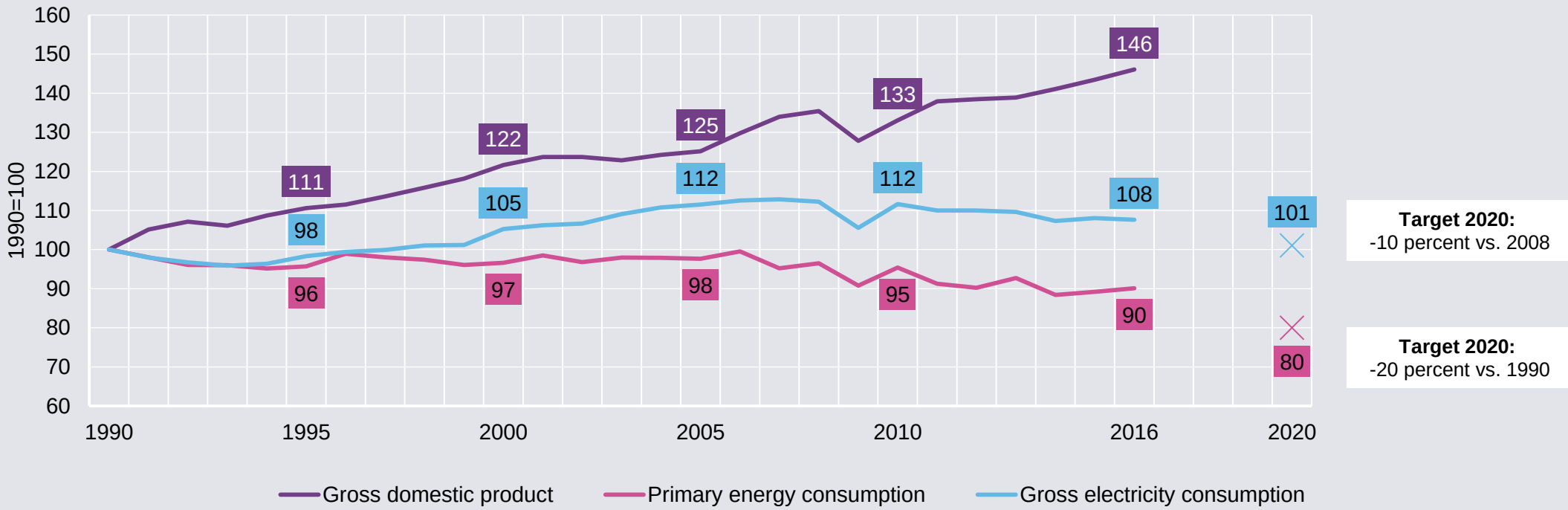
Electricity production and demand, 2000–2016, together with 2020 efficiency target



AG Energiebilanzen 2016a

Growth decouples from energy consumption in 2016: Economic growth at 1.8 per cent, electricity use falls slightly – yet meeting the 2020 efficiency target increasingly unlikely

Gross domestic product, primary energy consumption and electricity production, 1990–2016 (indexed, 1990=100)



AG Energiebilanzen 2016a; Statistisches Bundesamt, own calculations

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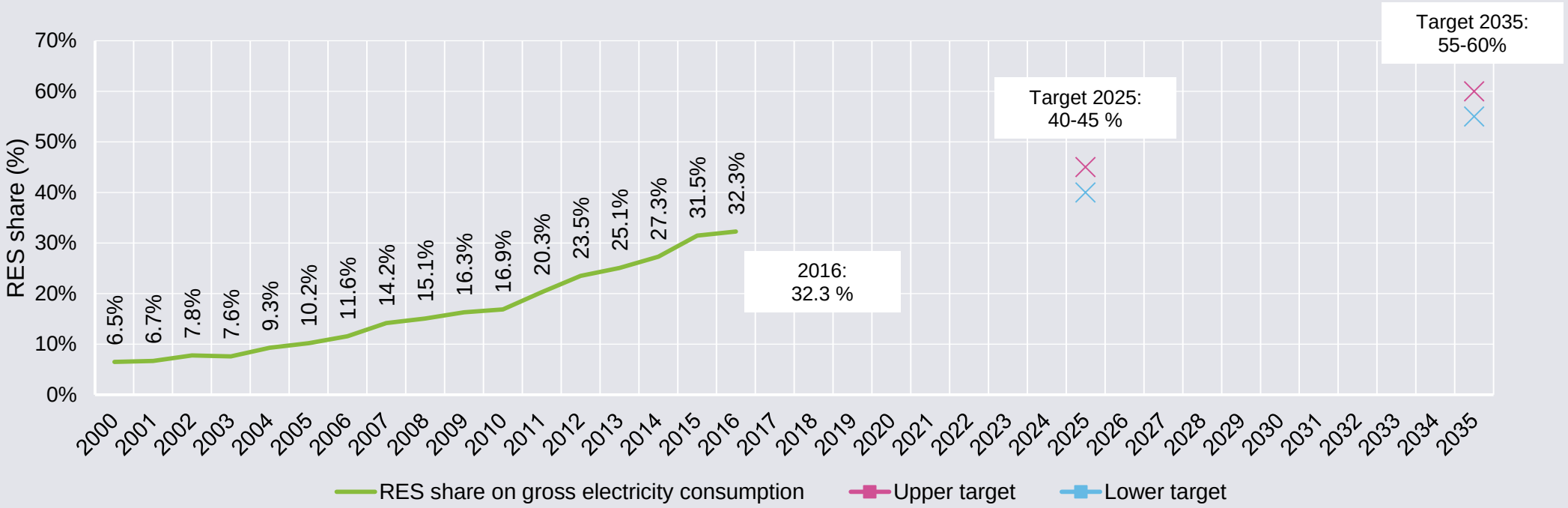
Renewables in the electricity sector 2016

Renewables cover 32.3 per cent of electricity use – share grows slightly relative to the previous year

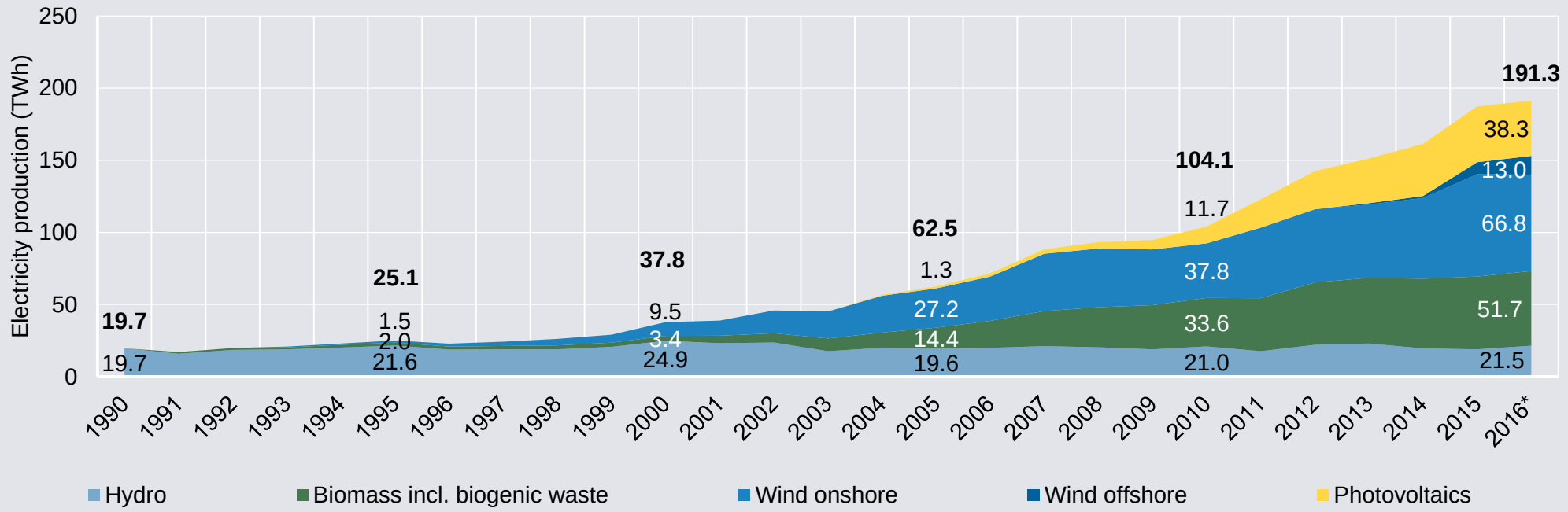
Share of renewables in gross energy consumption, 2000–2016, together with 2025 and 2035 targets



AG Energiebilanzen 2016a

Poor year for wind and sun results in decreased solar power (-0.4 TWh) and onshore wind power (-4.1 TWh); growth in offshore wind (+4.7 TWh), hydropower (+1.5 TWh) and biomass (+1 TWh)

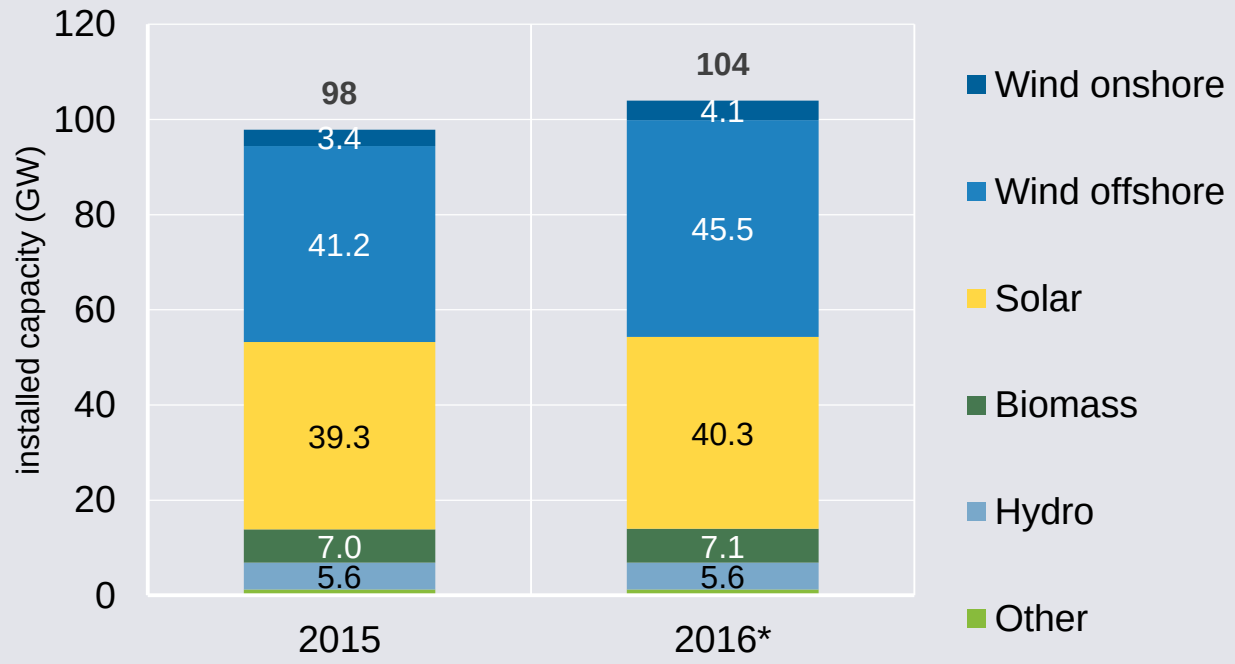
Electricity production from renewables, 1990–2016



AG Energiebilanzen 2016a

Six gigawatts of new capacity introduced in 2016: More onshore wind farms but PV expansion considerably below targets

Renewable capacity in 2015 and 2016



BNetzA 2016a, *on basis of BNetzA 2016b, FA Wind 2016 and BWE 2016

Increases in 2016 (estimated)

