

# The energy transition in the power sector: State of affairs 2015

*Review of major developments in  
Germany*

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## Key Findings

1

**Renewable energies are at a record level.** In 2015, power production from wind energy rose by around 50 percent and renewables produced more power than any energy source ever produced in Germany. They now cover around a third (32.5 percent) of the demand and dominate the power system.

2

**Coal power exports have reached an all-time high.** Despite the strong rise in power production from renewables, production from hard coal and lignite remained largely constant. This was mostly exported, reaching an all-time high of physical power flows of 50 terawatt-hours on balance (TWh). Measured by trade flows, net exports amounted to more than 60 TWh, 50 percent more than in the previous year or around 10 percent of all power production.

3

**The decarbonisation of the energy system is stagnating.** CO<sub>2</sub> emissions in 2015 from the German power plant fleet were around the same level as in 2014, due to the constant level of coal-fired electricity, while total energy-related greenhouse gas emissions rose slightly, due to weather conditions. Without a consistent decarbonisation strategy for power, heat and transport, Germany will not reach its climate protection goals.

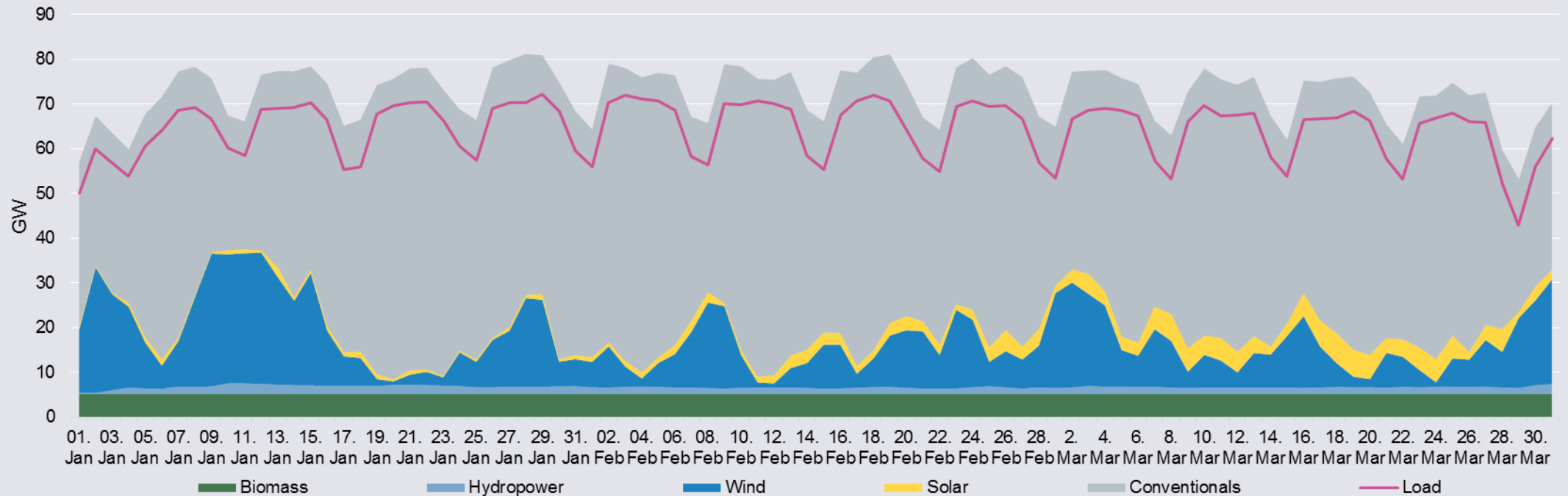
4

**The market power price remains in free-fall.** At 31.60 euros per megawatt-hour (MW) in 2015, Germany had the second-lowest market price for power in Europe after Scandinavia. On the futures electricity market for the coming years, power is trading at 30 euros. Household power prices are expected to rise slightly in 2016, due to a rise in levies and fees and will reach again the level of 2014.

# Power market overview 2015

## Q1 2015: Strong wind in January and March

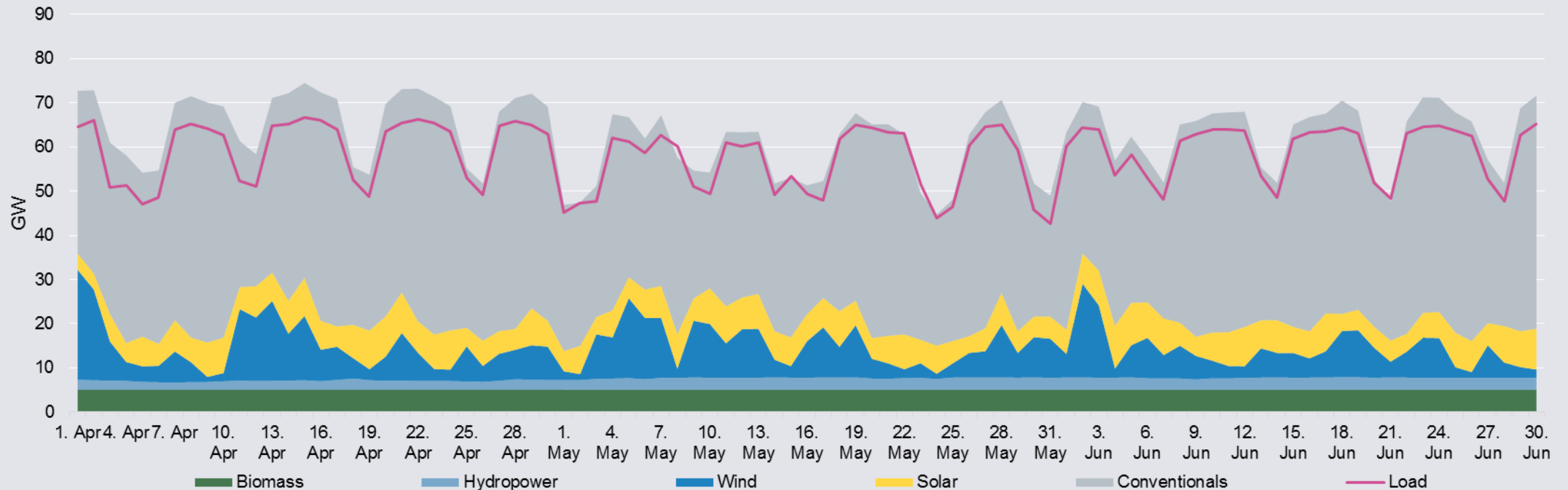
Net power generation and demand in the first quarter 2015



Agora Energiewende 2015, displayed are daily means

## Q2 2015: Sunnier April, lower load, less wind power

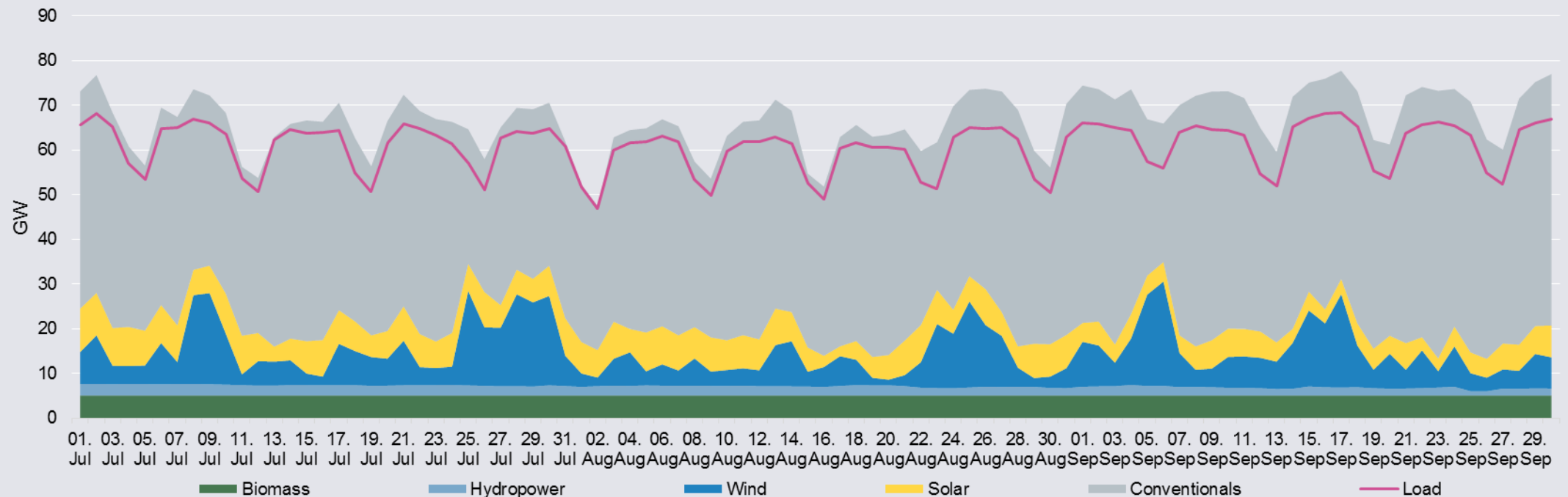
Net power generation and demand in the second quarter 2015



Agora Energiewende 2015, displayed are daily means

## Q3 2015: Very sunny summer months increase solar power production, load at low level

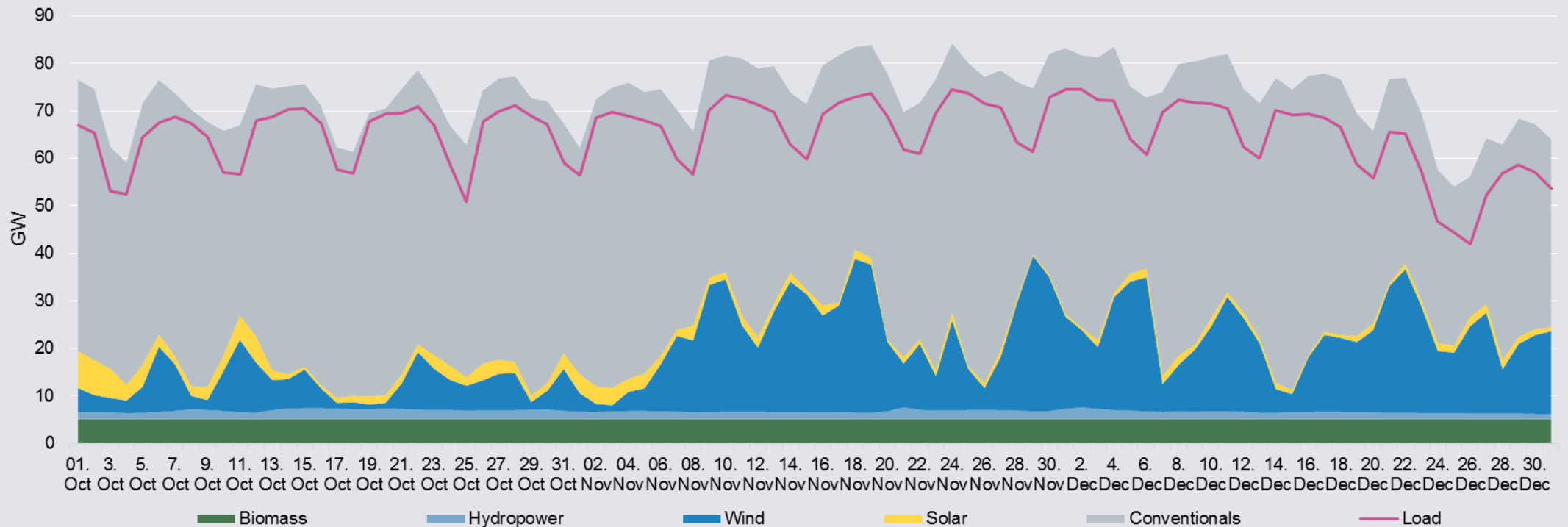
Net power generation and demand in the third quarter 2015



Agora Energiewende 2015, displayed are daily means

## Q4 2015: High wind power production in November and December, rising demand in autumn

Net power generation and demand in the fourth quarter 2015



Agora Energiewende 2015, displayed are daily means

## 10 points on the 2015 power market

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- **1. Renewable energy:** 2015 was a year of superlatives. Wind energy saw record growth of 50 percent, renewables were by far the dominant energy source with a 30 percent share of production. They now cover 32.5 percent of power consumption.
- **2. Power usage:** Electricity usage rose slightly in 2015 due to weather conditions compared to 2014, while the economy grew by 1.7 percent. However, the decoupling of power usage and growth is not happening fast enough: While the federal government's energy concept envisions a decline in power usage of 10 percent by 2020 over 2008, usage was only down 3.4 percent in 2015.
- **3. Conventional energy:** Nuclear and gas power plants produced somewhat less power than in the previous year, electricity from lignite and hard coal remained nearly constant. Because renewables are covering ever more of the domestic power needs, German coal power is being increasingly exported.
- **4. Climate protection:** The CO<sub>2</sub> balance of the power sector hardly changed compared to the previous year. Total greenhouse gas emissions in Germany even rose slightly and were 26 percent below those of 1990 in 2015. It is thus becoming more and more difficult for Germany to reach its 2020 climate targets.



## 10 points on the 2015 power market

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- **5. Power exports:** Power exports rose considerably in 2015. Physical power flows reached an all-time high at 50 terawatt-hours on balance. This was on balance around eight percent of all power production. Measured by trade flows, net exports amounted to around 61 terawatt-hours, 50 percent more than in the previous year. The Netherlands, Austria and France are the main power importers from Germany. The reason: Germany has the second-lowest market power price in Europe after Scandinavia.
- **6. Power prices:** Market power prices fell again in 2015. They were around 31.60 euros per megawatt-hour. On the futures market, prices decreased even further: In the second half of 2015, power for the years 2016 and 2017 traded at less than 30 euros per megawatt-hour.
- **7. Flexibility:** There was a mixed picture of the flexibility of the power system in 2015. While the number of hours with negative power prices nearly doubled to around 126 (2014: 64 hours), the average negative power price sank to around nine euros per megawatt-hour (2014: minus 15.55 euros).