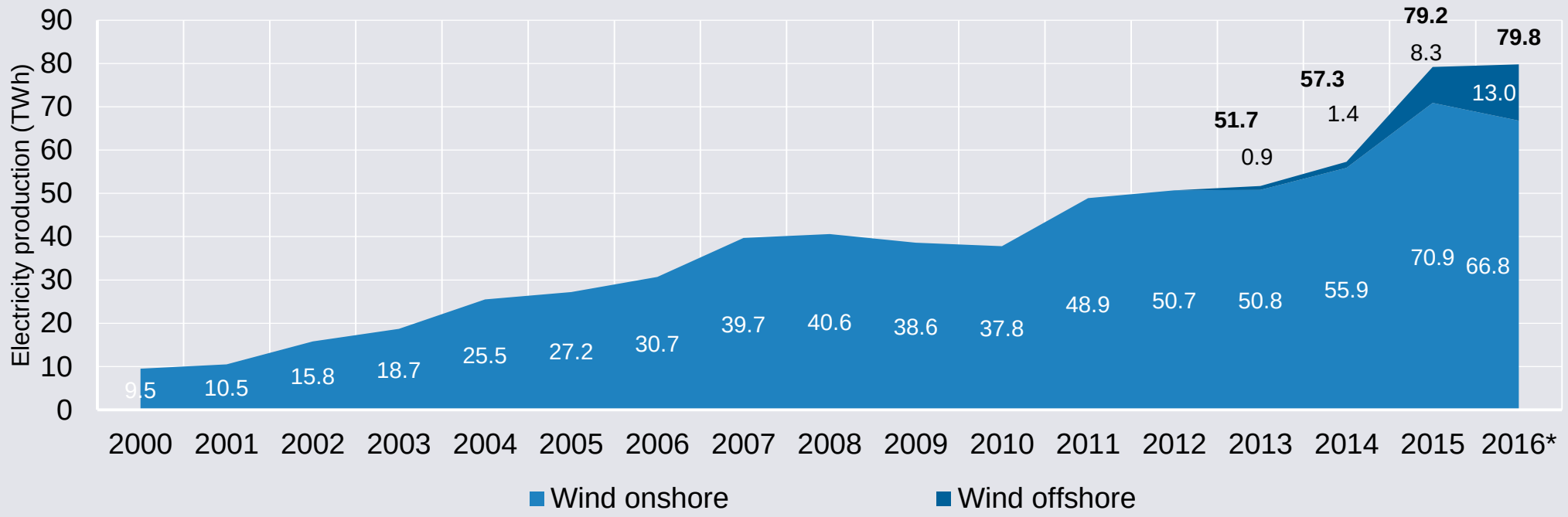
- Wind onshore: 4.3 gigawatts
- Wind offshore: 0.7 gigawatts
- Solar: 1 gigawatt
- Biomass: 40 megawatts

Expansion corridor defined by EEG 2014

- Wind onshore: 2.5 gigawatts per year
- Wind offshore: approx. 0.7–0.8 gigawatts per year
- Solar: 2.5 gigawatts per year
- Biomass: 100 megawatts per year

Wind power 2016: Offshore wind energy now makes up 2 per cent of power production (+4.7 TWh), offsetting onshore wind energy (-4.1 TWh)

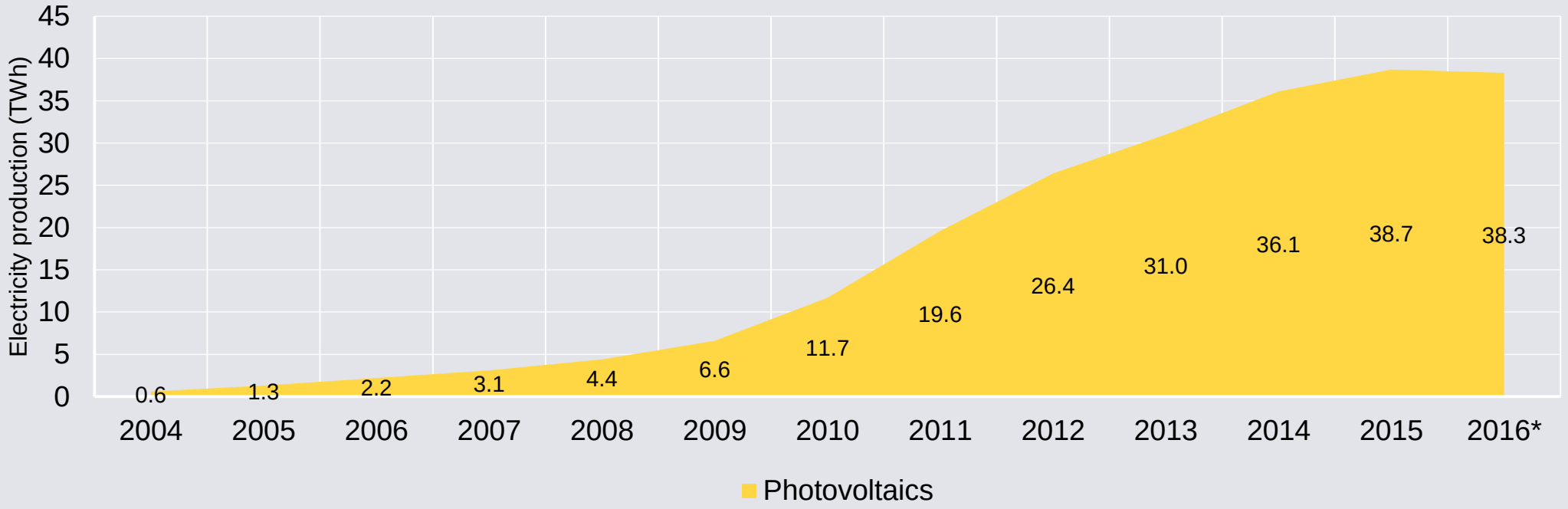
Power production from onshore and offshore wind turbines, 2000-2016



AG Energiebilanzen 2016a

Solar power production 2016:
Below average year for sun reduces solar generated electricity (-0.4 TWh)

Power production from PV installations, 2004-2016

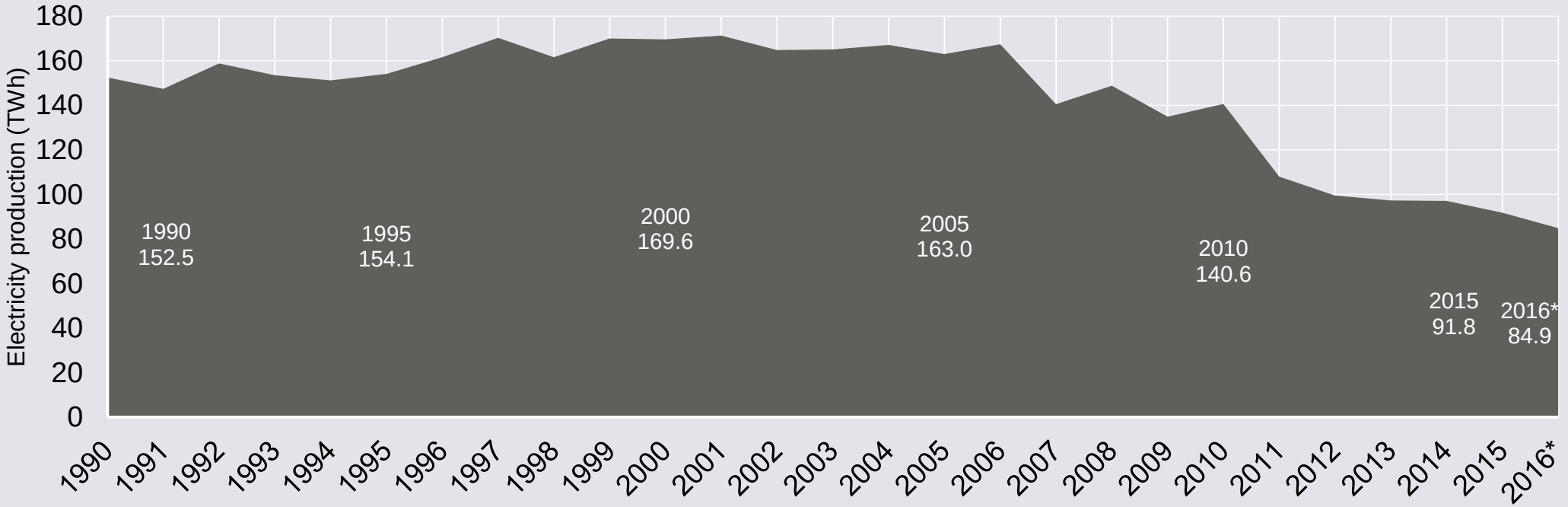


AG Energiebilanzen 2016a

Nuclear, coal and gas 2016

Nuclear energy 2016: Only half as much electricity from nuclear power as in 2000 (due to closure of Grafenrheinfeld in 2015 and to tax-based fuel switching shifts after 2017)

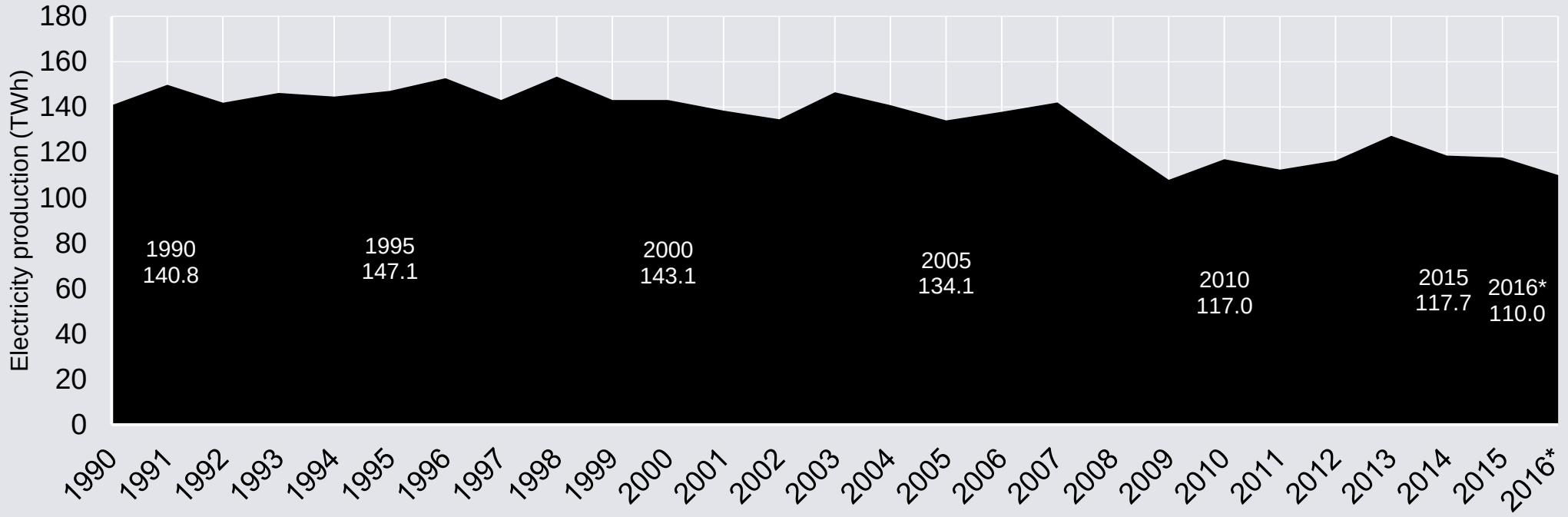
Power production from nuclear power plants, 1990-2016



AG Energiebilanzen 2016a

Power generation from hard coal is biggest loser in power mix 2016 (-7.7 TWh, -6.5 per cent)

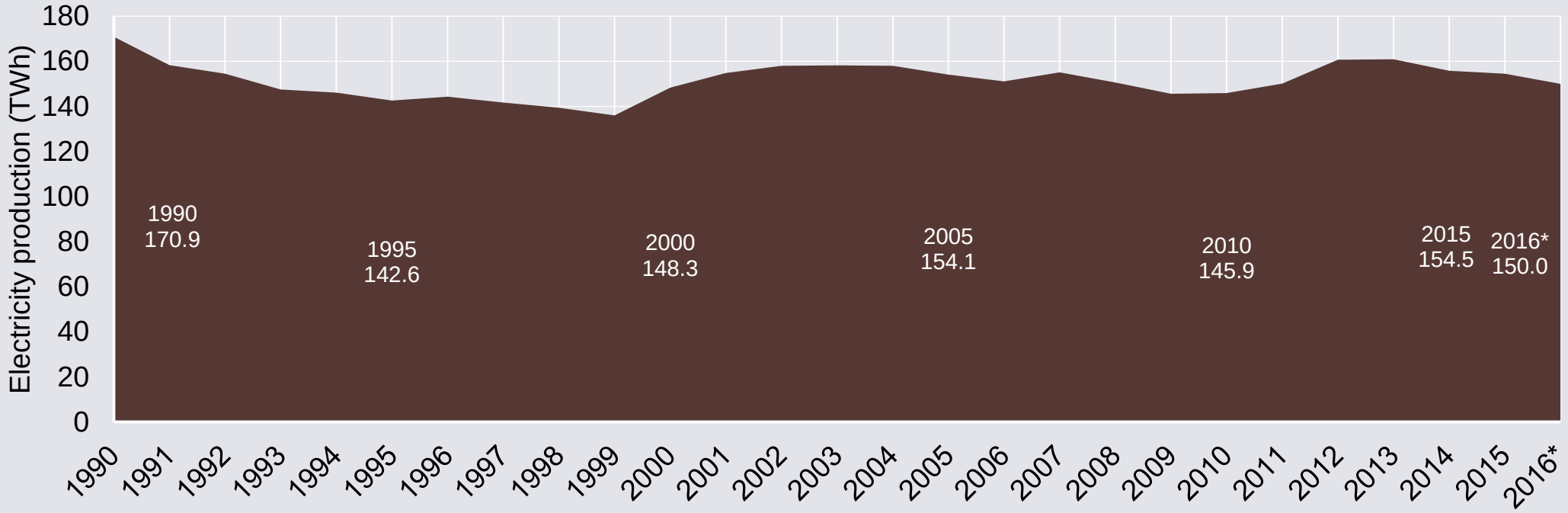
Power production from hard coal power plants, 1990-2016