## 10 points on the 2015 power market

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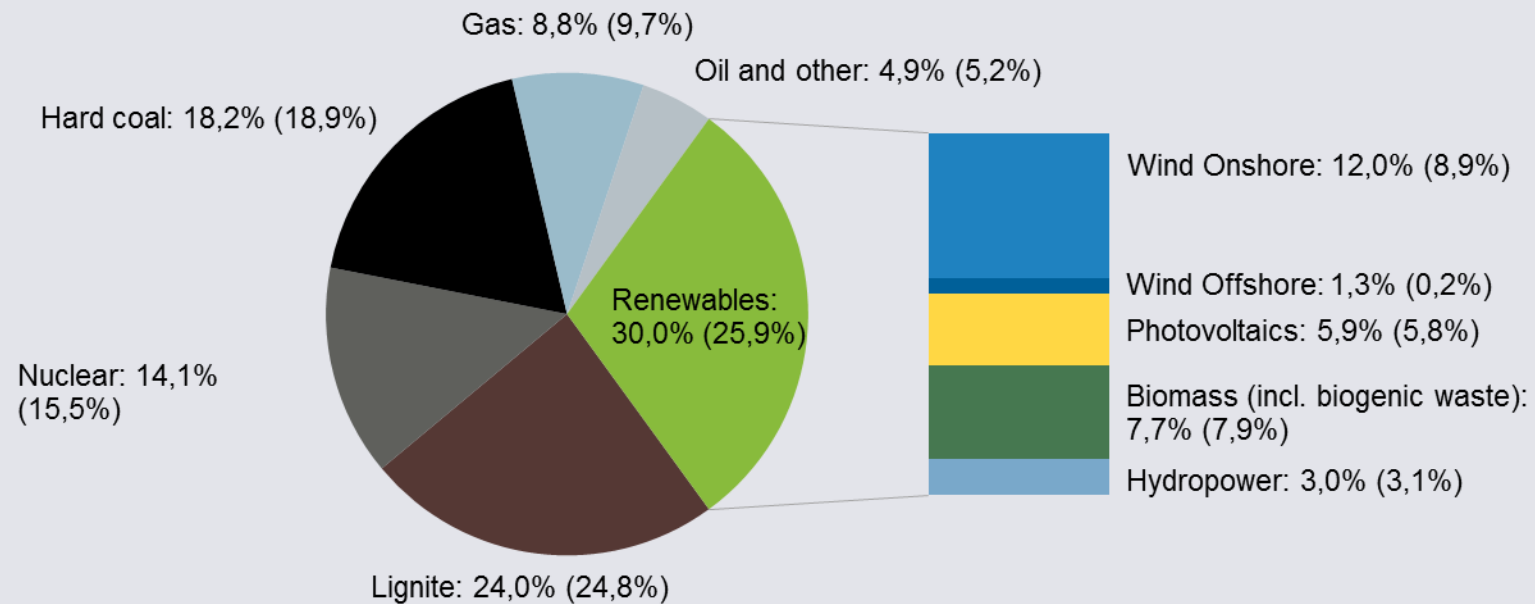
- **8. Record days:** On 23 August, the share of renewables reached its highest level: Between 1pm and 2pm, 83.2 percent of all power demand were covered by renewables. The litmus test for the power system came on 20 March, during the partial eclipse of the sun: The power system dealt extremely well with the sharp fluctuations in nationwide solar power production.
- **9. Popular sentiment:** A large majority of the population supports the energy transition: 90 percent of all citizens consider the Energiewende as “important” or “very important”. Solar (85 percent) and wind (77 percent) power are the most popular choices to be the main pillar of the energy system, while only 5 percent of the population favour nuclear and coal power.
- **10. Outlook 2016:** In production, the share of nuclear energy will decline slightly, while renewables will continue to expand, due to the continued build-up in wind power plants. Despite the decline in market power prices, household power prices are likely to rise slightly due to higher levies and fees, nearing the 2014 level.



**Electricity production  
and demand**

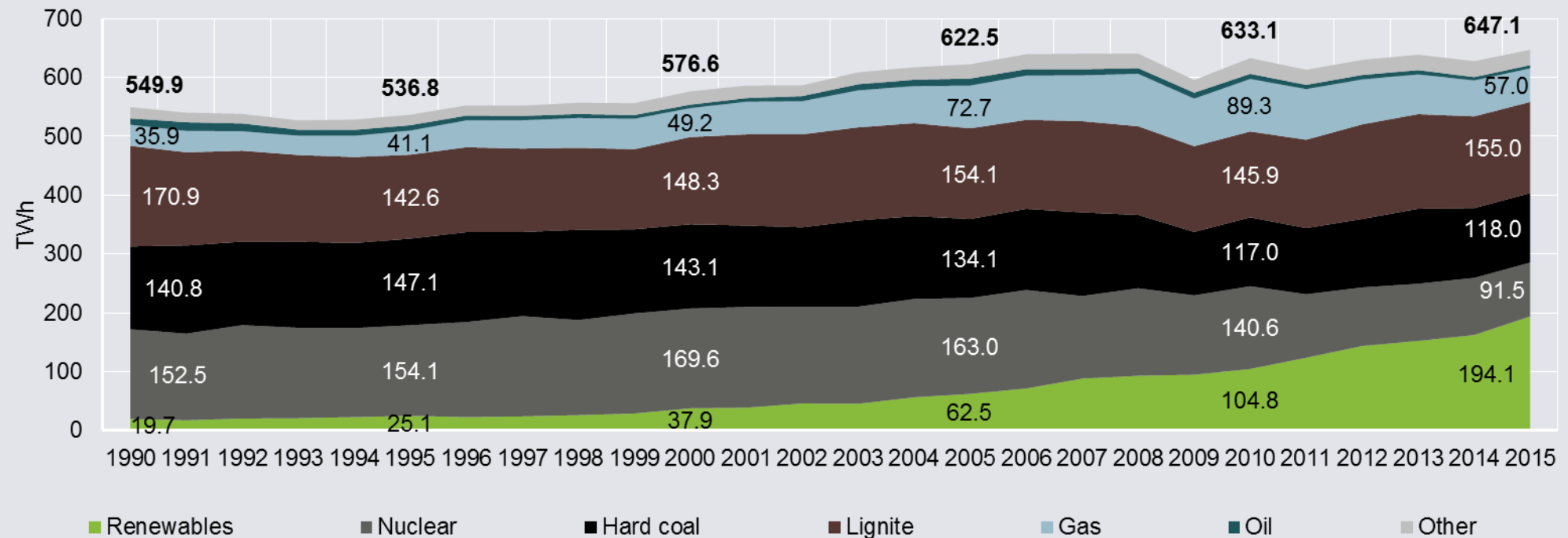
## Power mix 2015: Renewable energies produce 30 percent of German power and are by far the strongest energy source

2015 power mix (2014 values in brackets)



## Development of power production: Renewables produce more in 2015 than nuclear power at its peak

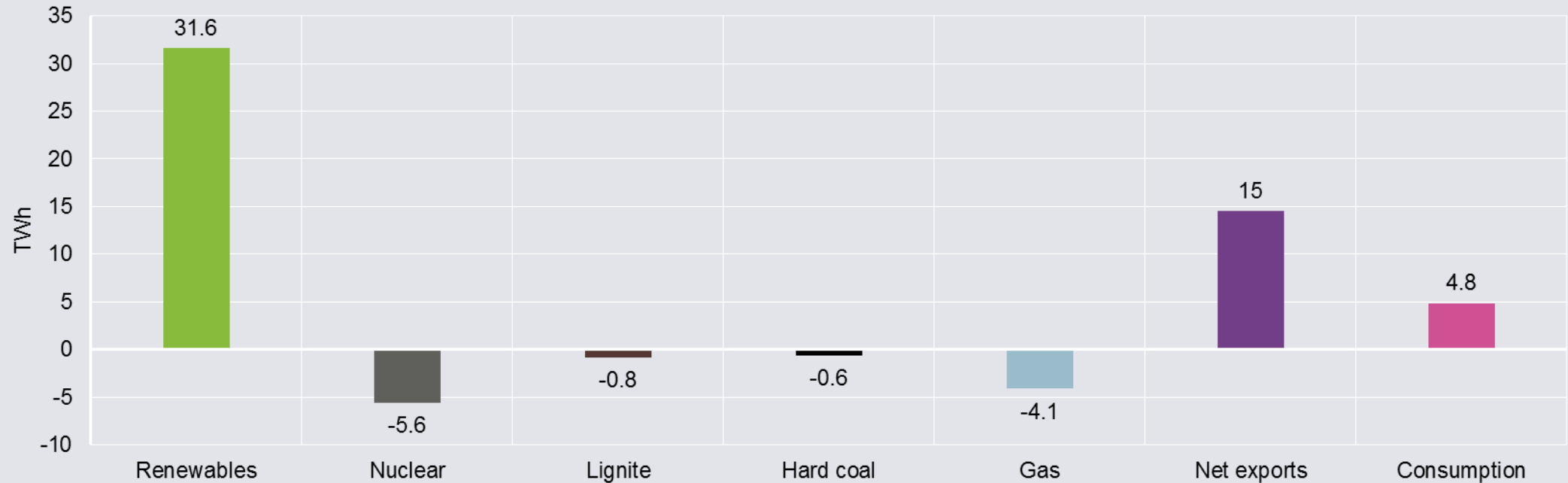
Power production development 1990-2015



AG Energiebilanzen 2015

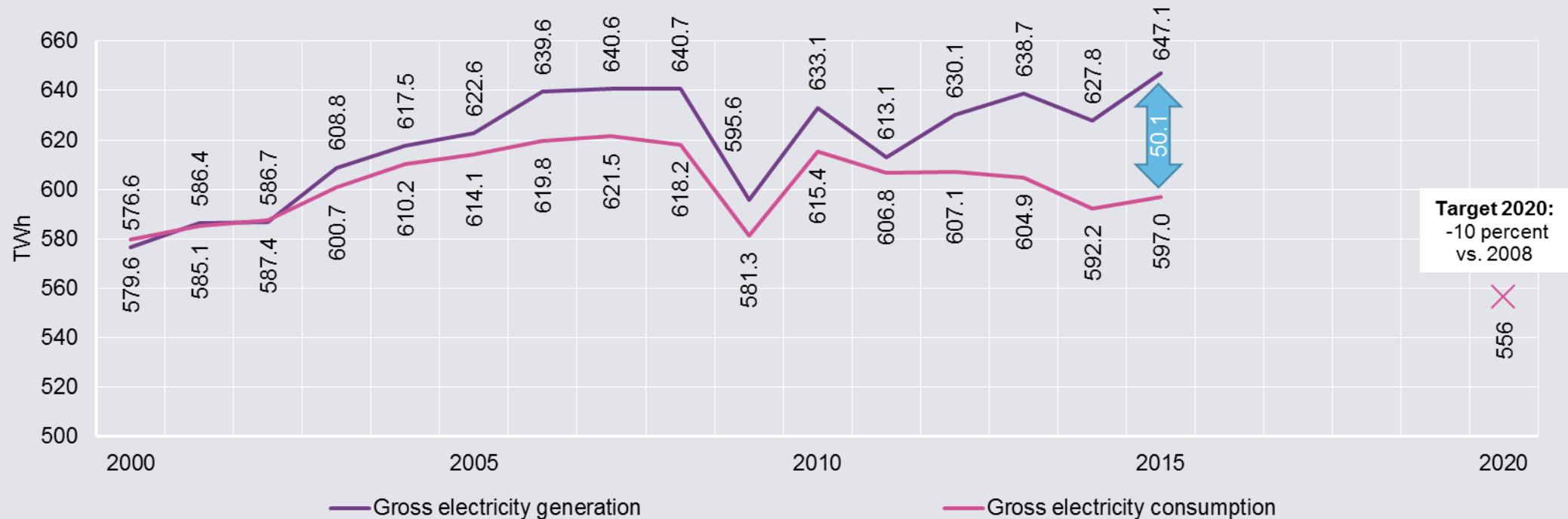
# Changes from 2014 to 2015: Renewables post record growth, nuclear and natural gas retreat slightly, coal is steady and is pushed into exports

Changes 2014-2015



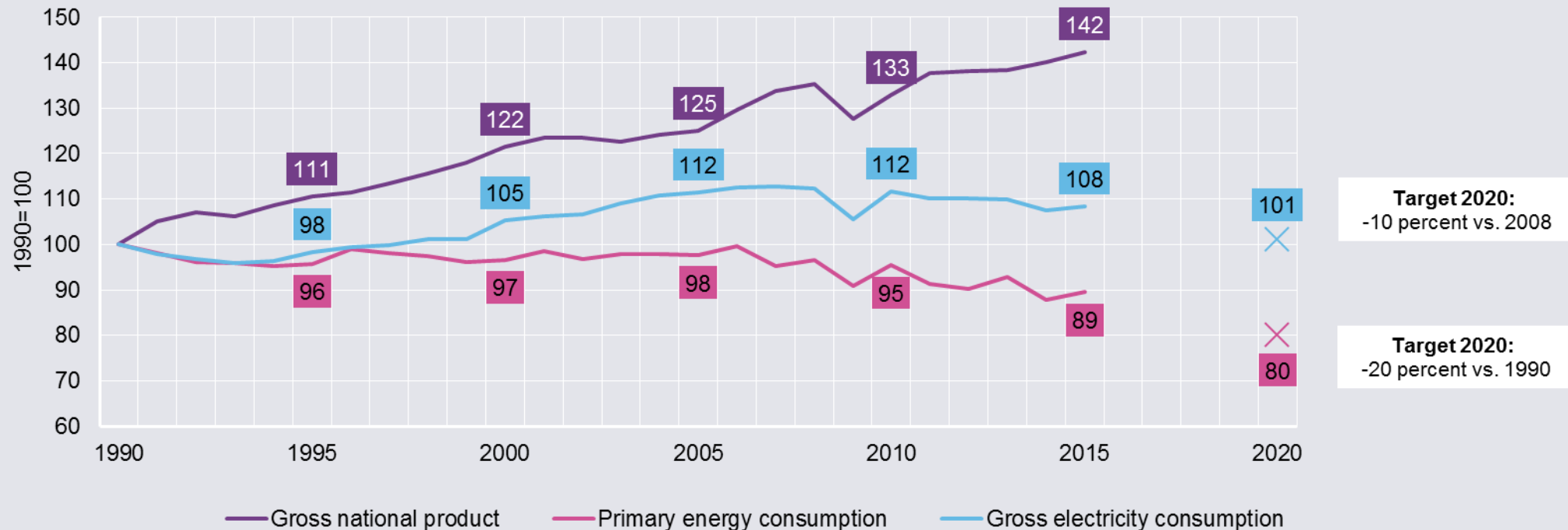
# Power consumption 2015: The gap between power consumption and production continues to expand