AG Energiebilanzen 2016a

Power generation from lignite gradually declines from its high level in 2016 (-4.5 TWh, -2.9 per cent)

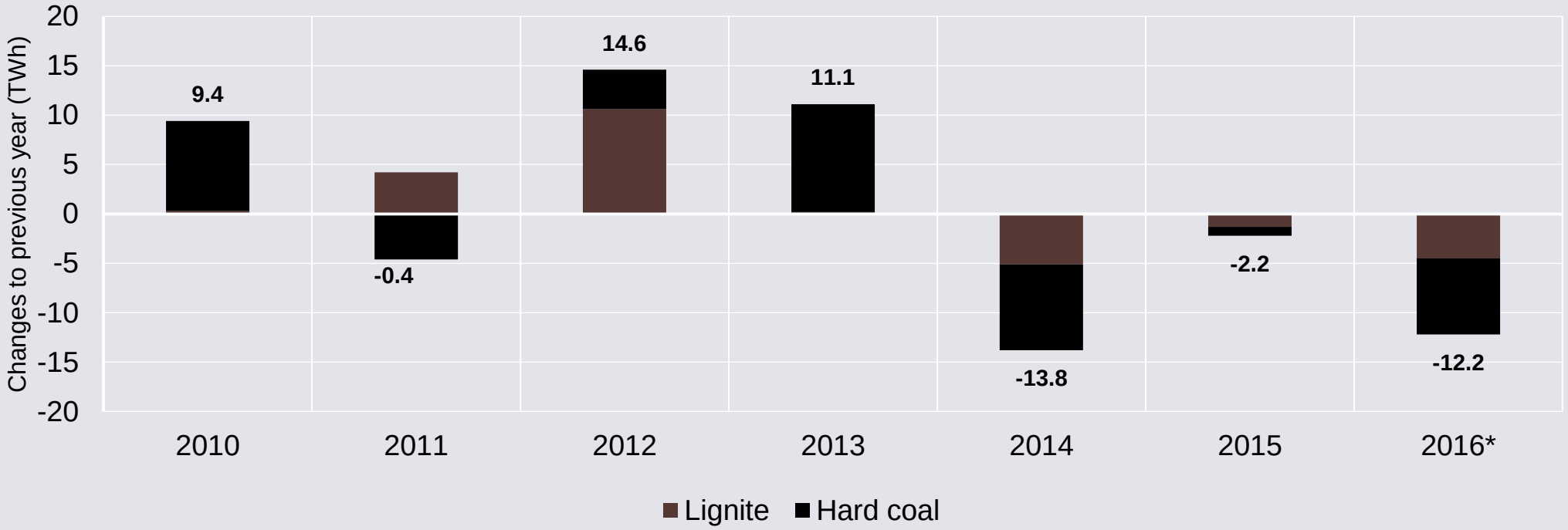
Power production from lignite power plants, 1990-2016



AG Energiebilanzen 2016a

Power generation from coal has declined since 2014 – should the 2016 trend (-12.2 TWh) continue, coal plants will no longer produce electricity by 2038

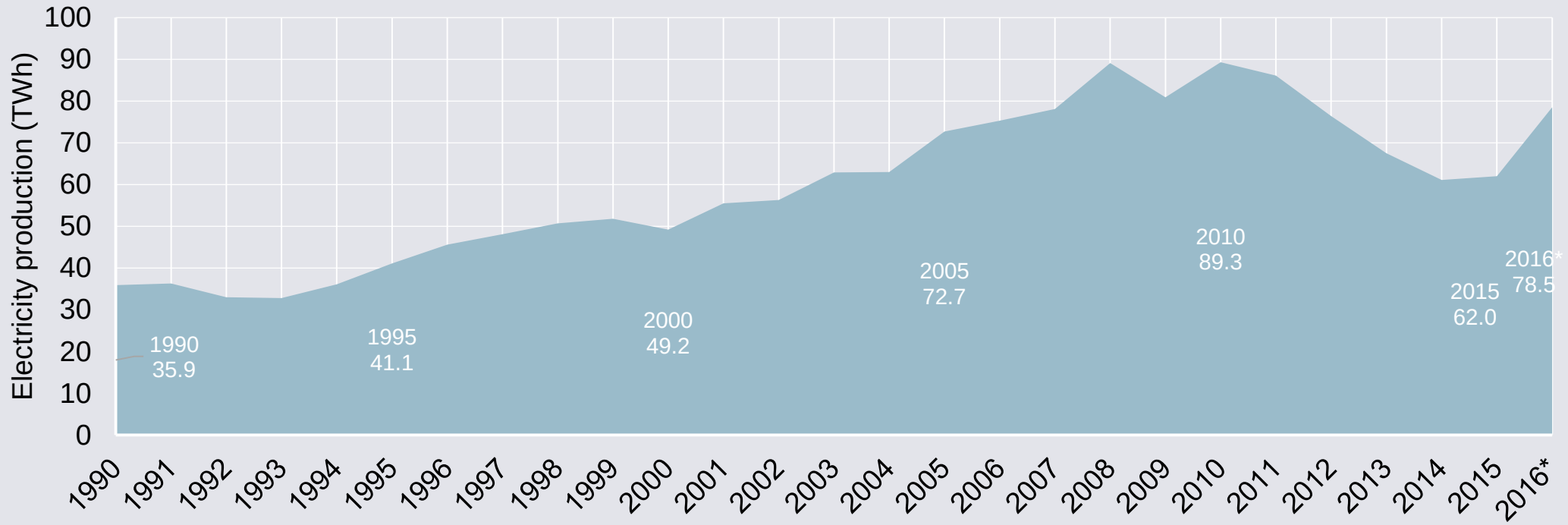
Changes in coal-fired power production relative to previous year, 2000-2016



AG Energiebilanzen 2016a

Power generation from natural gas in 2016: A steep rise (+16.5 TWh) at the expense of coal and nuclear power on account of low gas prices

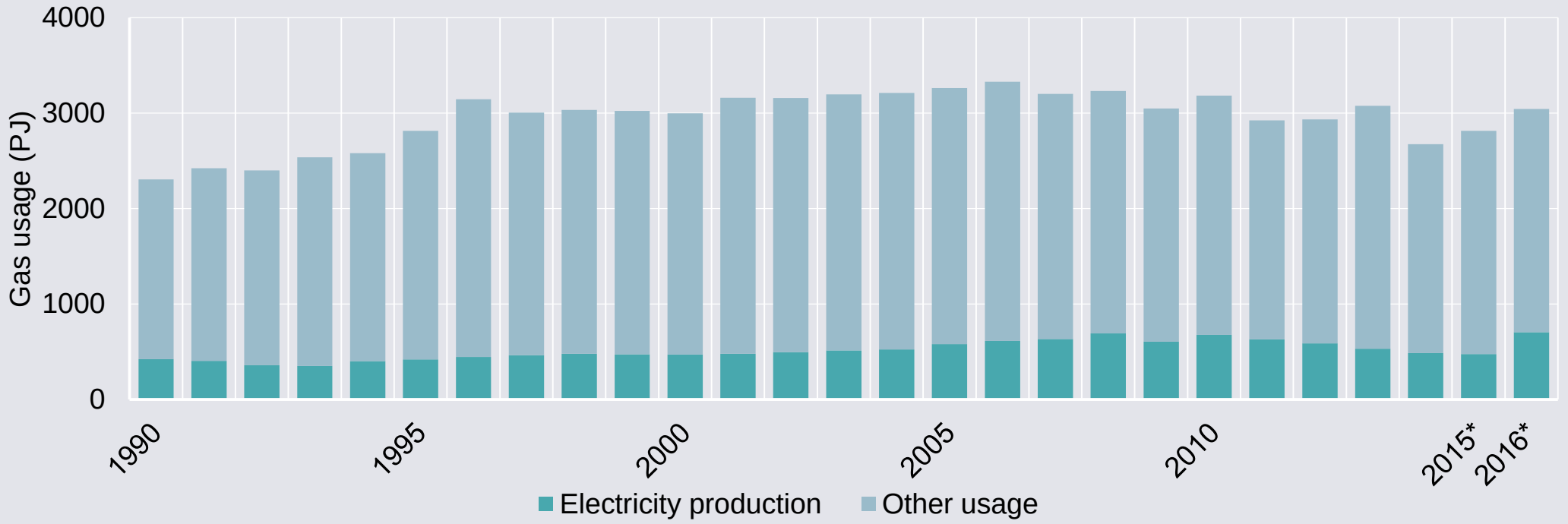
Power production from natural gas power plants, 1990–2016



AG Energiebilanzen 2016a

Natural gas consumption 2016: 10 per cent rise due especially to rising power generation from natural gas

Primary energy consumption of natural gas, 1990-2016

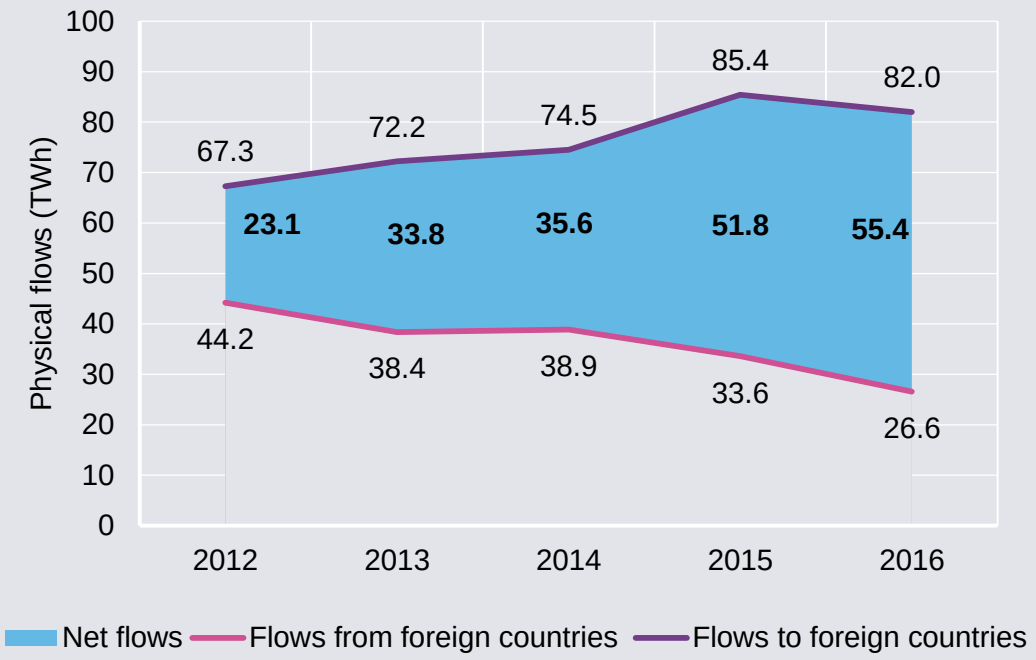


AG Energiebilanzen 2016b; *own calculations on basis of AG Energiebilanzen 2016a

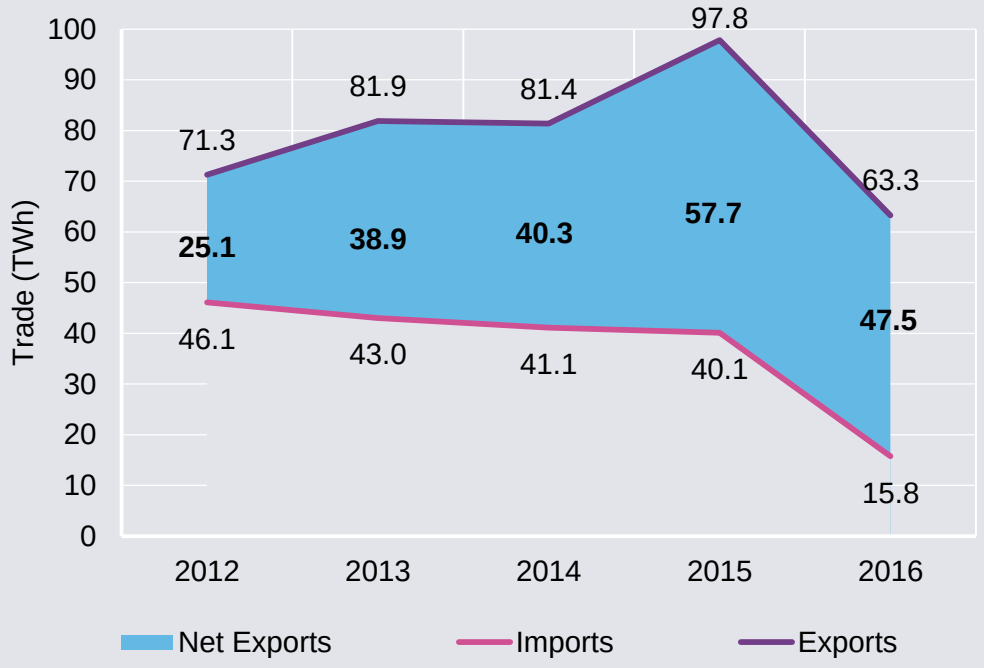
Power trading 2016

Germany hits another electricity export record in 2016 – the day-ahead power trade falls below the flow of physical electricity for first time