Development of gross power production and gross electricity consumption



# 2015 energy efficiency: While the economy is growing steadily, energy and power usage have declined since 2007 – but greater momentum is needed for 2020 efficiency goals

Gross domestic product, primary energy consumption and gross electricity consumption 1990-2015 (1990=100)

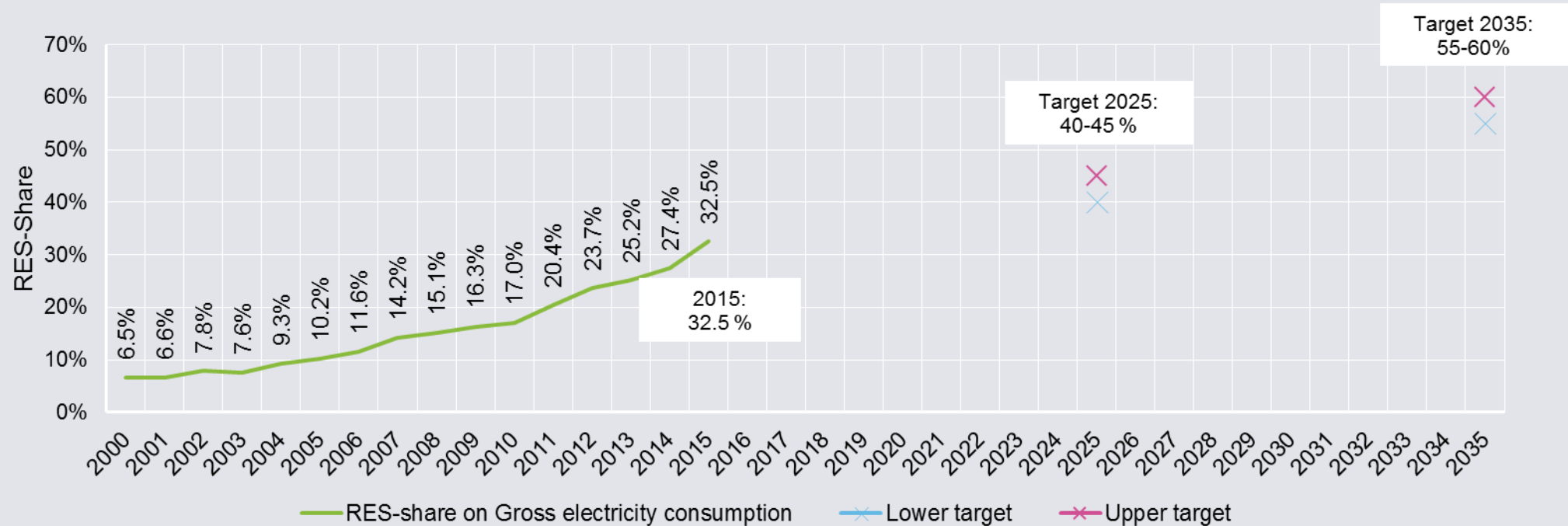


AG Energiebilanzen 2015, Statistisches Bundesamt, own calculations



# Renewable energies 2015: Renewables cover close to a third of power consumption

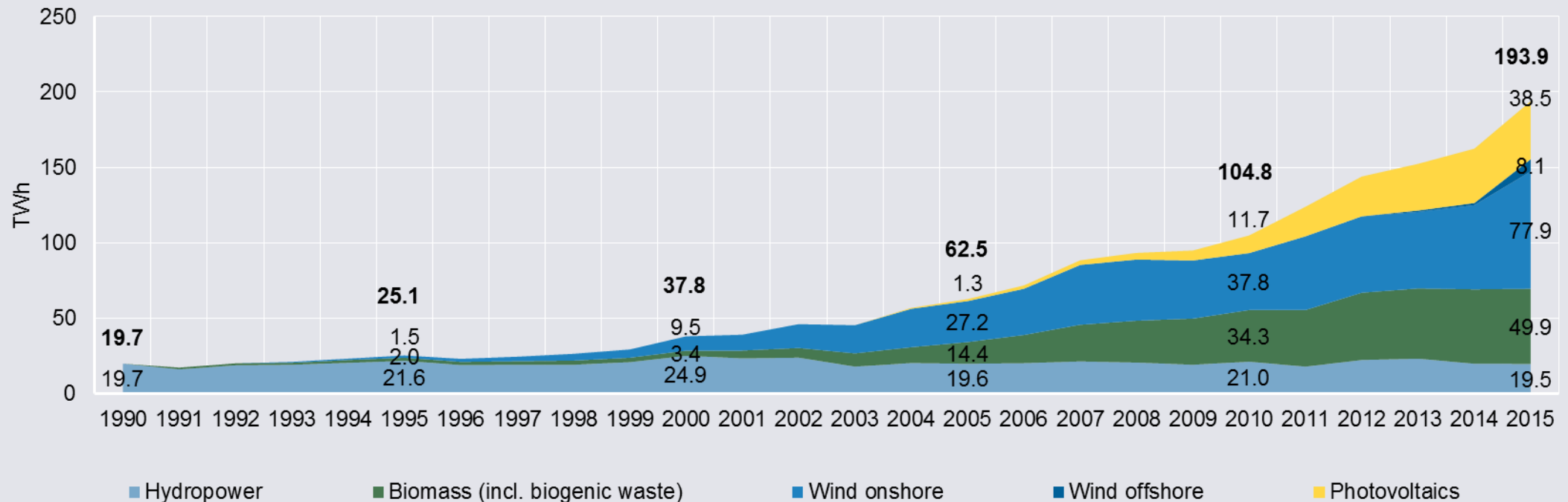
Share of renewable energies in gross power consumption 2000-2015



AG Energiebilanzen 2015

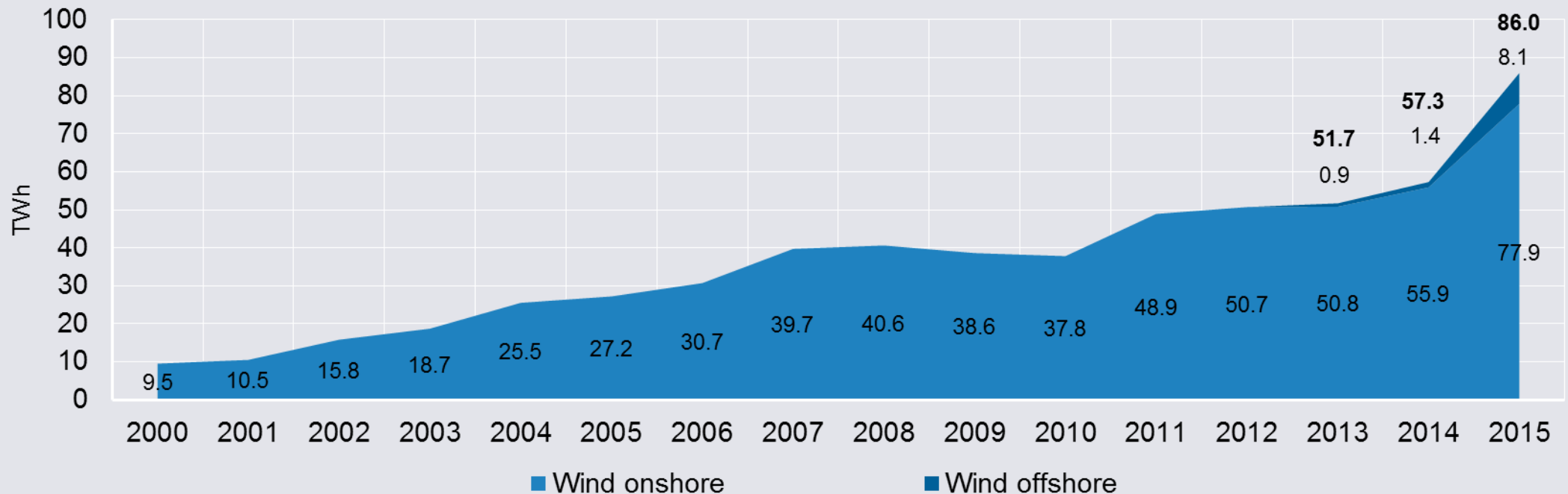
# Renewable energies 2015: Power production from renewables is nearly ten times greater than in 1990, wind power has largest share

Development of renewable energies 1990-2015



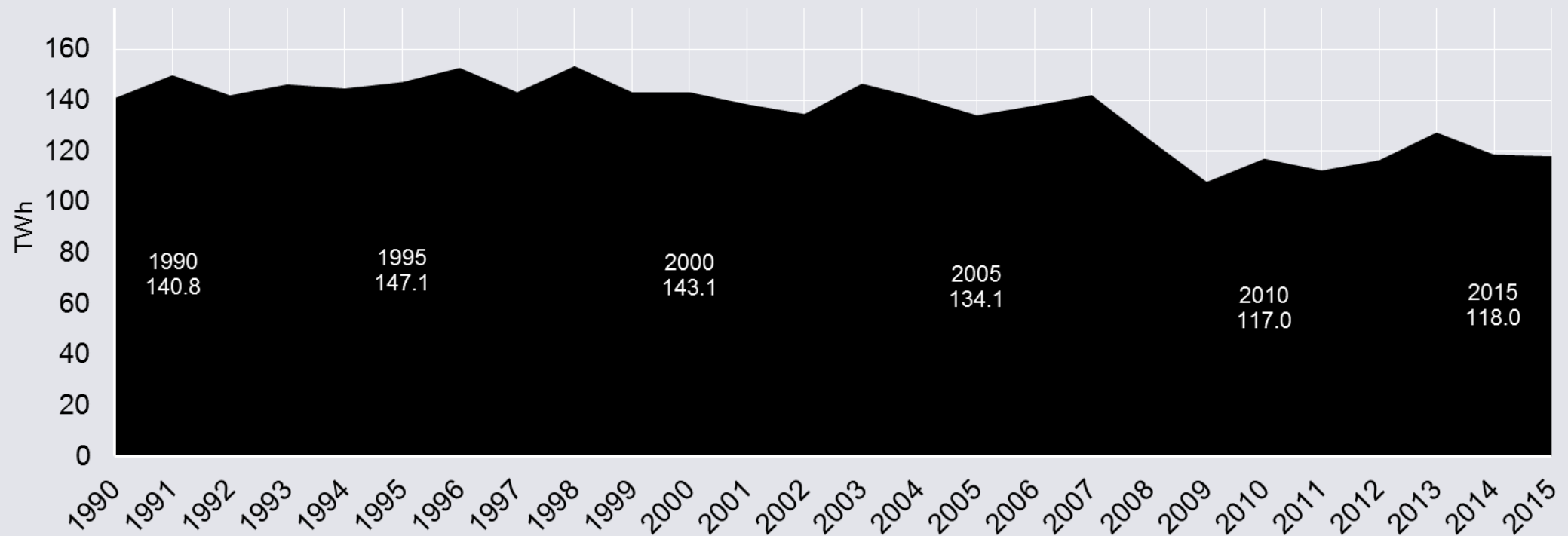
# Wind power 2015: Wind power production up 50 percent. The reason: Strong growth in new onshore and offshore wind plants and a lot of wind in 2015

Wind power production 2015



## Hard coal 2015: Power production remains at last year's level

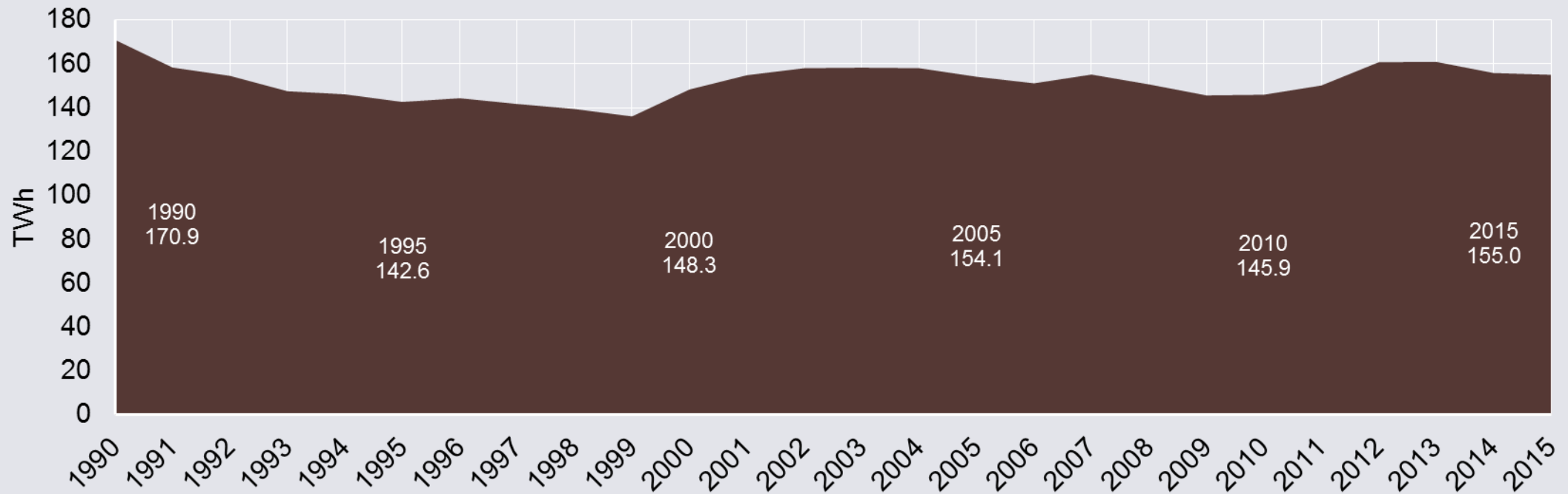
Power production from hard coal 1990-2015