Physical trade, 2012–2016



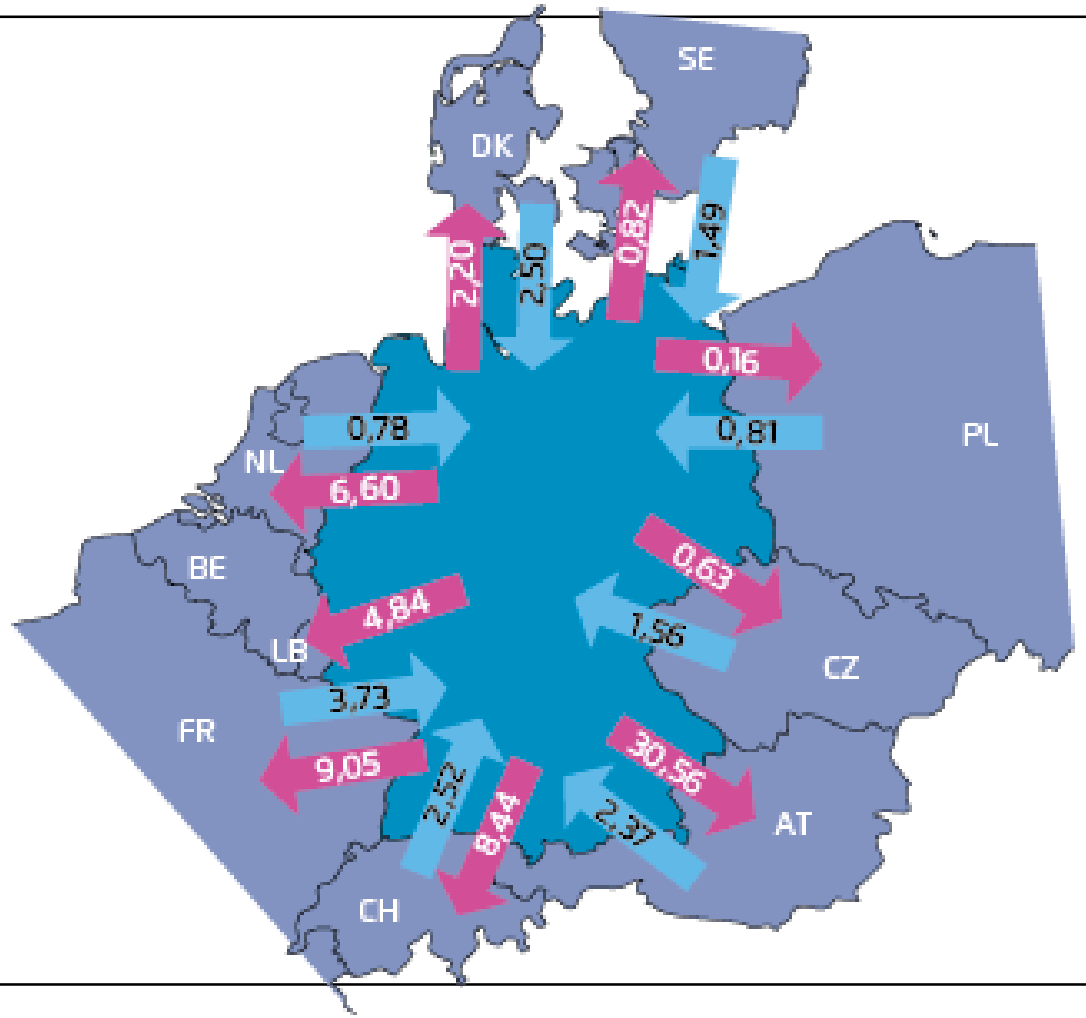
Power trade balance, 2012–2016



AG Energiebilanzen 2016a

Own calculations on basis of ENTSO-E 2016

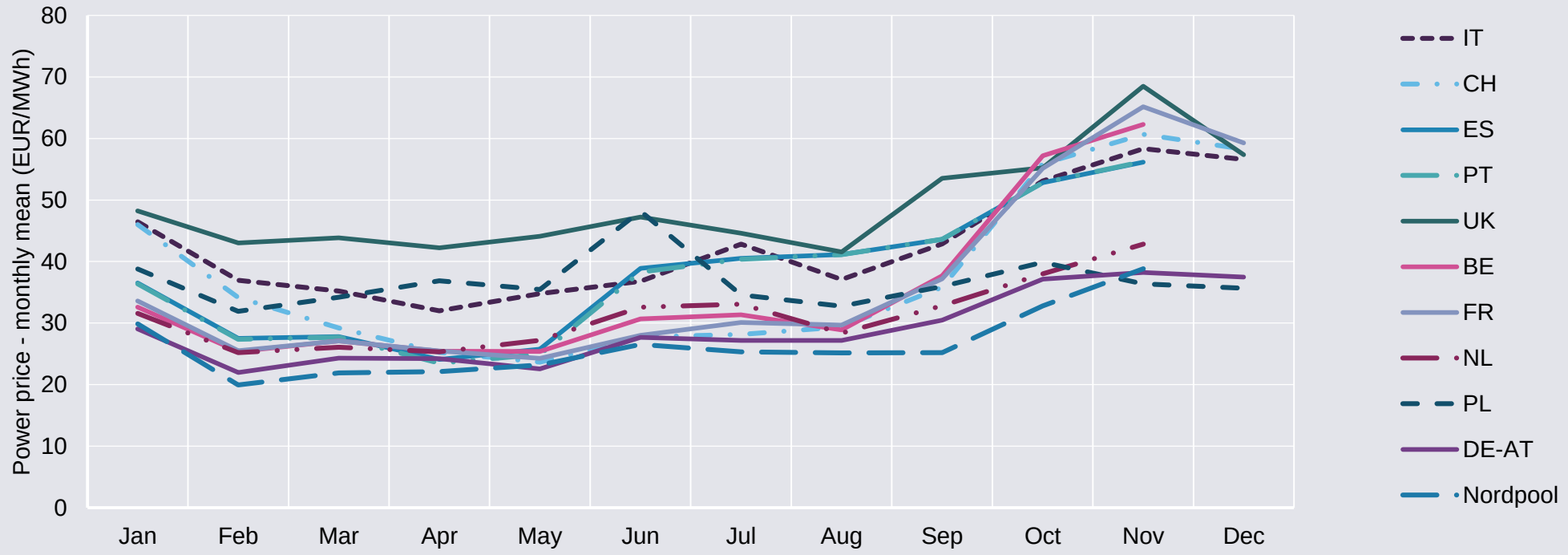
In 2016, Germany exported electricity primarily to Austria, France, Switzerland and the Netherlands



Exports: 63.3 TWh (2015: 97.8 TWh)
Imports: 15.8 TWh (2015: 36.9 TWh)
Balance: 47.5 TWh (2015: 60.9 TWh)
Traded electricity in TWh

European electricity prices in comparison, end of 2016: High spot market prices in the UK, FR, BE, ESP, PT, IT, CH Low spot market prices in DE/AT, PL, NL, Nordics

Spot market prices 2016 (Day-ahead base) in European comparison



EEX 2017, Nordpool 2017, Belpex 2017, OMEL 2017, Mercato Elettrico 2017, APX 2017, POLPX 2017

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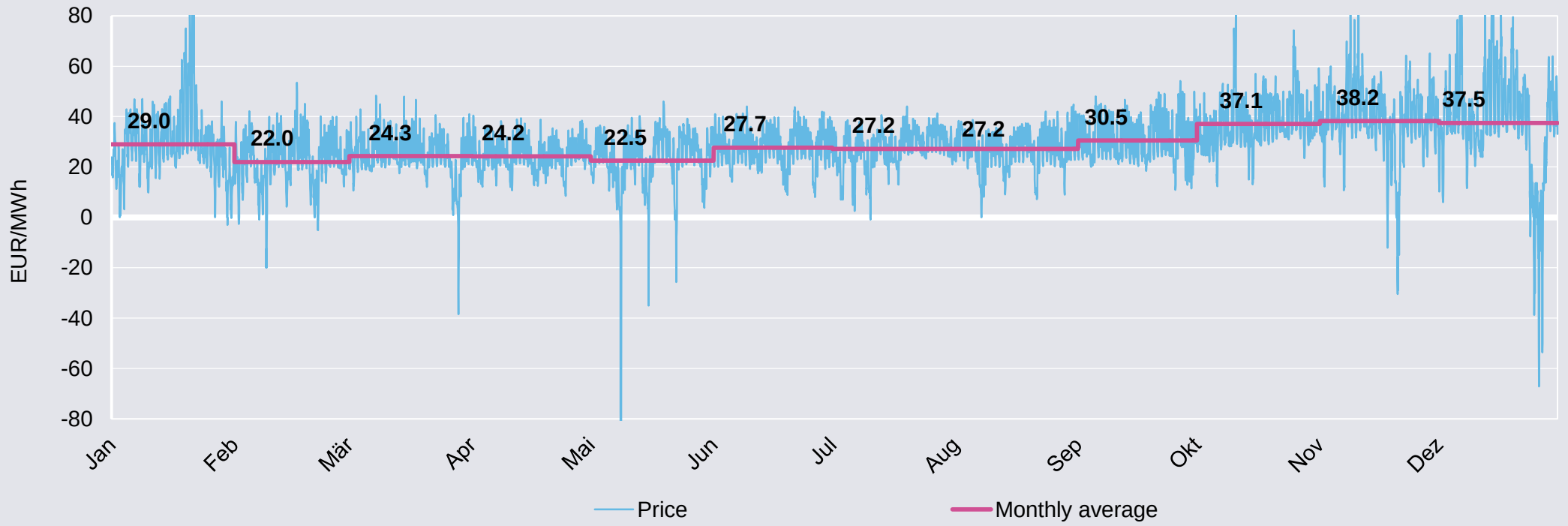
Electricity prices 2016

Spot market prices hit 12-year low – 29 euros per megawatt hour – in 2016; prices to rise again by year's end

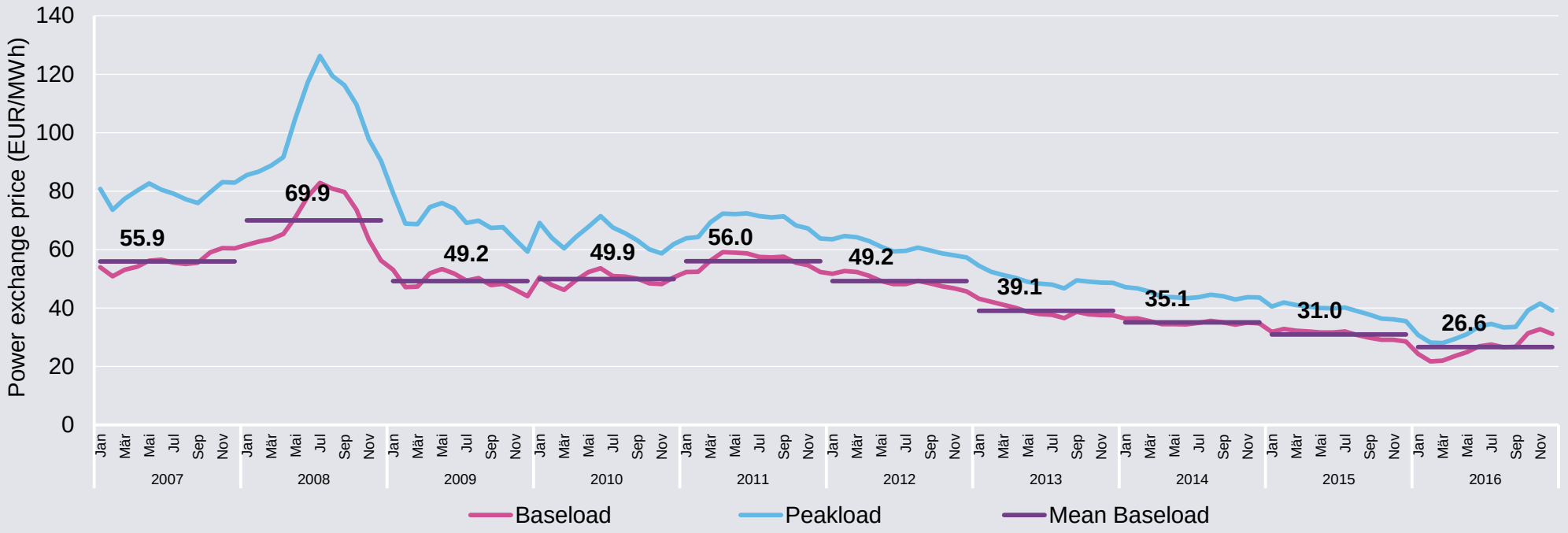
Spot market prices in day-ahead trading 2016



EPEX 2016

Electricity futures 2016: power purchases for the coming year at 26.6 euros per megawatt hour, once again 14 per cent under 2015 levels