AG Energiebilanzen 2015

## Lignite 2015: Power production continues at high level

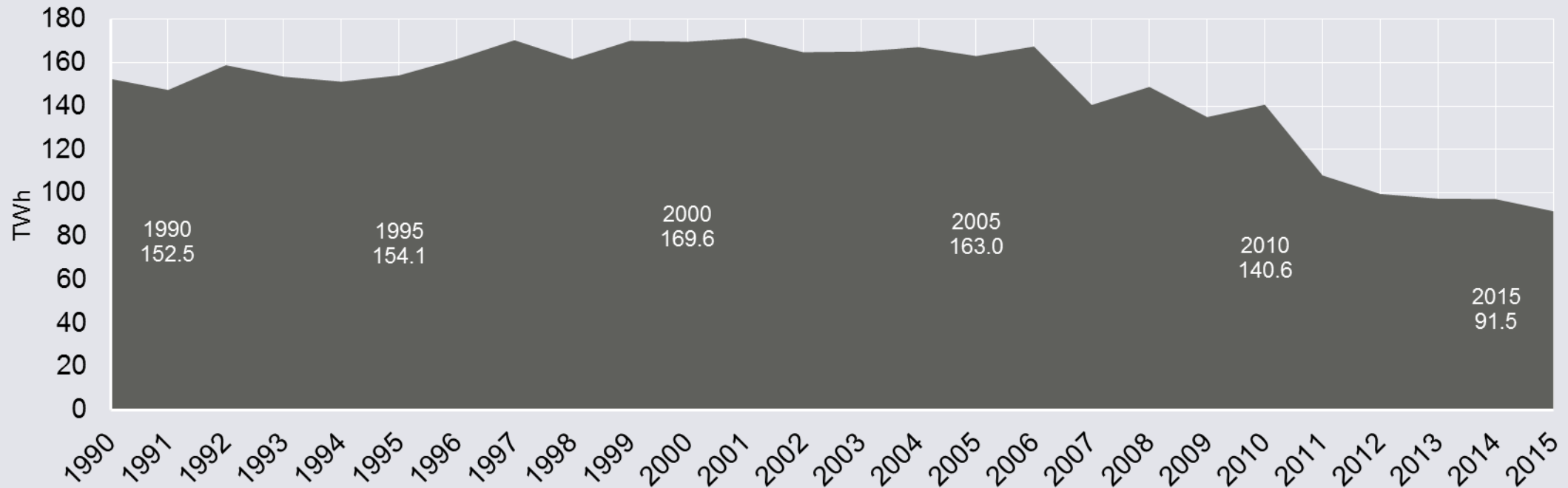
Power production from lignite 1990-2015



AG Energiebilanzen 2015

# Nuclear power 2015: Shutdown of nuclear plant Grafenrheinfeld at the end of June is evidenced by slight decline in nuclear power production

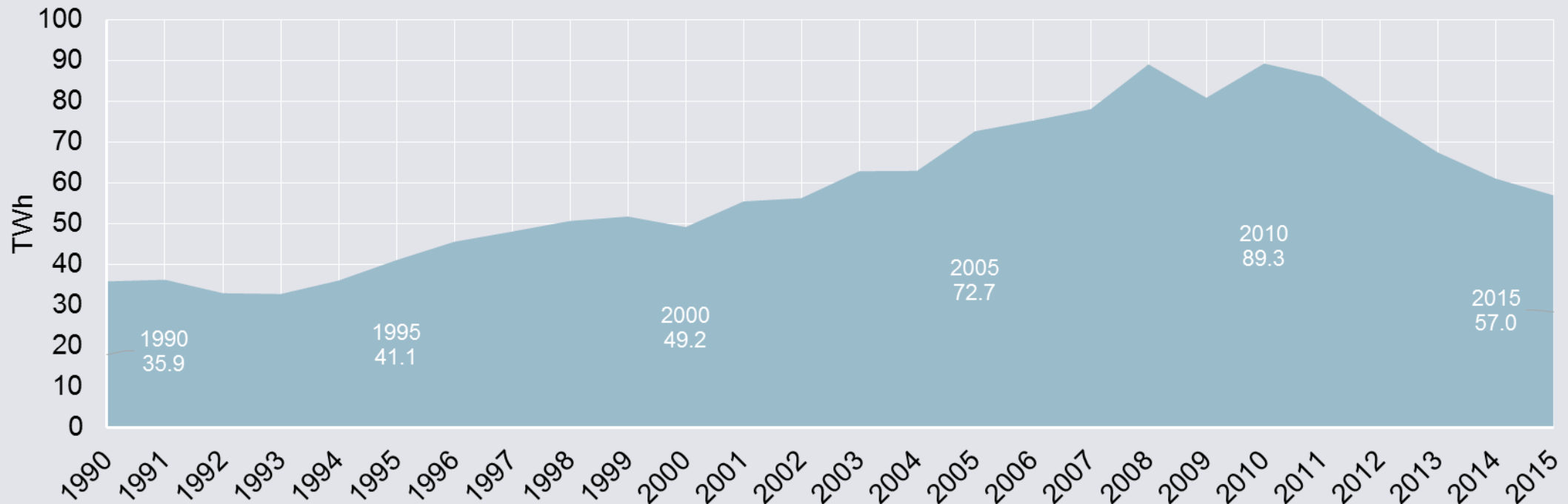
Nuclear power production 1990-2015



AG Energiebilanzen 2015

## Natural gas 2015: Natural gas continues to be sidelined in the power mix and is almost exclusively used in CHP plants

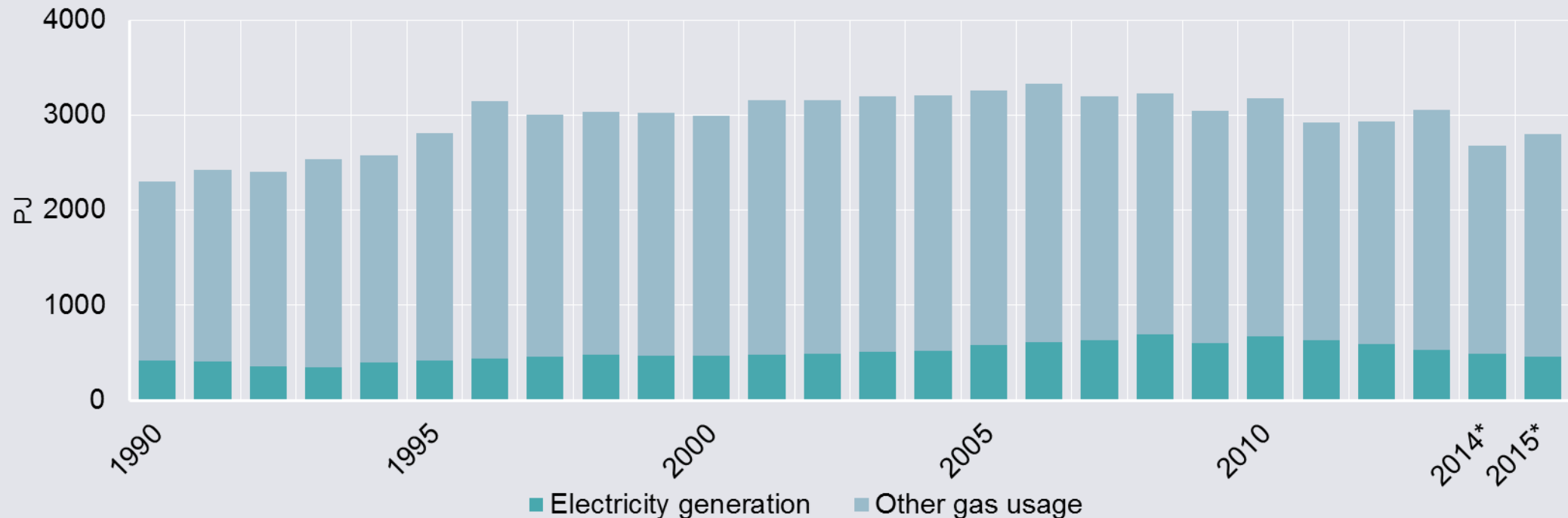
Power production from natural gas 1990-2015



AG Energiebilanzen 2015

# Natural gas consumption 2015: Despite lower natural gas power production, gas consumption rises overall in 2015 due to the colder winter

Primary energy consumption of natural gas 1990-2015



AG Energiebilanzen 2015b, \*own calculations based on AG Energiebilanzen 2015

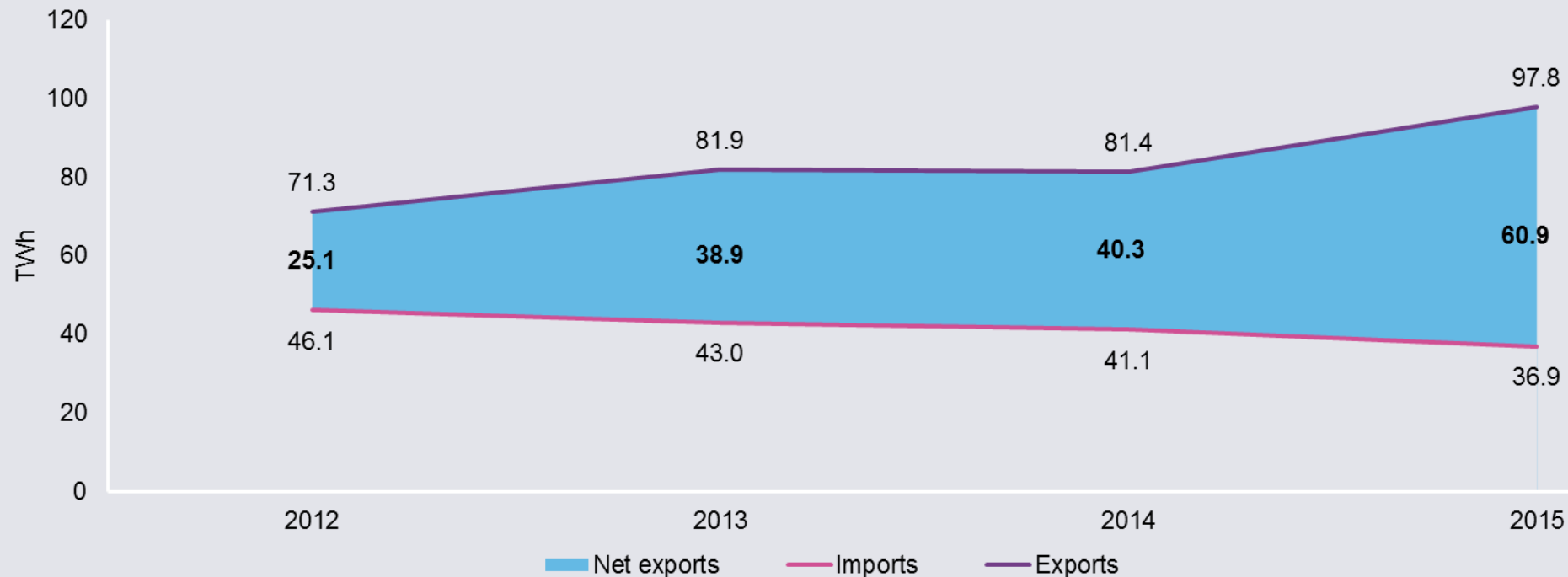




**Power exchange with  
neighbours**

# Power trading 2015: Germany posts new net power export record at 60.9 terawatt-hours – 10% of all power produced in German is sold abroad

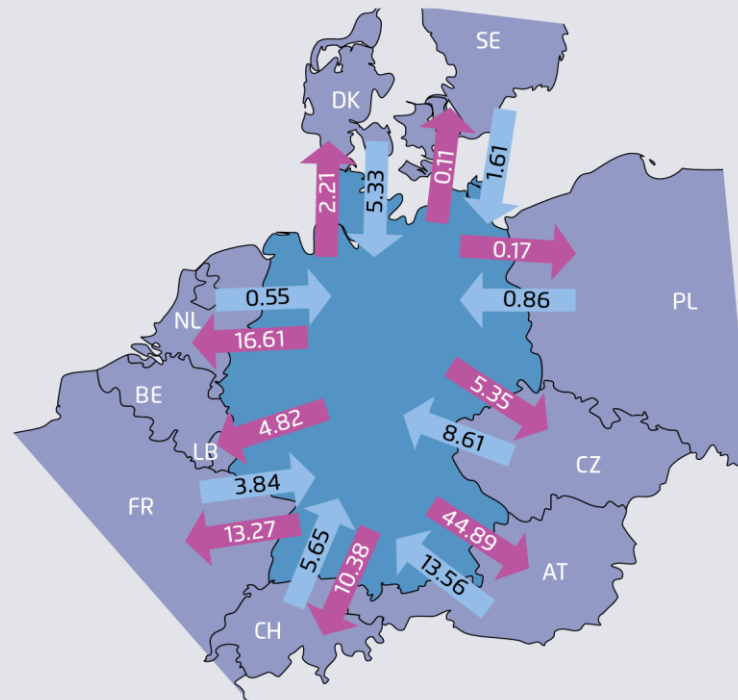
Trade flows and trade balance 2012-2015



Calculations based on ENTSO-E 2015. Shown are commercial exchanges, not physical flows

## Power trade 2015: Brisk international power trade – power is exported mainly to Austria and the Netherlands

Trade flows with neighbouring countries 2015

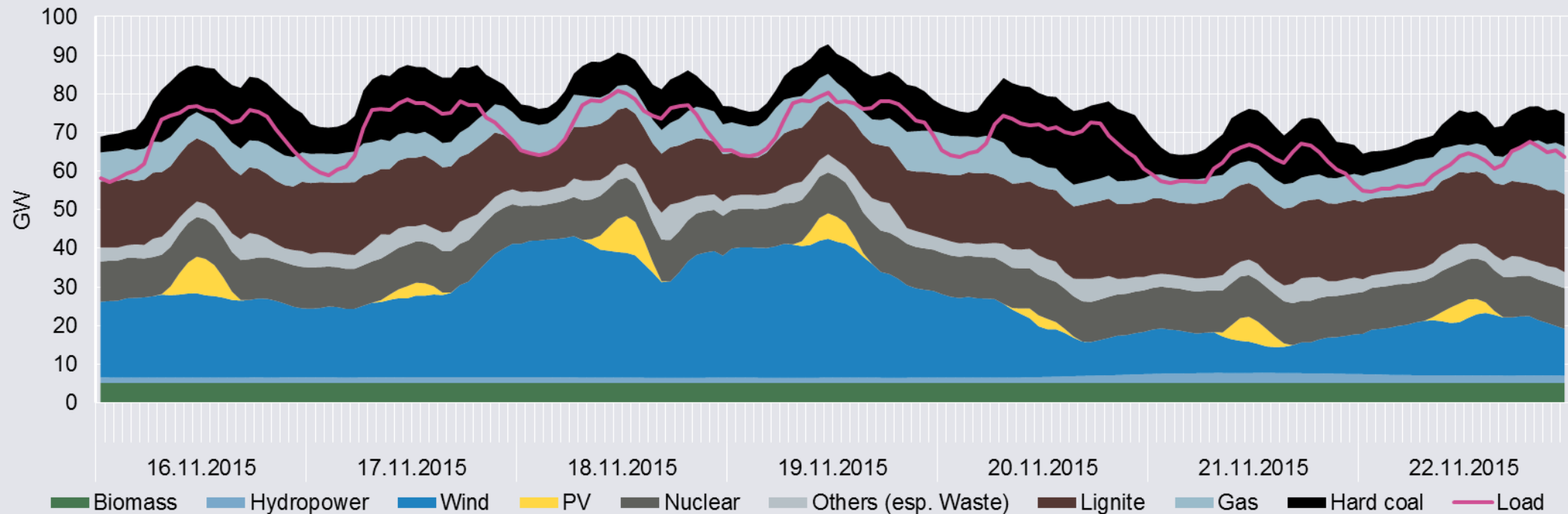


Exports: 97.8 TWh (2014: 76.5 TWh)  
 Imports: 36.9 TWh (2014: 41.1 TWh)  
 Net-Exports: 60.9 TWh (2014: 35.1 TWh)  
 Commercial exchanges in TWh

Calculations based on ENTSO-E 2015. Shown are commercial exchanges, not physical flows

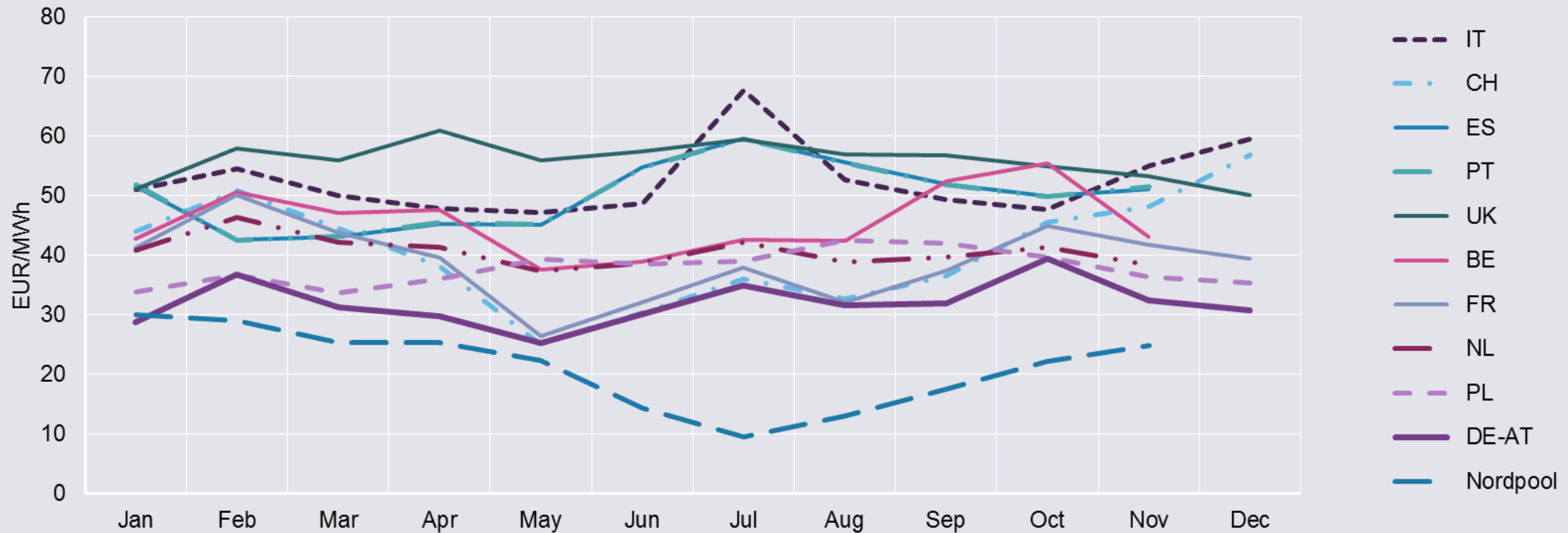
# Typical power production in a November week in 2015 – a large portion of hard coal power production (right margin of the merit order) is exported

Power production in calendar week 47



# Power trade 2015: The reason for high power exports is that Germany has the lowest power prices in Europe after Scandinavia

Power prices on European exchanges 2015 (Day-ahead Base)



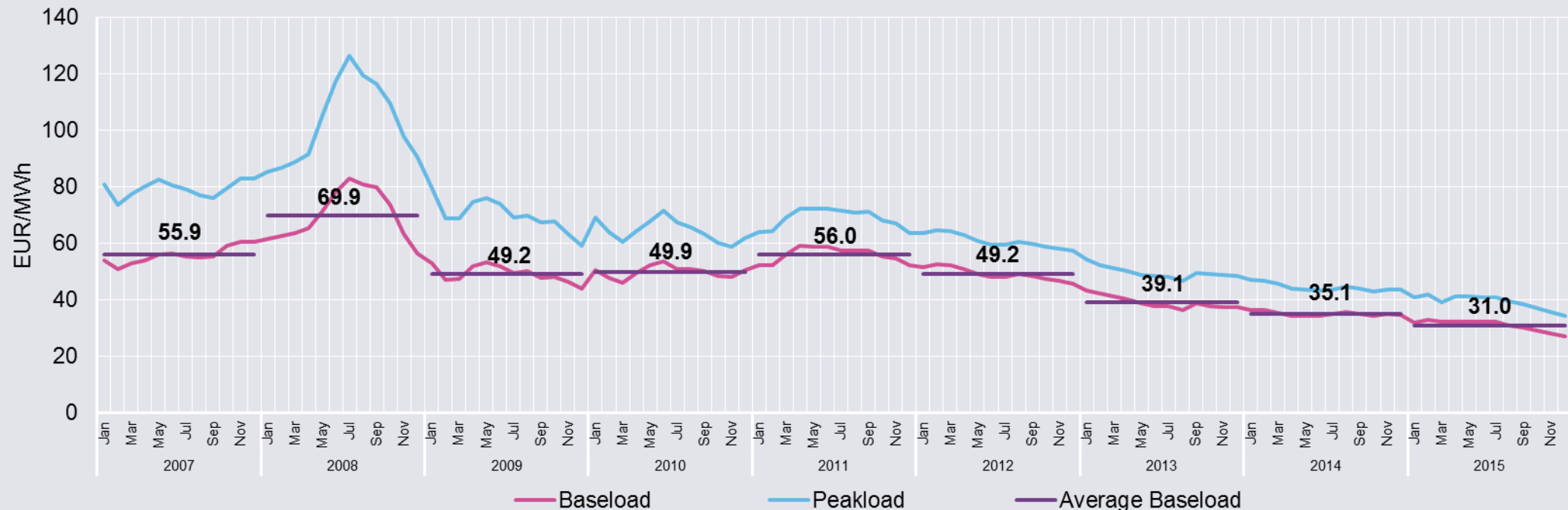
EPEX 2015 BELPEX 2015, OMEL 2015, GME 2015, Nordpool2015, APX Power 2015, PolPX2015, Quandl2015



**Power and fuel prices**

# Power exchange prices 2008-2015: Year-ahead futures price continues to decline in 2015

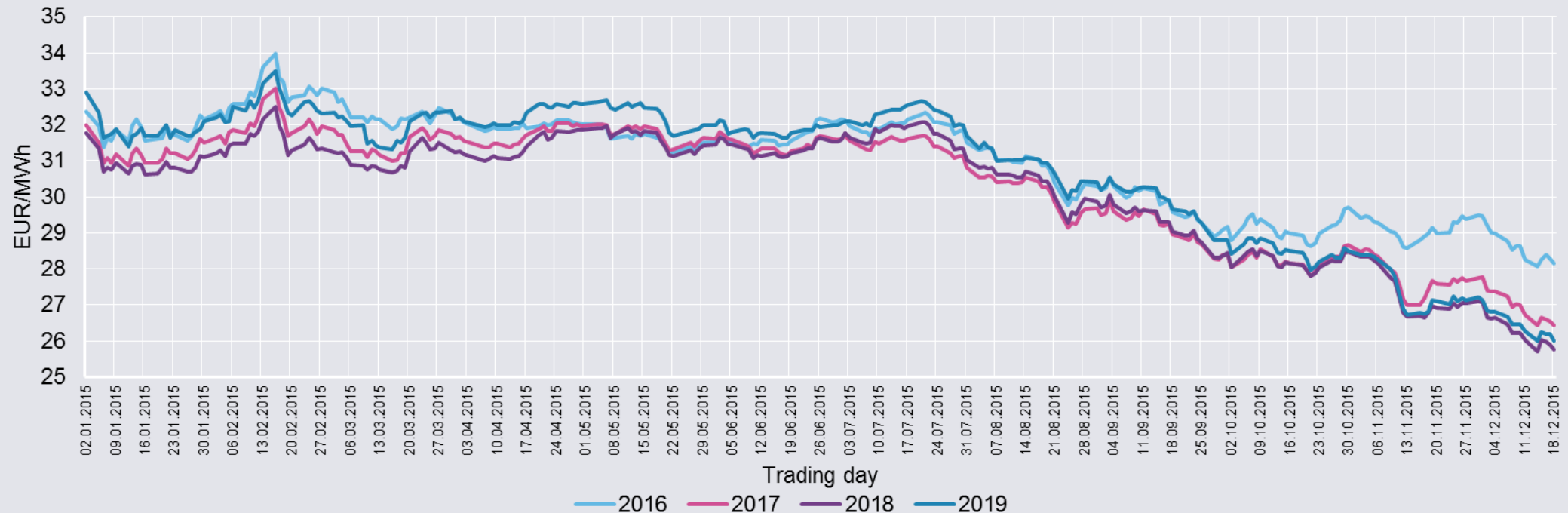
Development of rolling year-ahead futures prices 2007-2012



EEX 2015

# Power exchange prices in the trading year 2015: Power for 2016-2019 can be bought for under 30 euros per megawatt-hour

Futures price in the trading year 2015 for the years 2016-2019

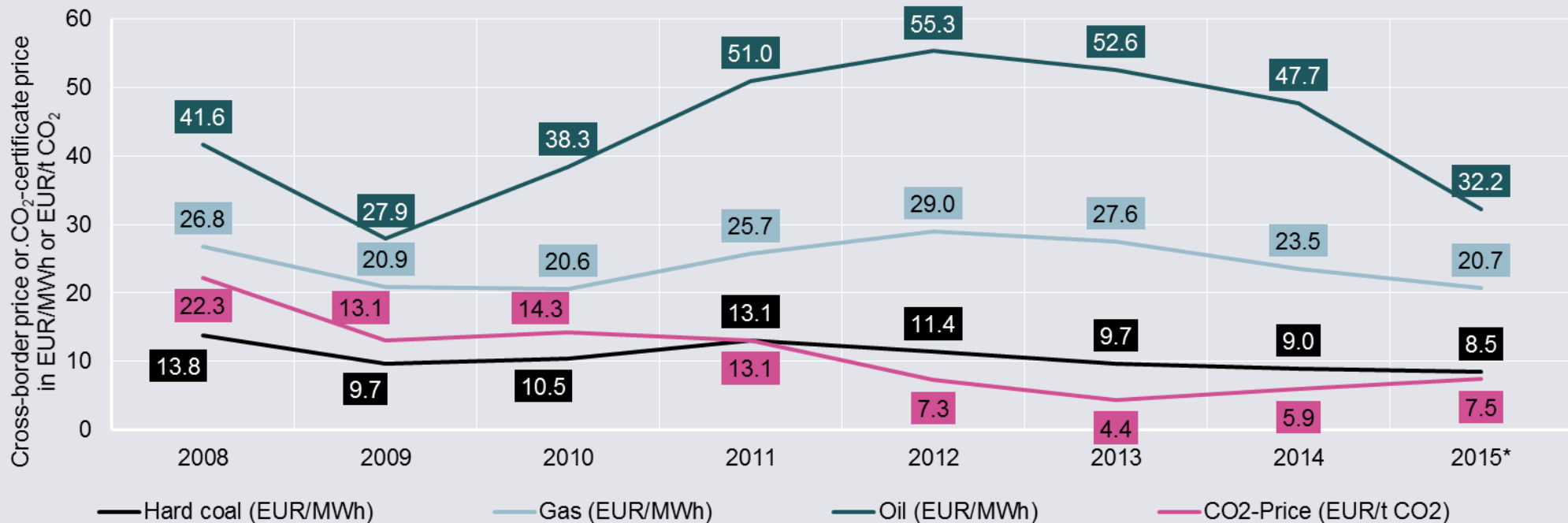


EEX 2015



## Fuel prices 2015: Oil, natural gas and coal prices decline, in some cases significantly, CO<sub>2</sub> prices rise slightly