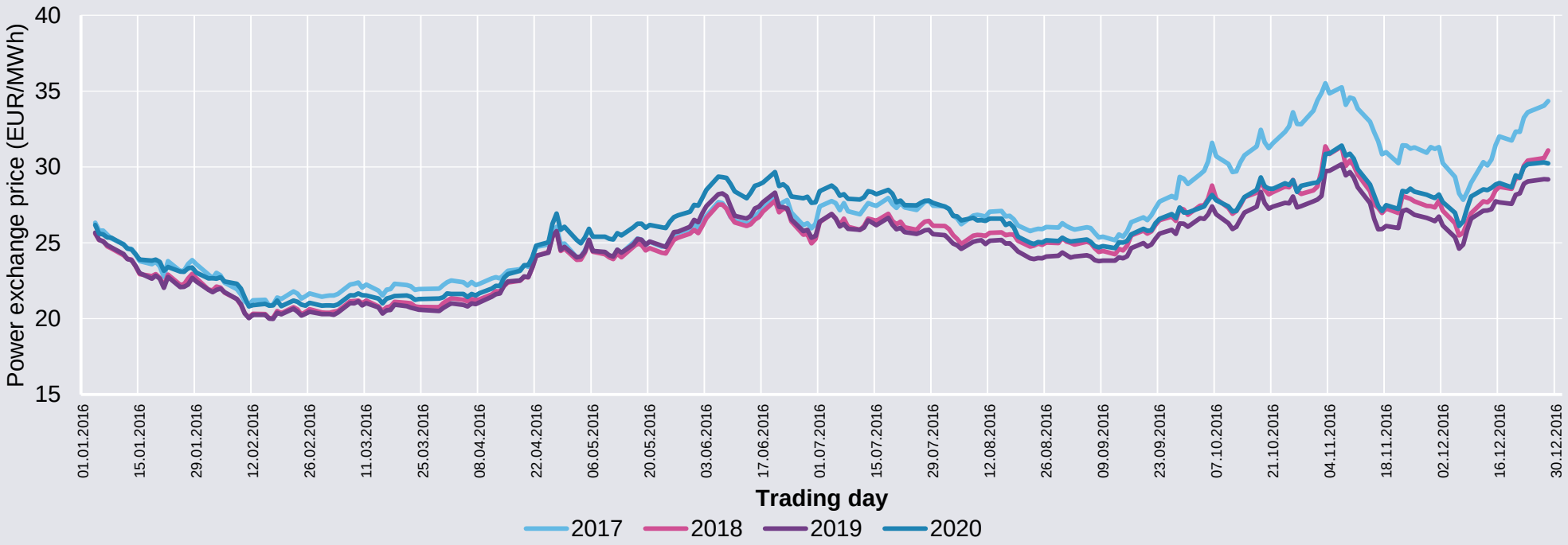
Rolling year-ahead futures, 2007-2016



EEX 2017

Electricity supply contracts, 2018–2020: Even in the future, traders do not expect prices to exceed 30 euros per megawatt hour

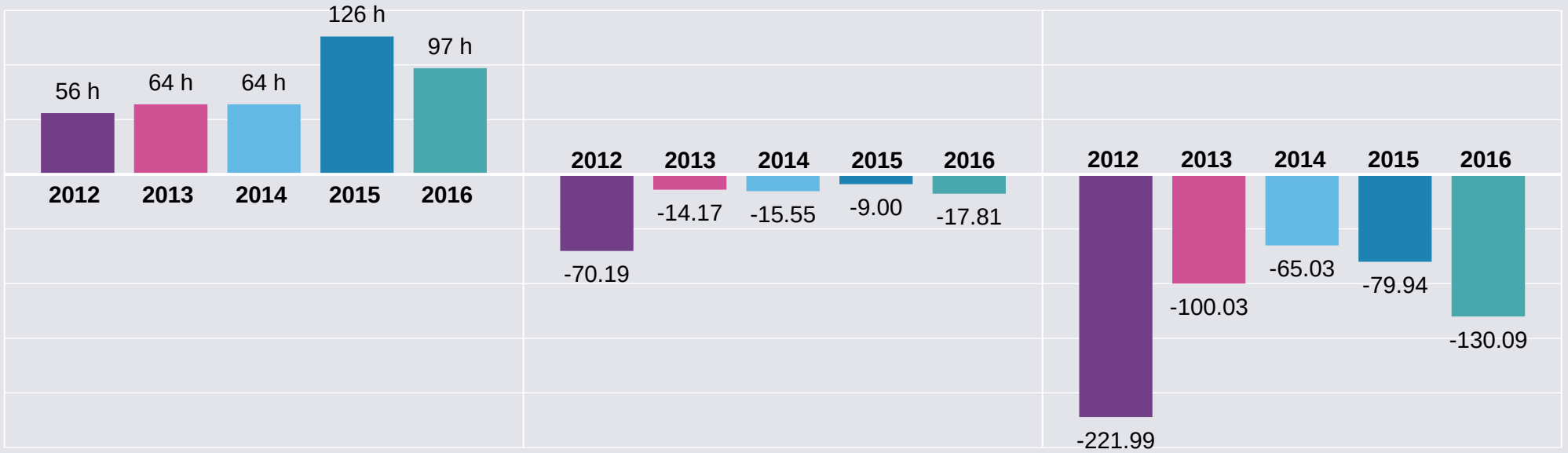
Future prices in trading year 2016 for 2017–2020



EEX 2017

Flexibility 2016: Fewer hours with negative prices than in 2015, yet prices are lower during these times

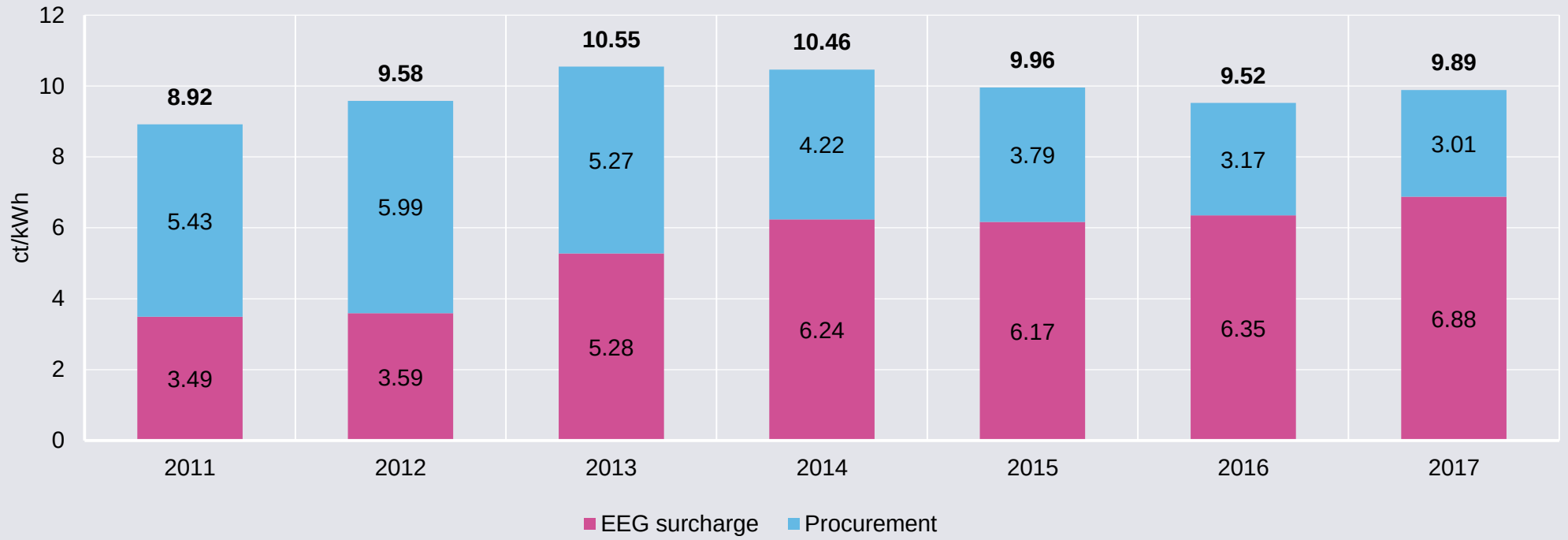
Hours with negative electricity prices – median negative price and lowest price – 2012-2016



EPEX 2016

Power procurement costs 2017: Increase of EEG surcharge (+0.53 ct/kWh) exceeds decline of power procurement costs (-0.16 ct/kWh)

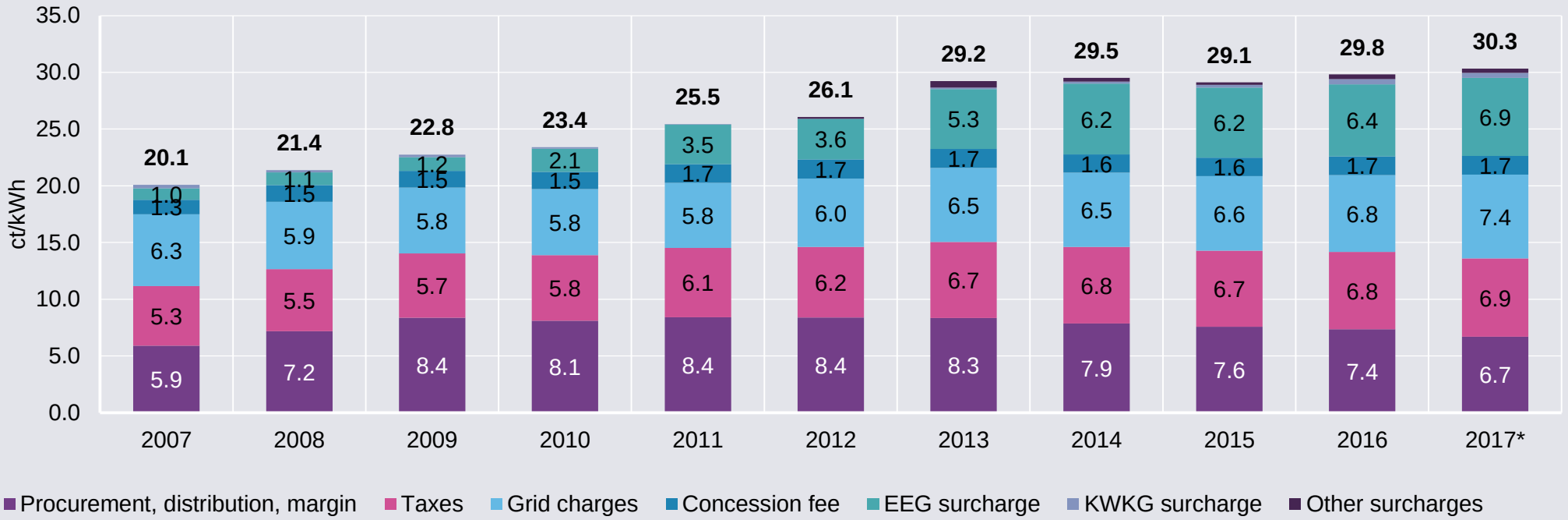
Power procurement costs (70% one-year-ahead future (base), 30% one-year-ahead future (peak)) and the EEG surcharge, 2011-2016



EEX 2016, netztransparenz.de

Household power prices in 2016 to exceed the 30-cent mark for the first time due to increased feed-in tariffs, increased EEG surcharge and high sales margins

Average electricity prices for a 4-person household (3500 KWh annual use), 2007-2017

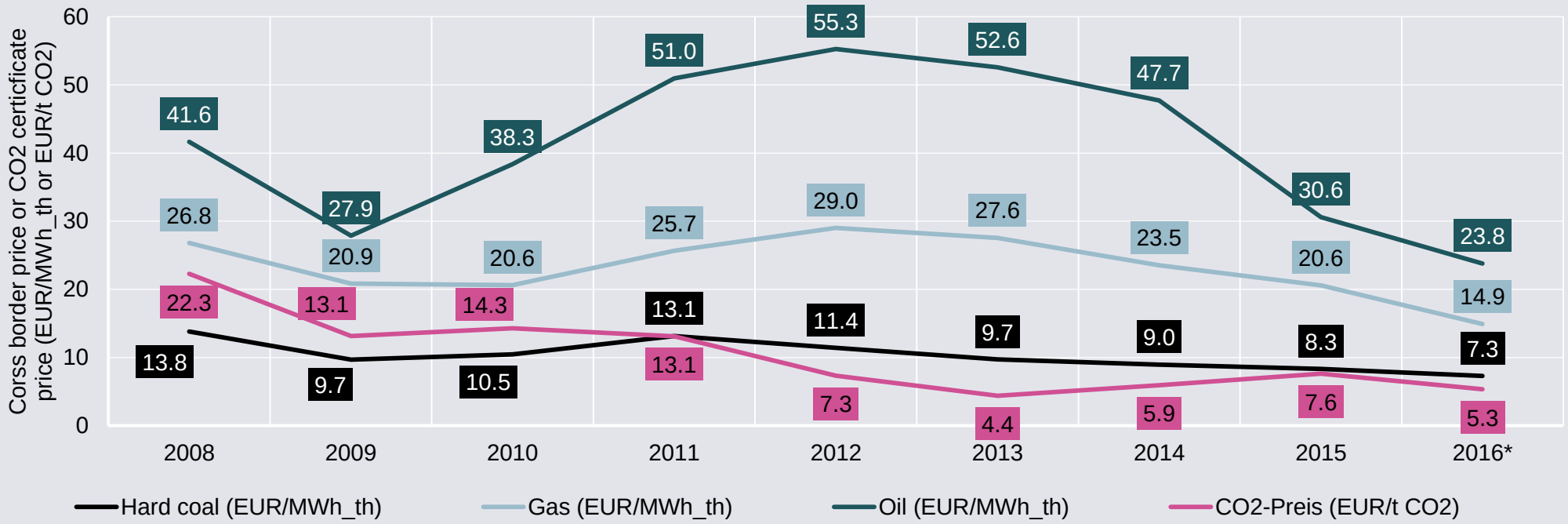


BNetzA 2016, *own estimates

Costs for energy commodities and renewables 2016

Prices for energy commodities 2016: Coal, oil and gas reach lowest levels, CO_2 certificates at second lowest point since 2008