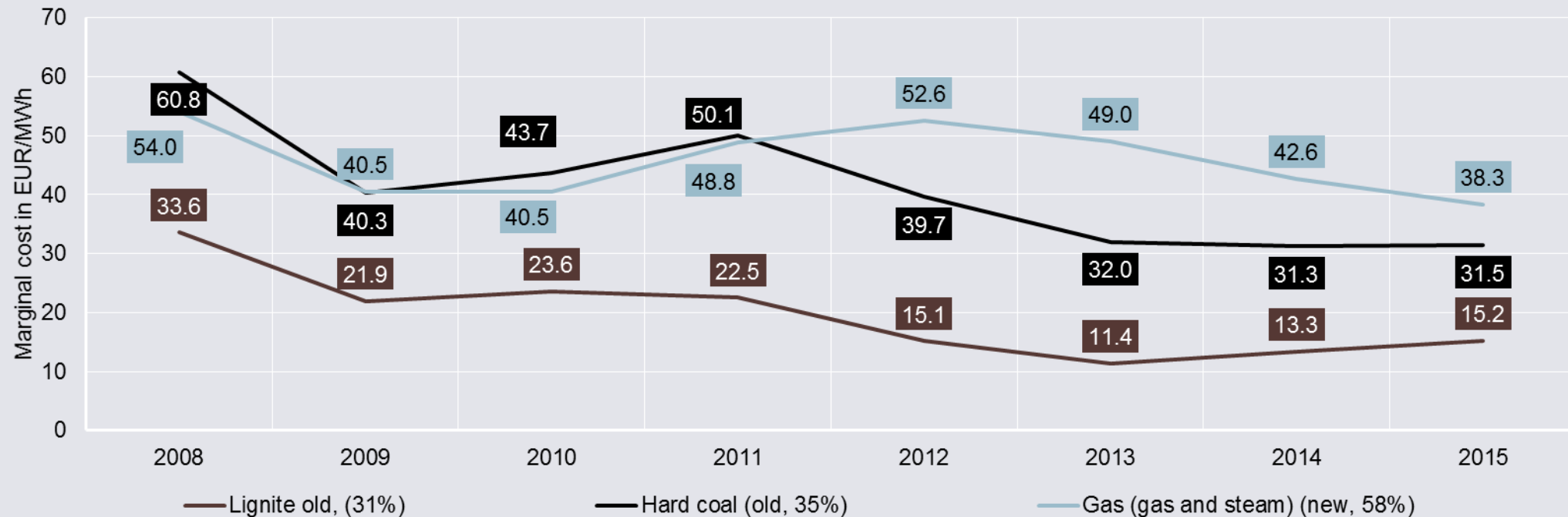
Cross-border prices for natural gas, hard coal, mineral oil 2008-2015



BAFA 2015a, BAFA 2015b, BAFA 2015c, EEA 2015, DEHSt2015, own calculations

# Merit order 2015: Despite lower prices for natural gas and slightly higher CO<sub>2</sub> prices, new gas plants cannot compete against old coal plants

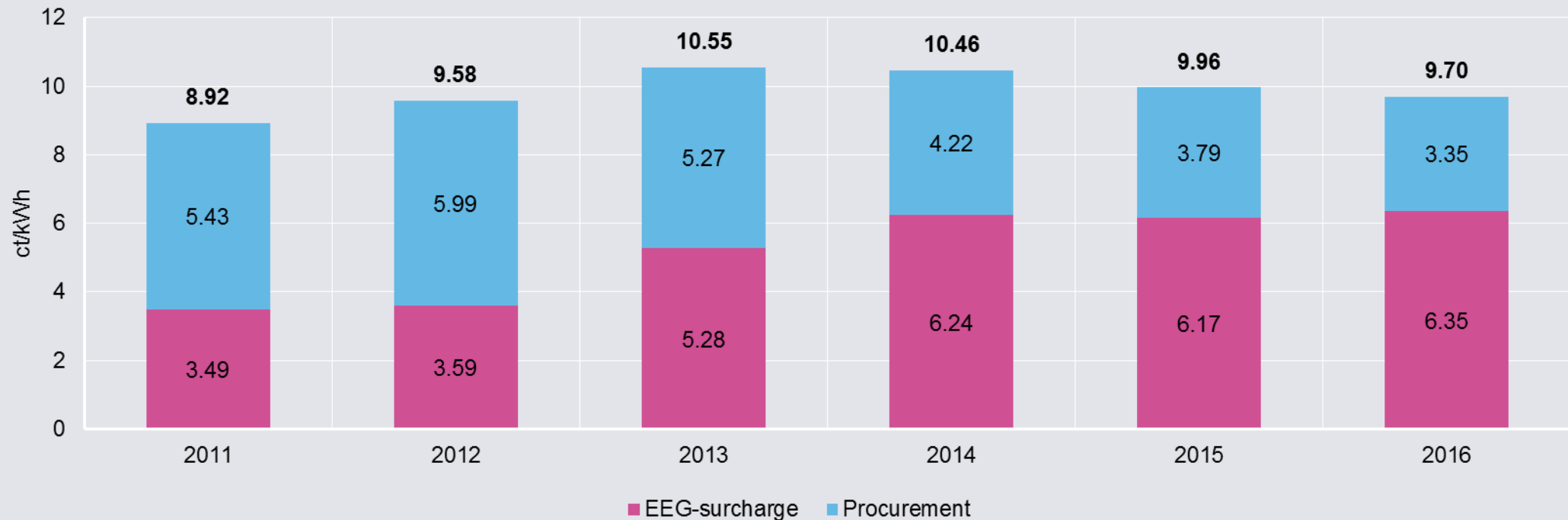
Marginal costs for new gas, lignite and old hard coal power plants 2008-2015



BAFA 2015b, BAFA 2015c, DEHSt2015, EEA 2015, Lazard2015, Statistisches Bundesamt 2015, UBA 2015, own calculations

# Power procurement costs 2015: The combined cost of power procurement and EEG surcharge will also be under 10 cents per kilowatt-hour in 2016

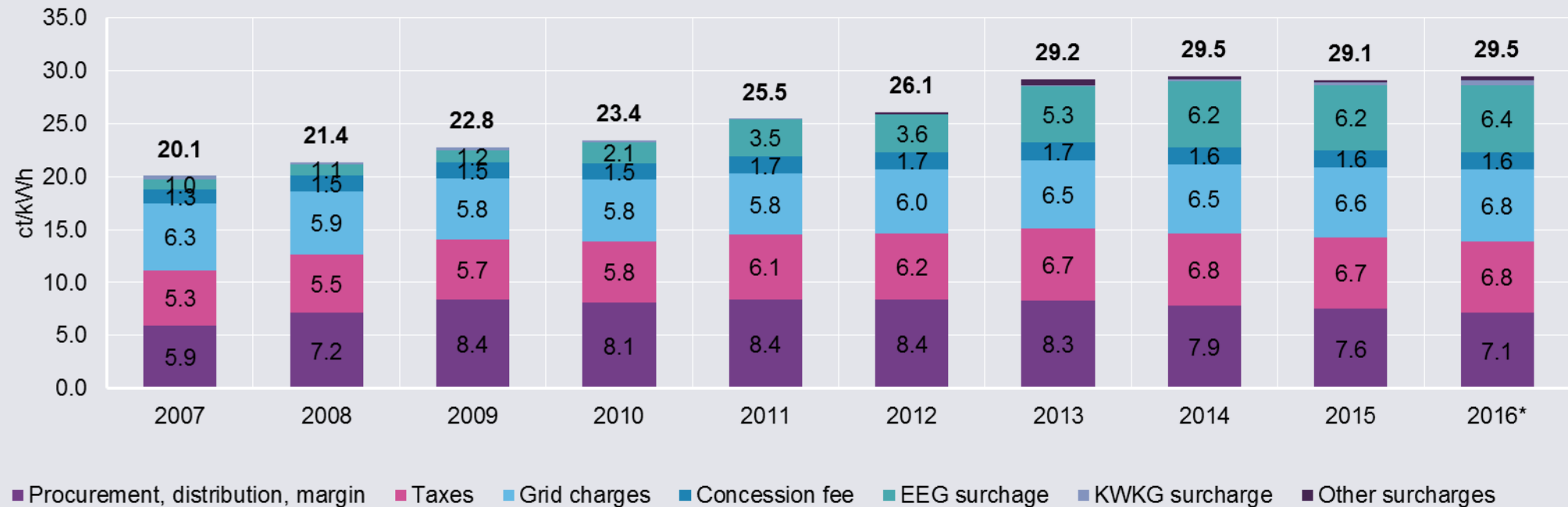
Procurement costs (70 percent one-year-ahead future (base)), 30 percent one-year-ahead future (peak)) and EEG surcharge 2011-2016



EEX 2015, TSOs 2015

# Household power prices 2015/2016: Household power prices are expected to rise slightly and will again be around 2014 levels

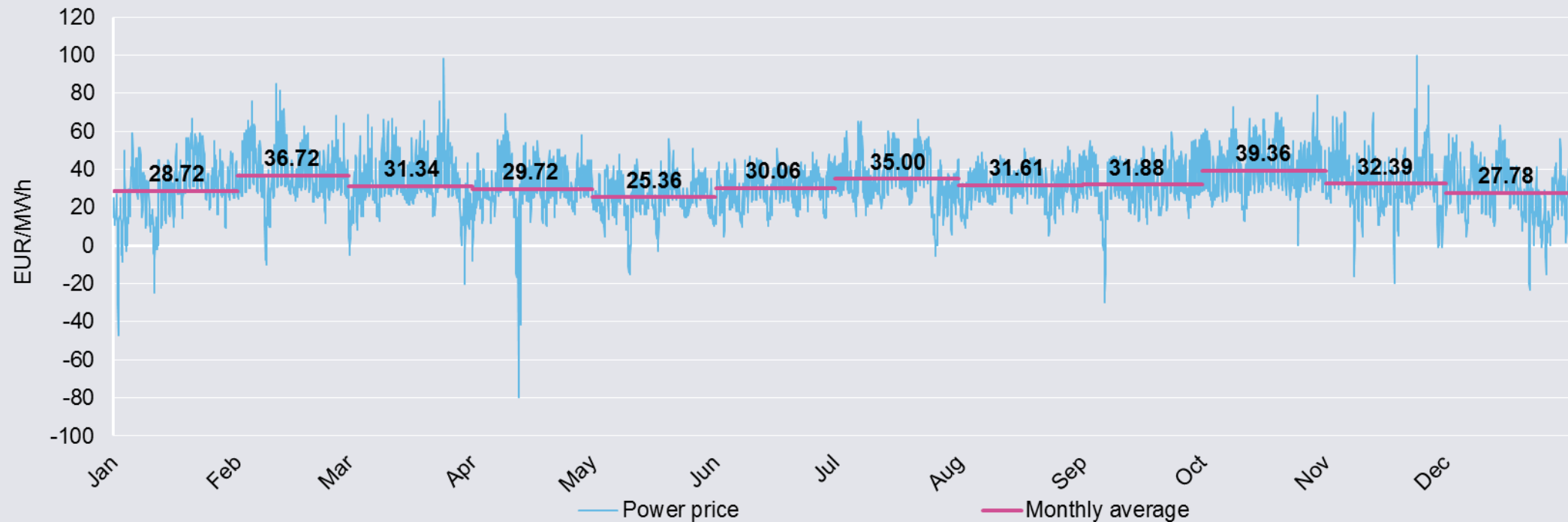
Household power prices 2007-2016



BNetzA 2015; \* own estimate

# Power exchange prices 2015: The spot-market power price in 2015 averages 31.60 euros per megawatt-hour

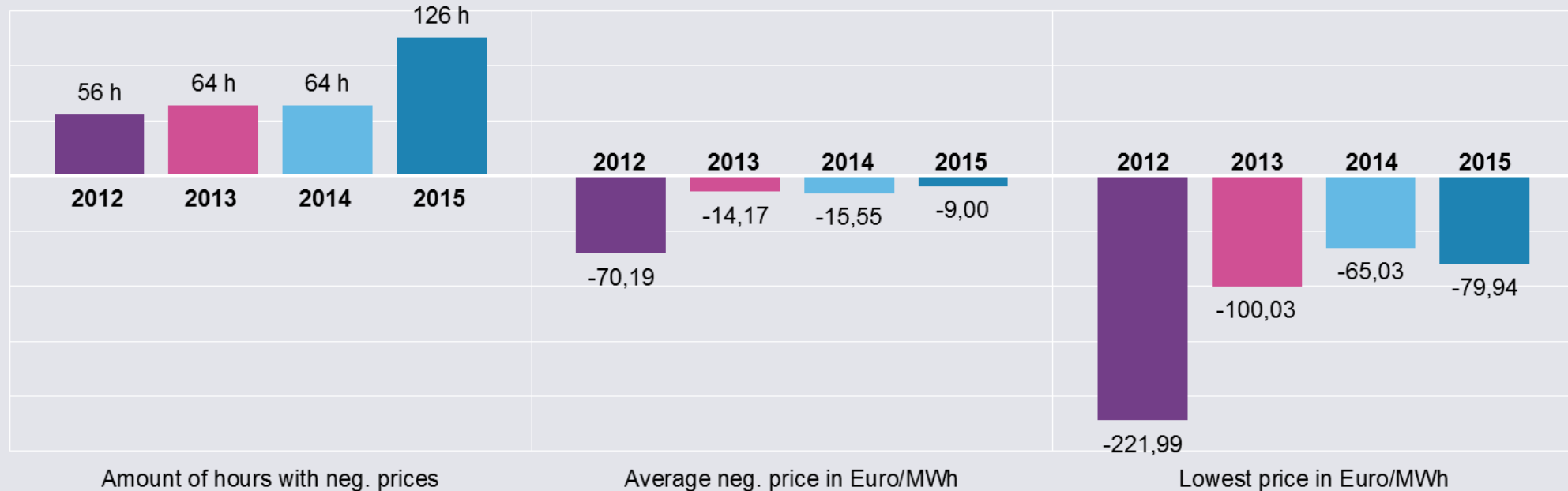
Day-ahead power prices 2015 and monthly average