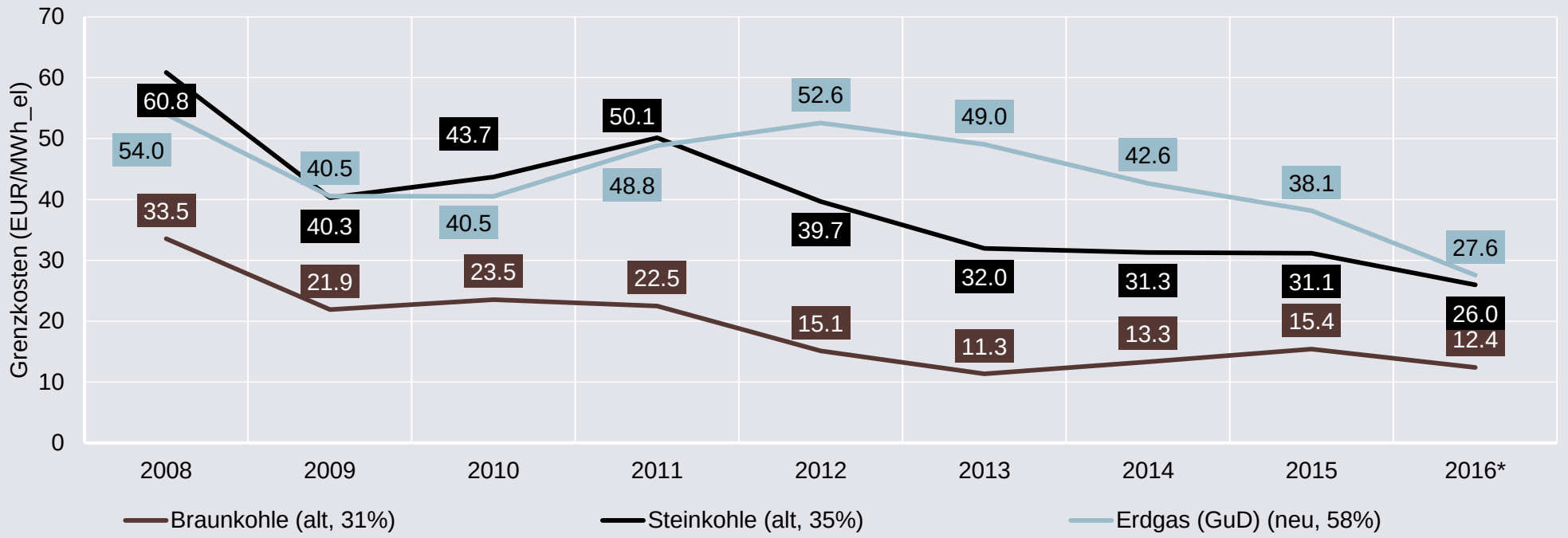
Border-crossing prices for natural gas, hard coal and mineral oil as well as certificate prices for CO_2



BAFA 2016a, BAFA 2016b, BAFA 2016c, EEA 2015, DEHSt 2016, own calculations

Power generation costs 2016: For the first time since 2011, new gas-fired power stations are competitive with pre-existing hard-coal power plants

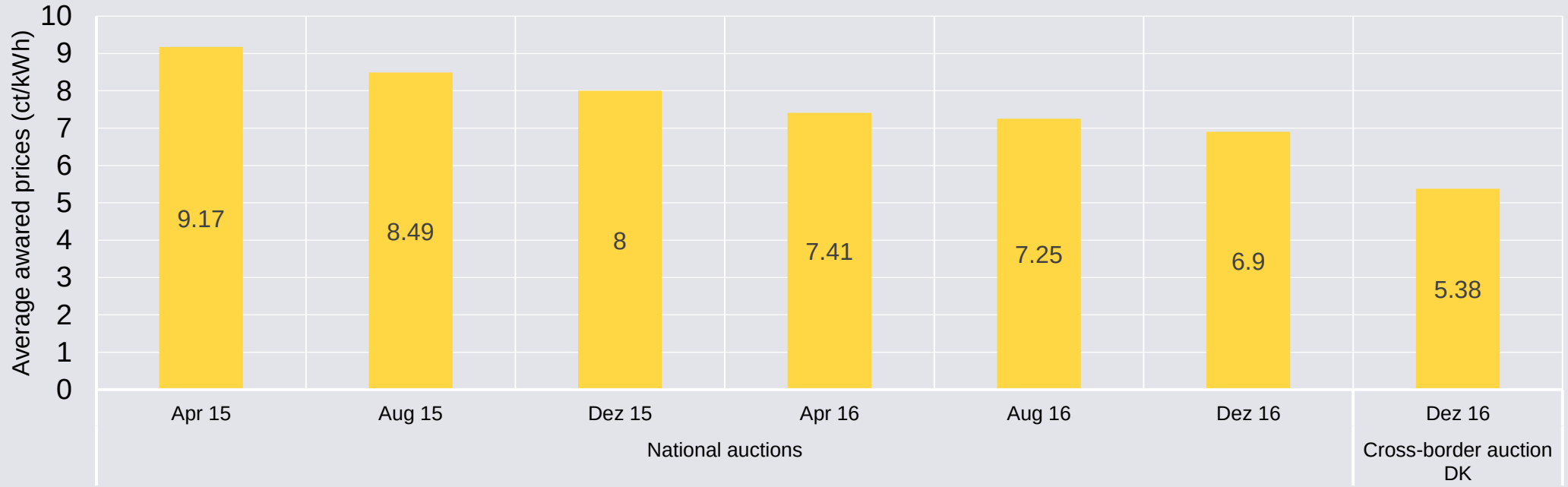
Marginal costs for new natural gas and for old lignite and hard-coal power plants (efficiency factor in parentheses)



BAFA 2016a, BAFA 2016b, DEHSt 2016, EEA 2015, Lazard 2015, Statistisches Bundesamt 2015, UBA 2015, own calculations

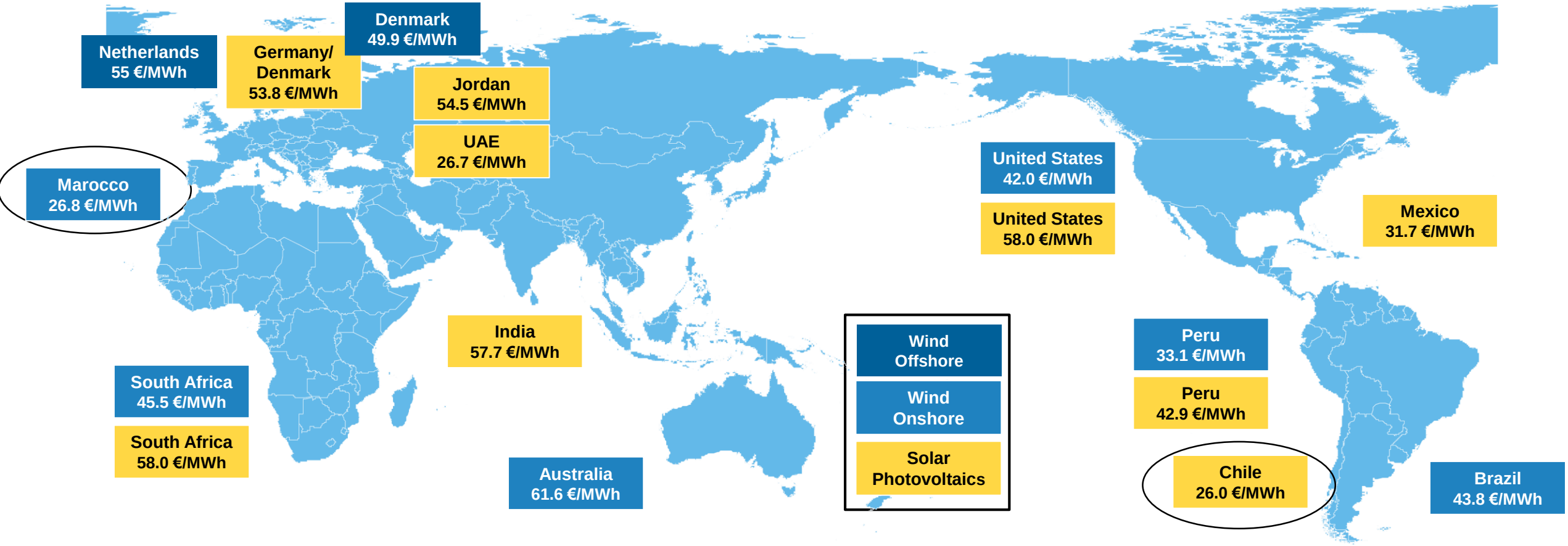
Costs for renewables continue to sink – compensation for solar in Germany decreases from 9.2 ct per kWh to 5.4 ct per kWh in December 2016 in DE/DK auction

Results of the first German PV auctions nationally and cross-border with Denmark



BNetzA 2016

Global costs for renewables in 2016: Wind offshore, wind onshore and solar energy constantly outdo each other with better offers



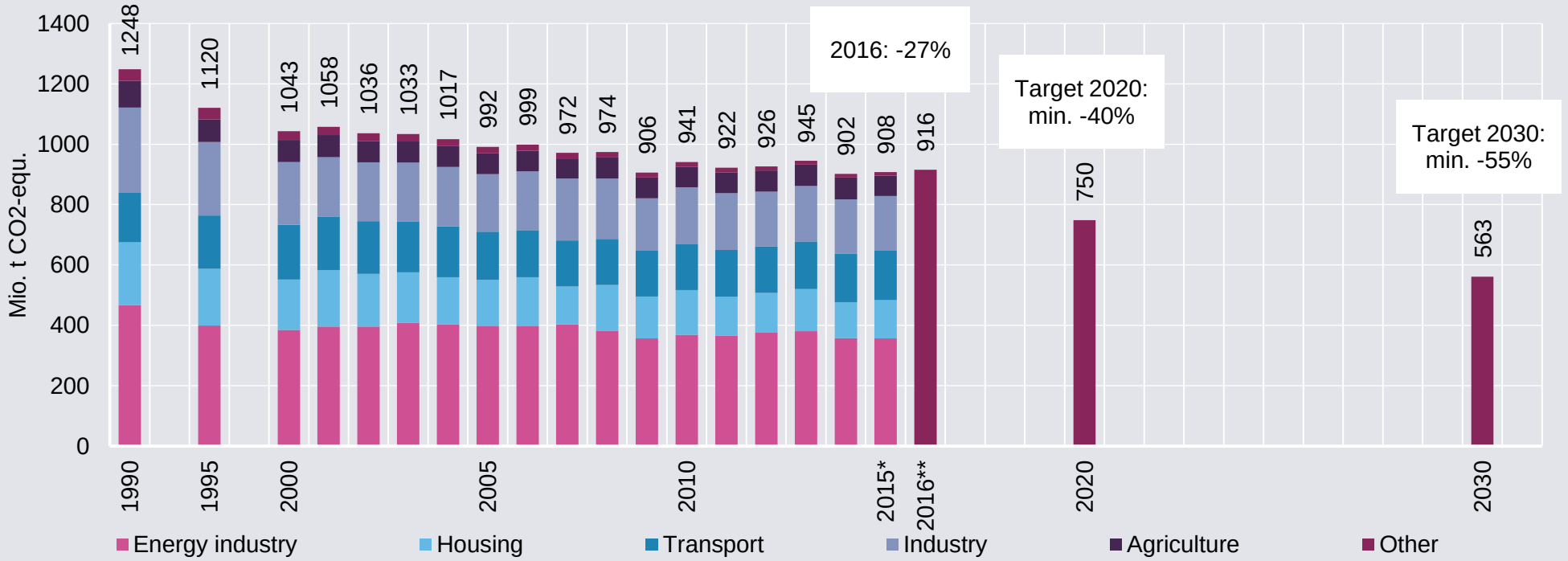
Fortum 2016; Sources: announcements by the investing companies and IEA report "Renewable Energy Medium-Term Market Report 2015" for US, Brazil, South Africa, Australia and Jordan. Values reported in nominal EUR, 1 EUR = 1,12 USD, 1 EUR = 75,3 INR, 1 EUR = 9.48 SEK. United States values calculated excluding tax credits. Typical contract lengths are 15-25 years. The prices indicate levels with which investors have been willing to invest, however, they may not describe the actual comparable costs as the bid prices may be reduced by preferential land prices, site exploration cost, targeted low-cost loans etc. The price level at which investors can hedge their renewable production for the next 4 years: average of 2017-2020 electricity (LUL) + elcertificate futures with 29.8.2016 closing prices. This low price levels still result in continuation of investments in onshore wind in Sweden.