EEX 2015

# Negative prices 2015: The number of hours with negative prices has nearly doubled, but the average negative price has declined

Number of hours with negative prices, average negative price and lowest price

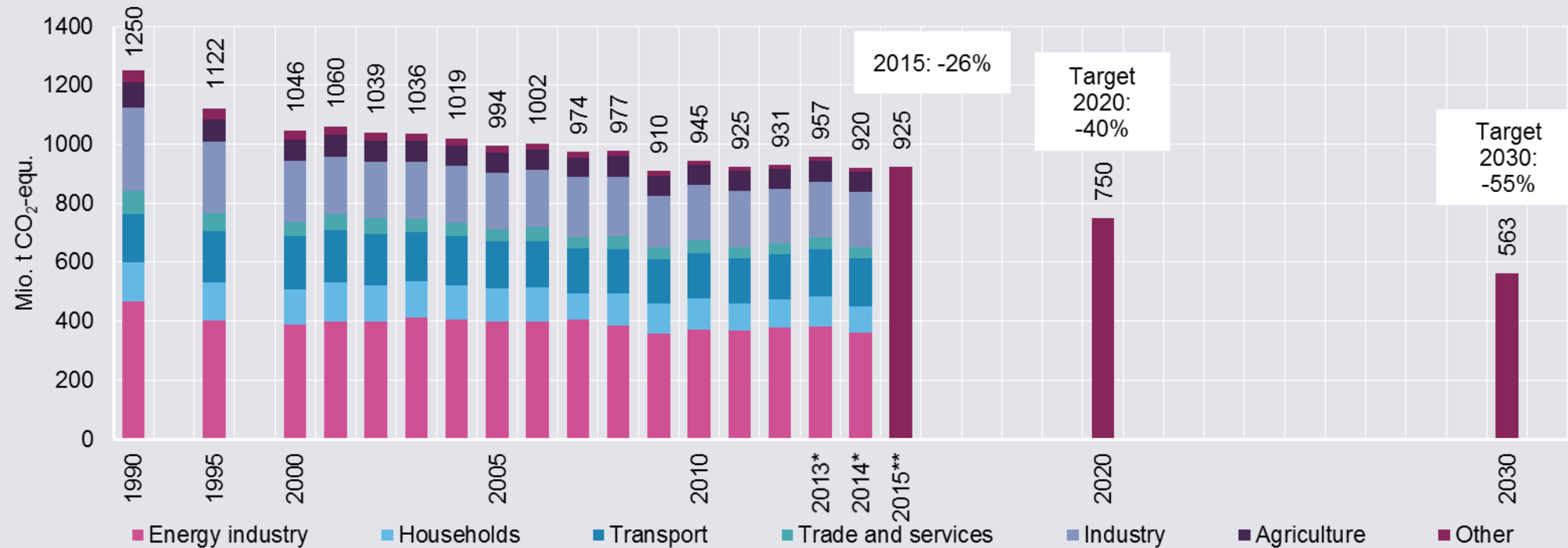




# Climate protection

# Emissions 2015: Greenhouse gas emissions rise again in 2015 due to the cold winter and minimal advances in climate protection measures in power, heat and transport

Greenhouse gas emissions by sector 1990-2015, and reduction targets for 2020 and 2030

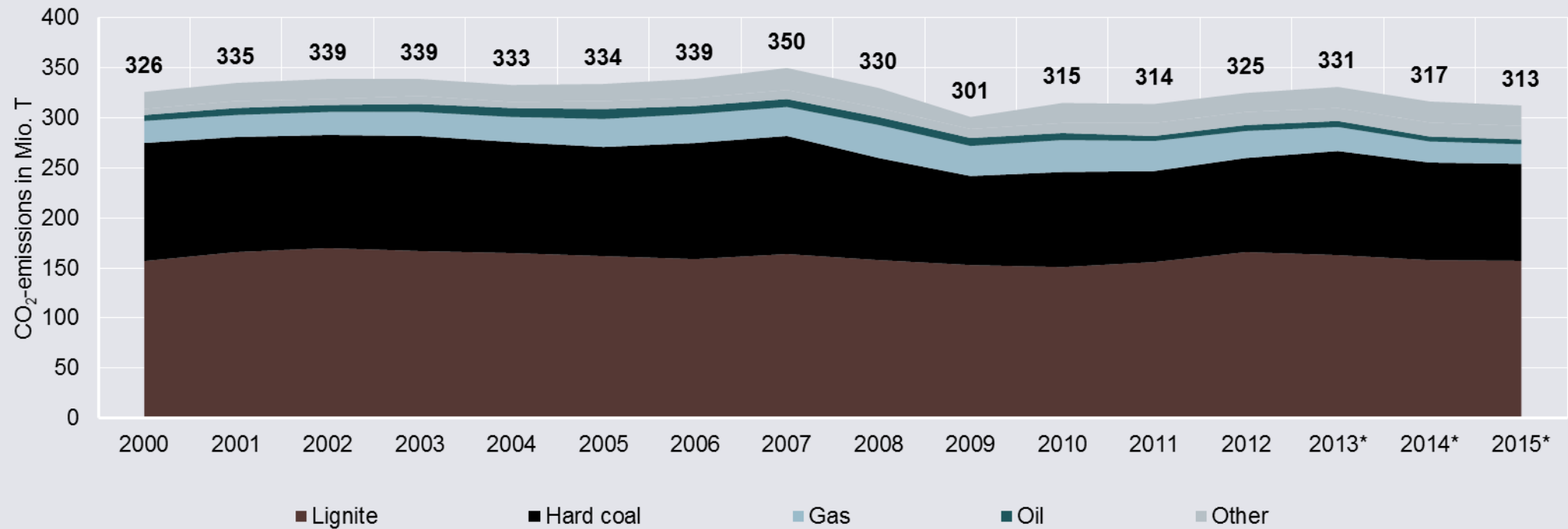


UBA 2015b, \*own calculations, \*\*own estimate



## Power sector emissions 2015: CO<sub>2</sub> emissions from the power sector fall only slightly in 2015, back to 2011 levels

CO<sub>2</sub> emissions in the power sector 2000-2015 by energy source



UBA 2015a; \* own calculations

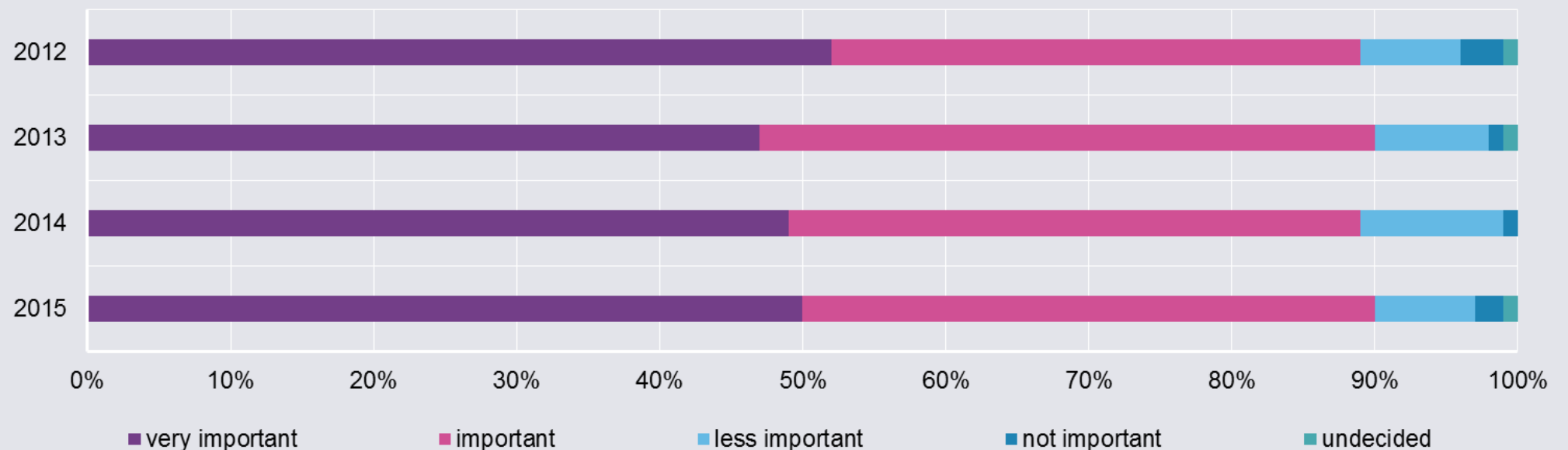


# Public sentiment

## Public sentiment 2015: The energy transition enjoys a stable 90-percent support rate among the population in 2015

Meaning of the energy transition 2012-2015

The *Energiewende* is...

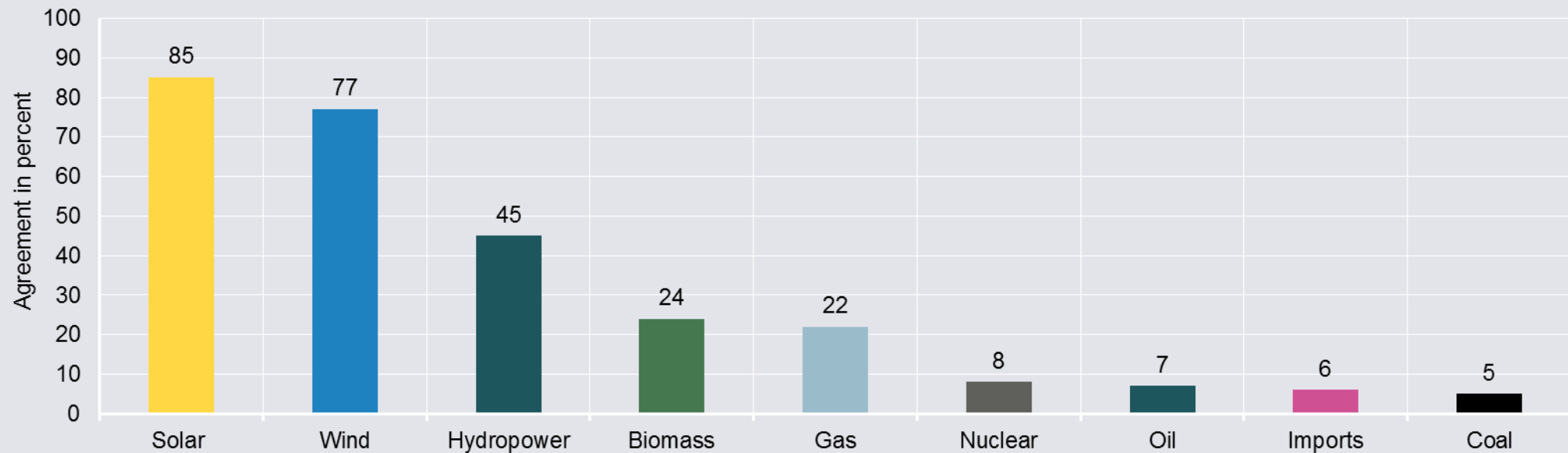


BDEW Energiemonitor 2012, 2013, 2014, 2015

## Public sentiment 2015: Sun and wind enjoy high level of support, coal the lowest

Public opinion about the important energy sources of the future

In 20, 30 years, the energy supply should be secured by...