Agora Energiewende

Climate protection and public sentiment 2016

Greenhouse gas emissions rise again in 2016 (+8 mio. t CO_2 equ.); to reach the 2020 target, 41 mio. t CO_2-equ. must be saved annually

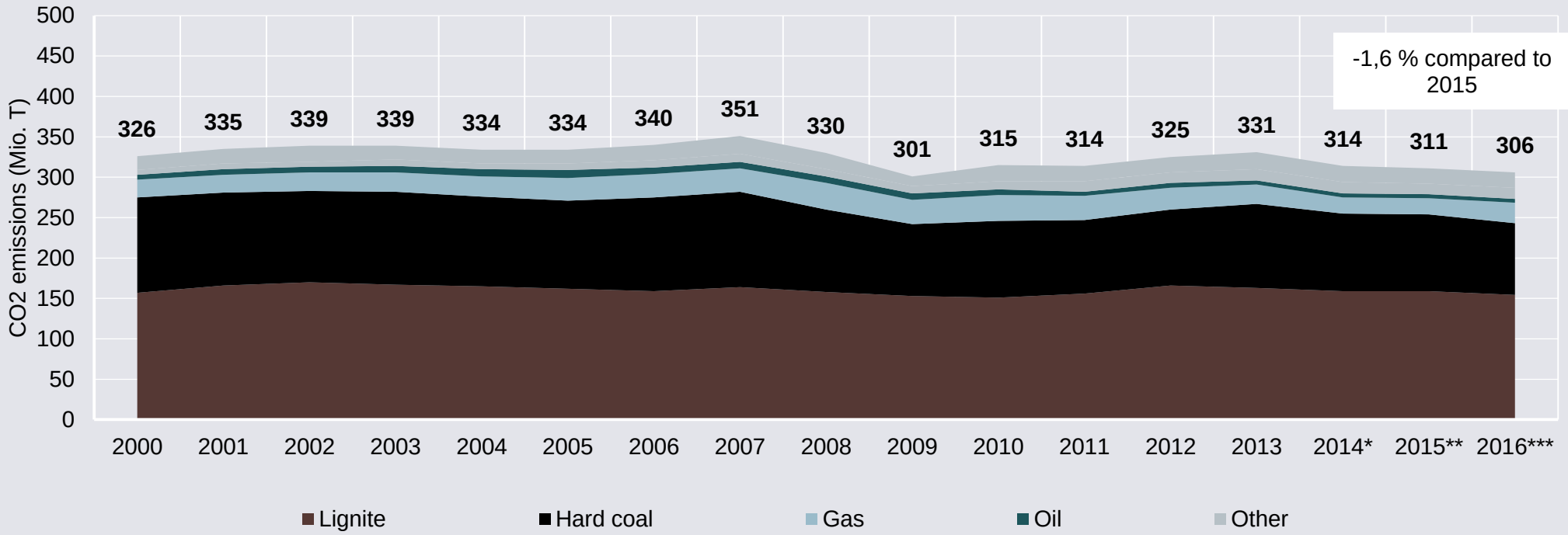
Greenhouse gas emissions by sector, 1990–2016, together with reduction targets for 2020 and 2030



UBA 2016, eigene Schätzungen

CO_2 emissions from the power sector 2016: Emissions decline by 5 mio. t, mostly due to coal-gas switch; lignite and hard coal remain major emitters

CO_2 emissions in the power sector by energy source, 2000-2016

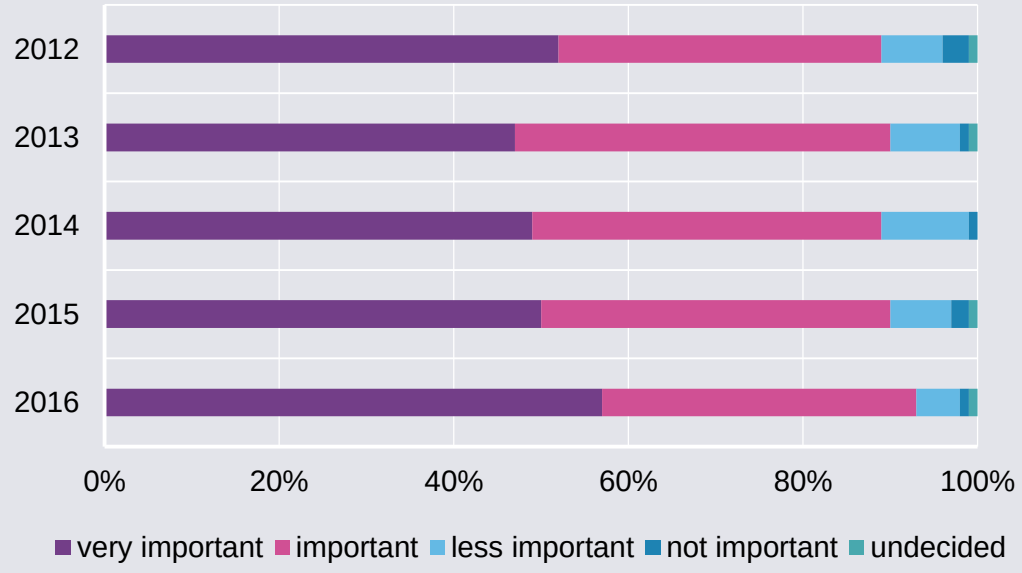


UBA 2016a (*preliminary, **Estimate UBA), ***own calculations

The significance of the energy transition reaches a high level: Popular sentiment towards the energy transition, 2012-2016

N=1013

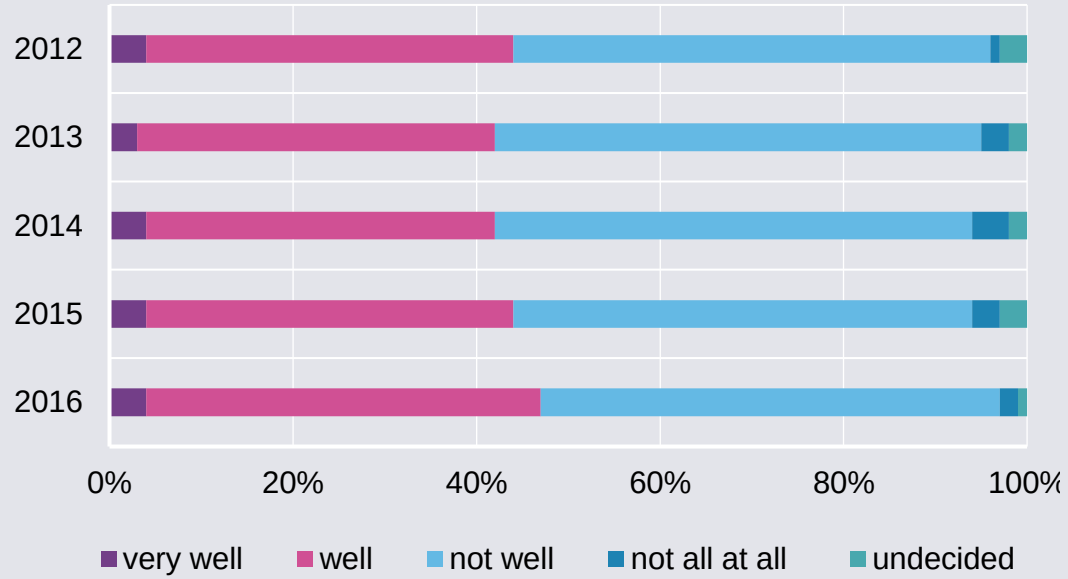
The *Energiewende* is...



Forschungsgruppe Wahlen, commissioned by BDEW 2016

N=1013

The *Energiewende* proceeds...

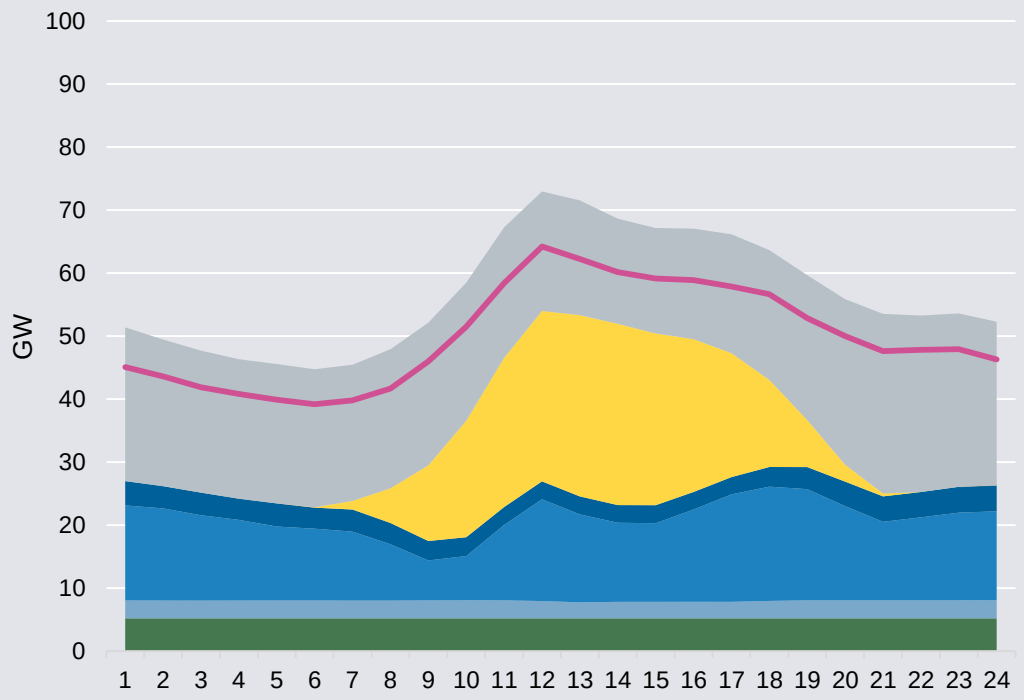


Forschungsgruppe Wahlen, commissioned by BDEW 2016

Special days in 2016

Highest and lowest renewable energy shares in 2016: At 1 pm on 8 May, renewables at 86.3 per cent; at 5 pm on 21 January, renewables at 11.0 per cent

Power generation and use on 8 May 2016



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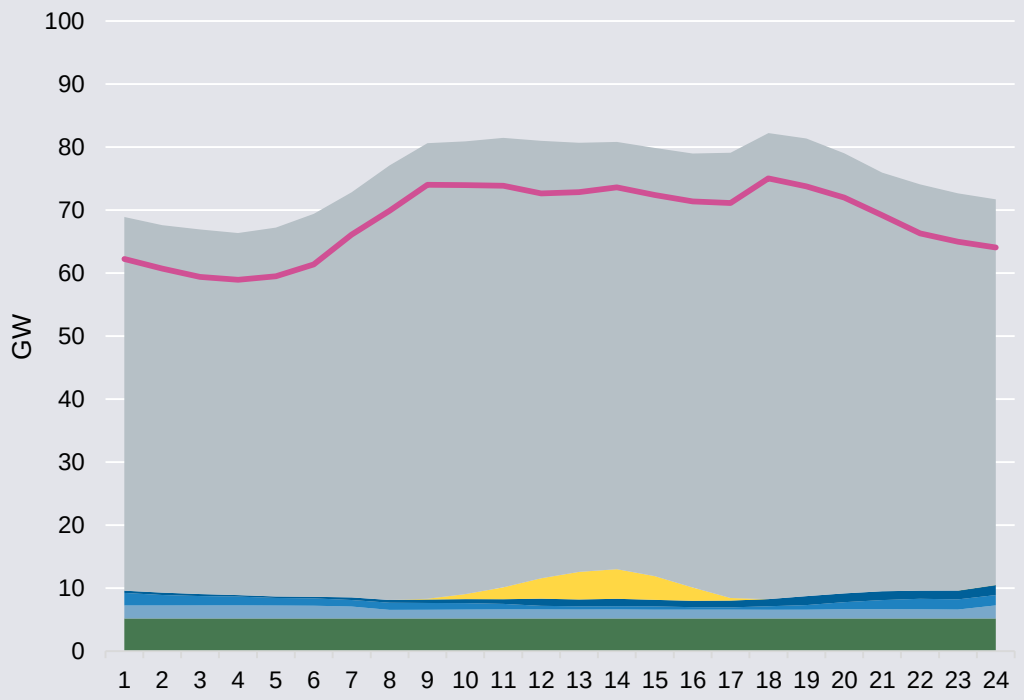
Power generation and use on 21 January 2016



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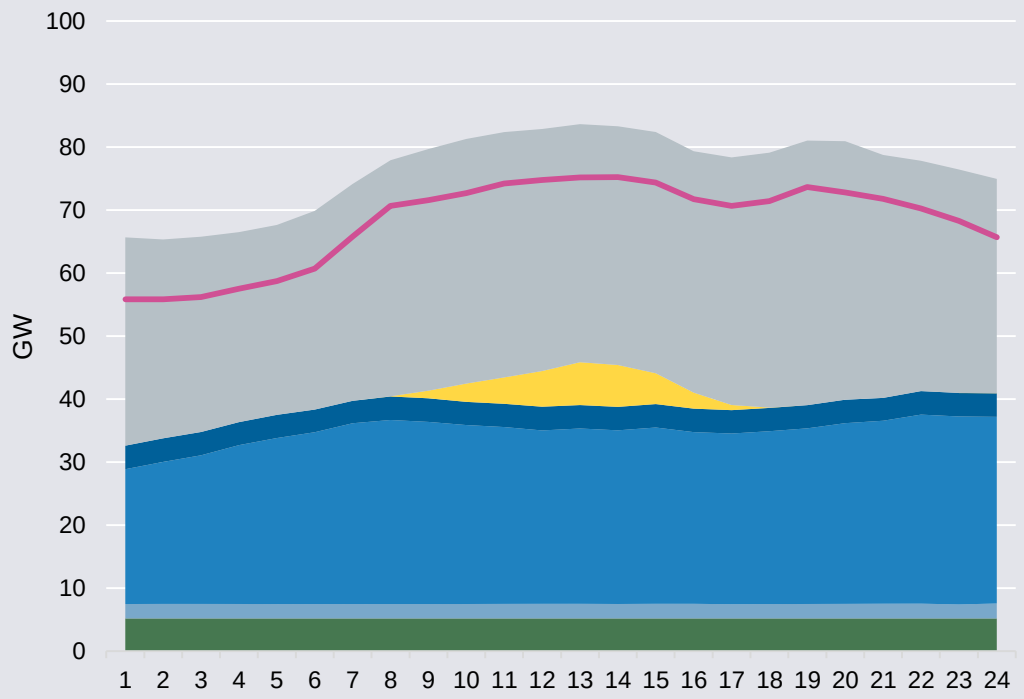
Maximum feed-in from wind power on 8 February at 9 pm, 33.745 gigawatts; maximum PV feed-in at 1 pm on 6 May, 28.885 gigawatts

Power generation and use, 8 February 2016



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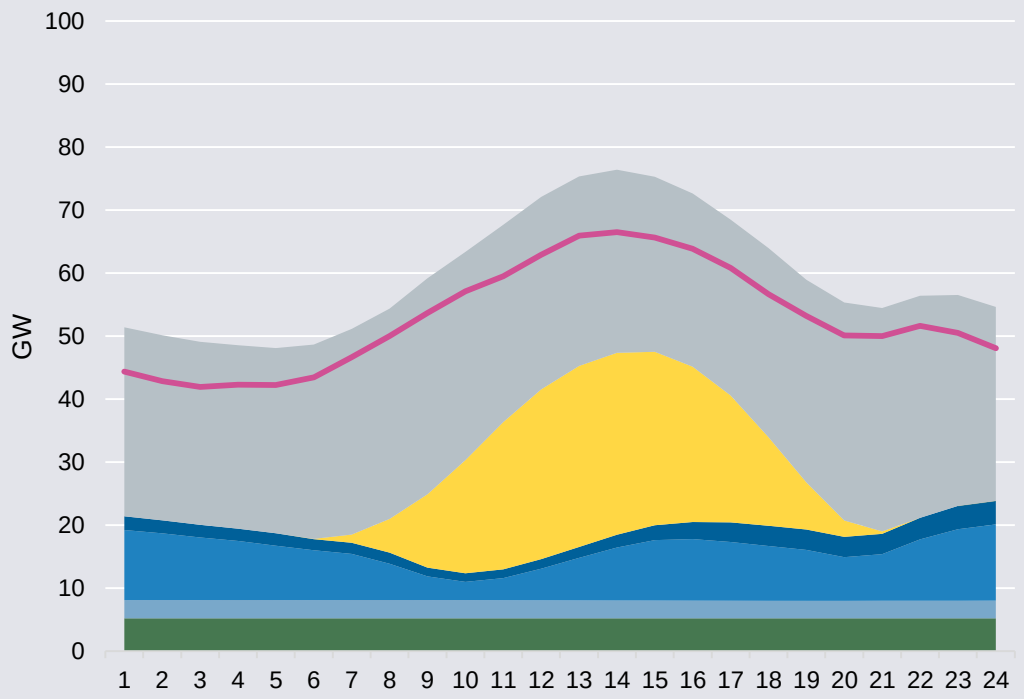
Power generation and use, 6 May 2016



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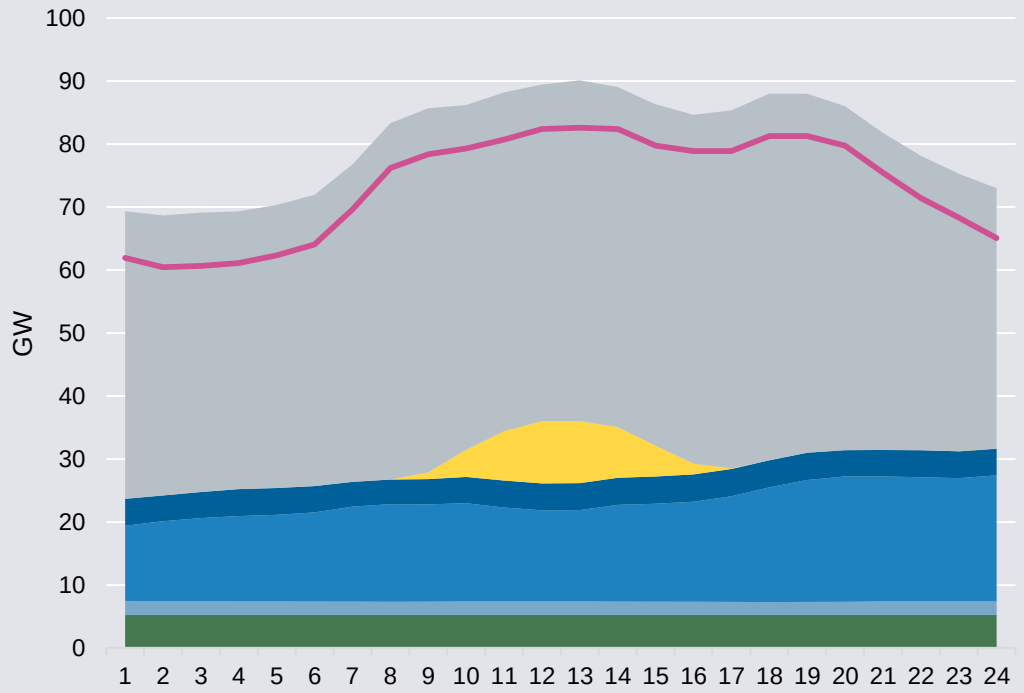
Highest load on 30 November at 12 pm, 82.613 gigawatts; Lowest electricity feed-in from coal-fired plant on 27 March at 3 pm, 7.6 gigawatts

Power generation and use, 30 November 2016



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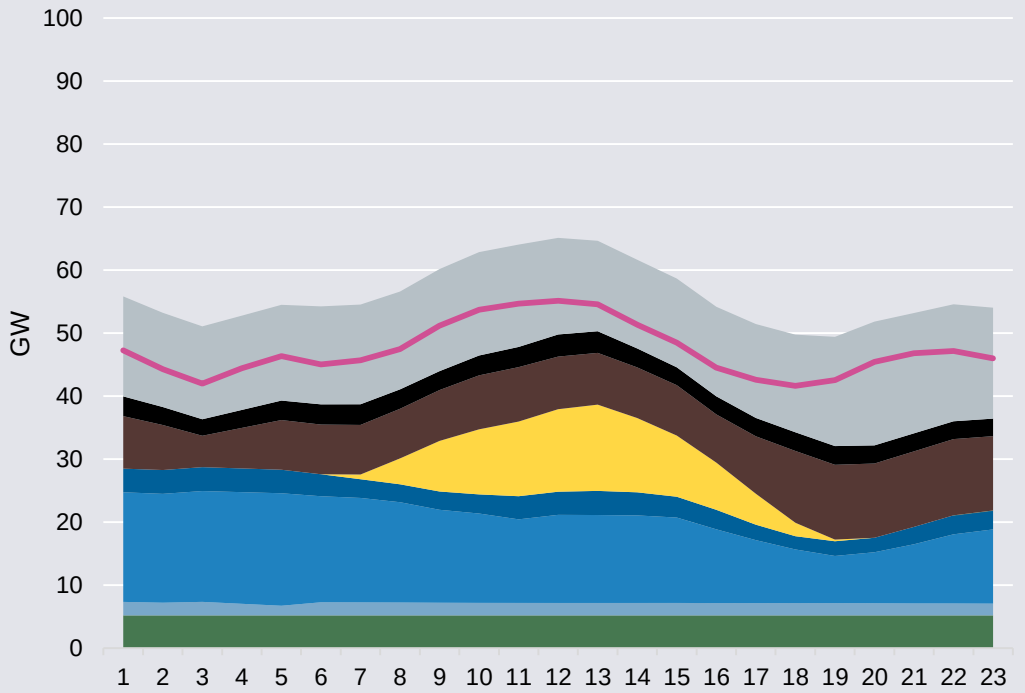
Power generation and use, 27 March 2016



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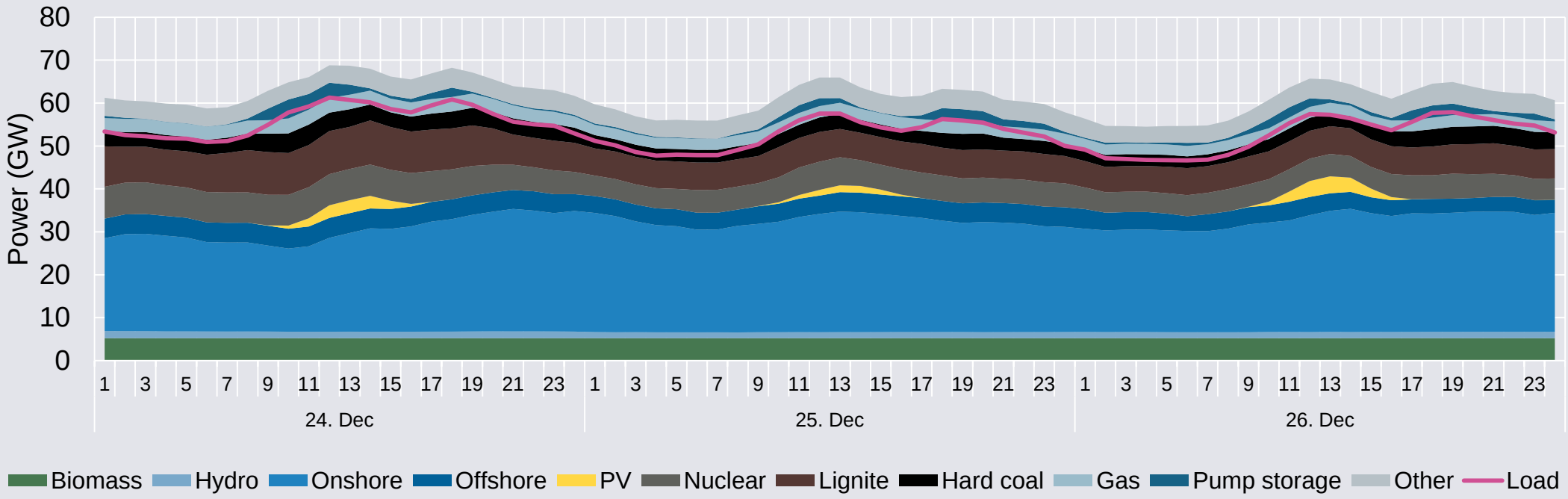
A record-breaking Christmas: Renewables continually covered more than 50 per cent of power use, reaching as high as 76 per cent; hard coal averaged only 6.3 per cent

Power generation and use over Christmas 2016



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Outlook 2017

Outlook for 2017

- → Further growth of wind capacity expected: transitional regulations apply in 2017; many project developers will build facilities based on EEG 2014; multiple offshore wind parks under construction
- → Solar power generation for self-consumption will become more attractive: increased tariff for installations smaller than 750 kW
- → Power plants totalling 4 GW will be shut down in the conventional energy sector:
  - Nuclear power plant Gundremmingen B to shut down by the end of December
  - On October 1, the lignite blocks Frimmersdorf P and Q will become reserve power plants
  - Five hard-coal power plants with 2 GW of capacity from STEAG slated for closure
- → EEG 2017 will come into effect, with tenders as the main remuneration instrument; first tender results for wind offshore and wind onshore, as well as first reliable information about realisation results for solar auctions
- → Bundestag elections 2017: Important decisions must be made after the elections concerning coal consensus, climate protection, renewable energy expansion and levies and surcharges

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Thank you for your attention!

Questions or Comments? Feel free to contact me:

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