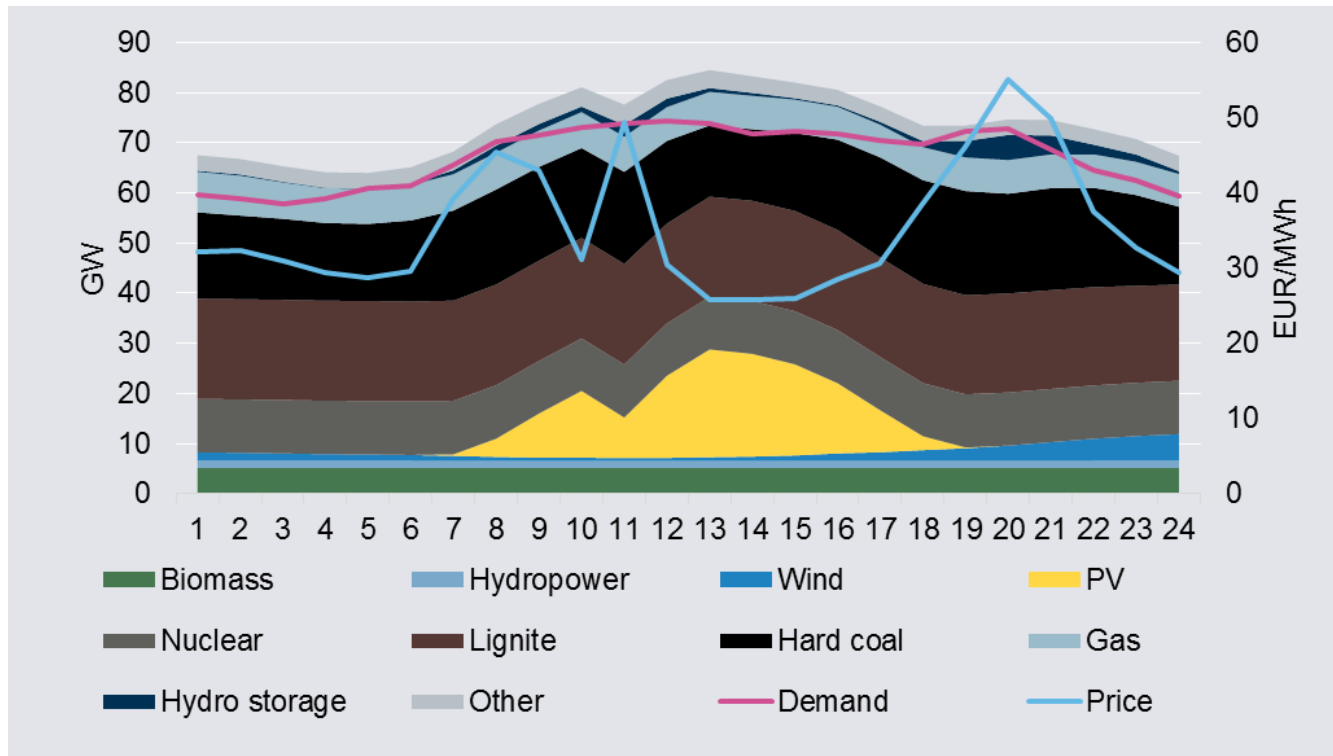
Bundespresseamt 2015, quoted from zeit.de and phasenpruefer.de



**Special days in 2015**

## Solar eclipse 2015: Flexible power system secures power supply in partial solar eclipse on 20 March

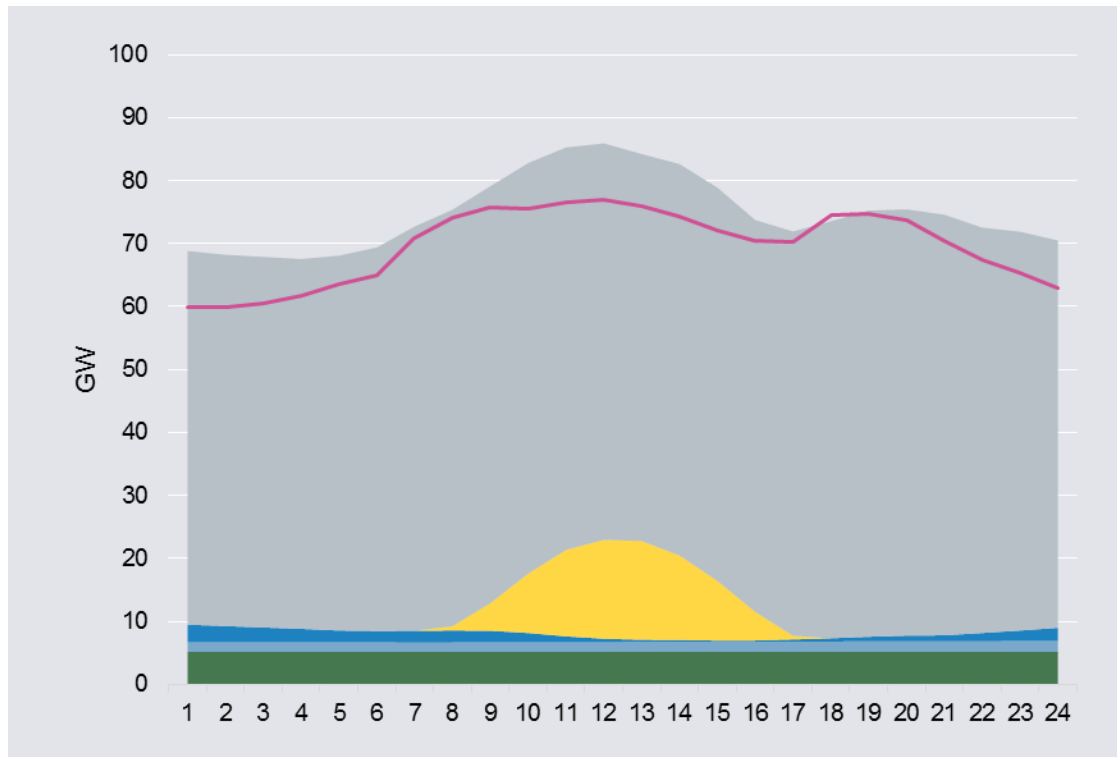
Power production on 20 March 2015



- Hourly pv feed-in between 9am and 10am: 13 gigawatts
- Hourly pv feed-in between 10am and 11am: 8 gigawatts
- Hourly pv feed-in between 11am und 12pm: 16 gigawatts
- Hourly pv feed-in between 12pm und 1pm: 21 gigawatts

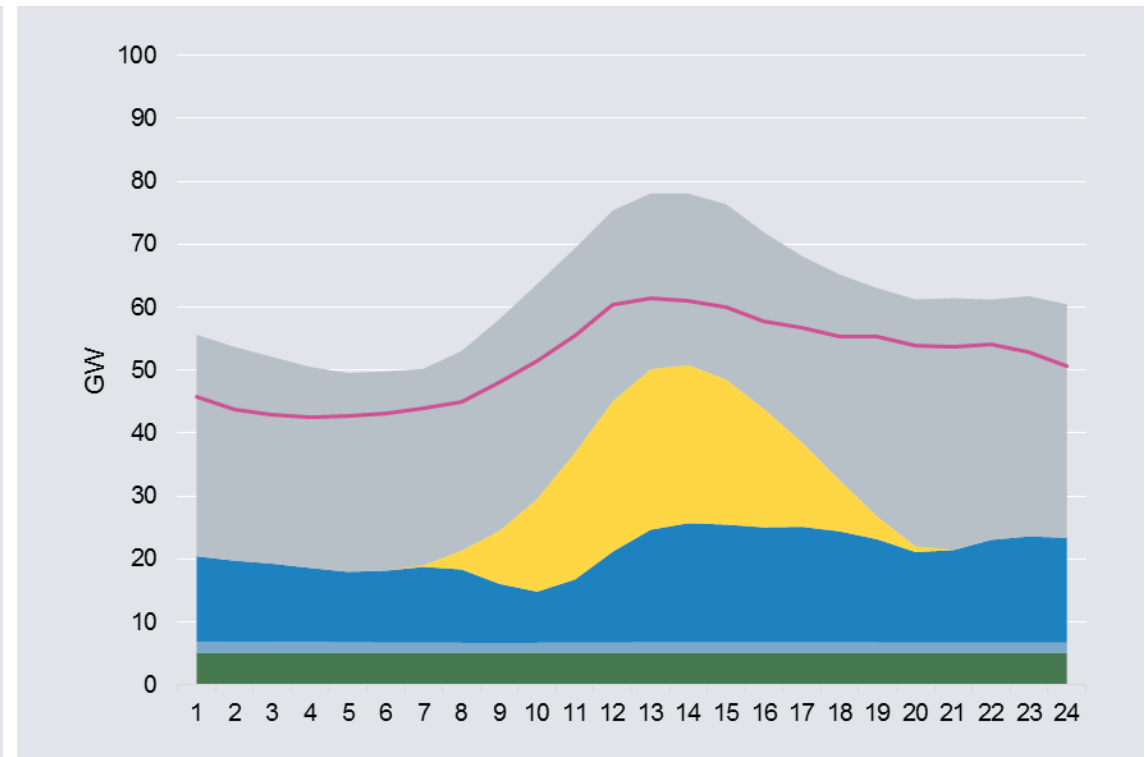
# Share of renewable energies 2015: The renewables share swung between 9.9 percent (minimum in November) and 83.2 percent (maximum in August)

Minimum renewables share on 3 November, 5pm: 9.9 percent



Agora Energiewende 2015

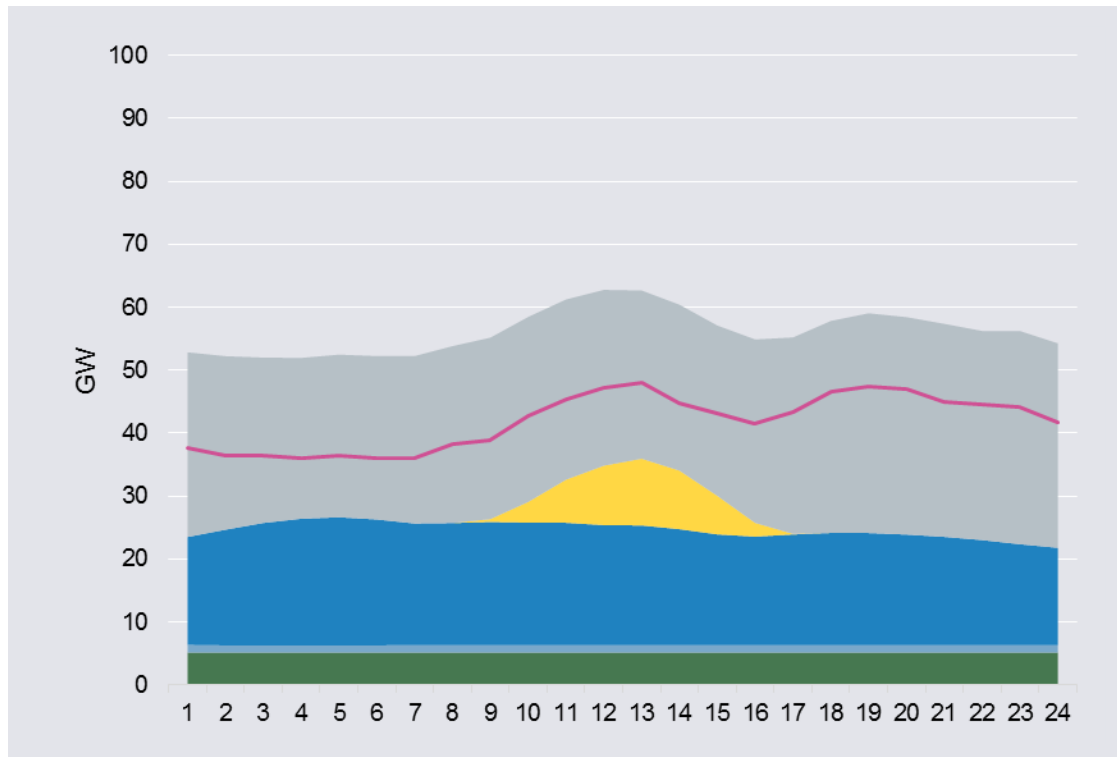
Maximum renewables share on 23 August, 1pm: 83.2 percent



Agora Energiewende 2015

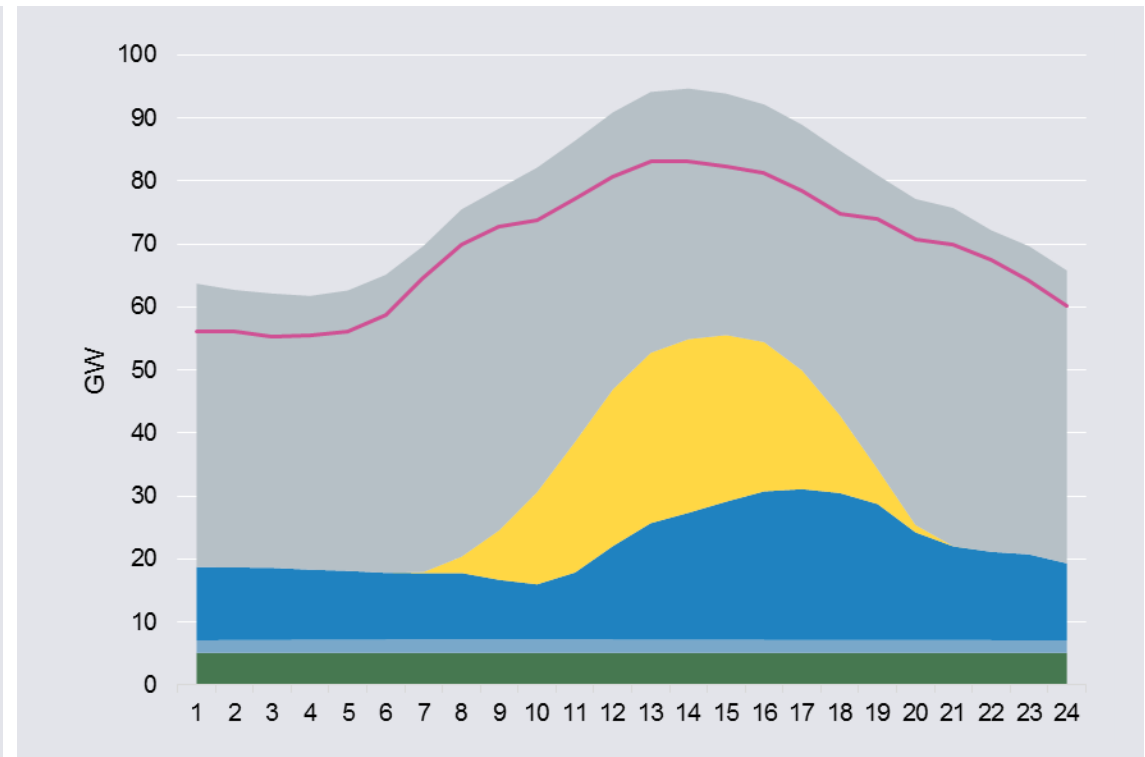
## Power demand 2015: Large difference between cold April day (maximum) and Christmas (minimum)

Minimum load on 26 December 3pm: 36 GW



Agora Energiewende 2015

Maximum load on 15 April, 1pm: 83.2 GW

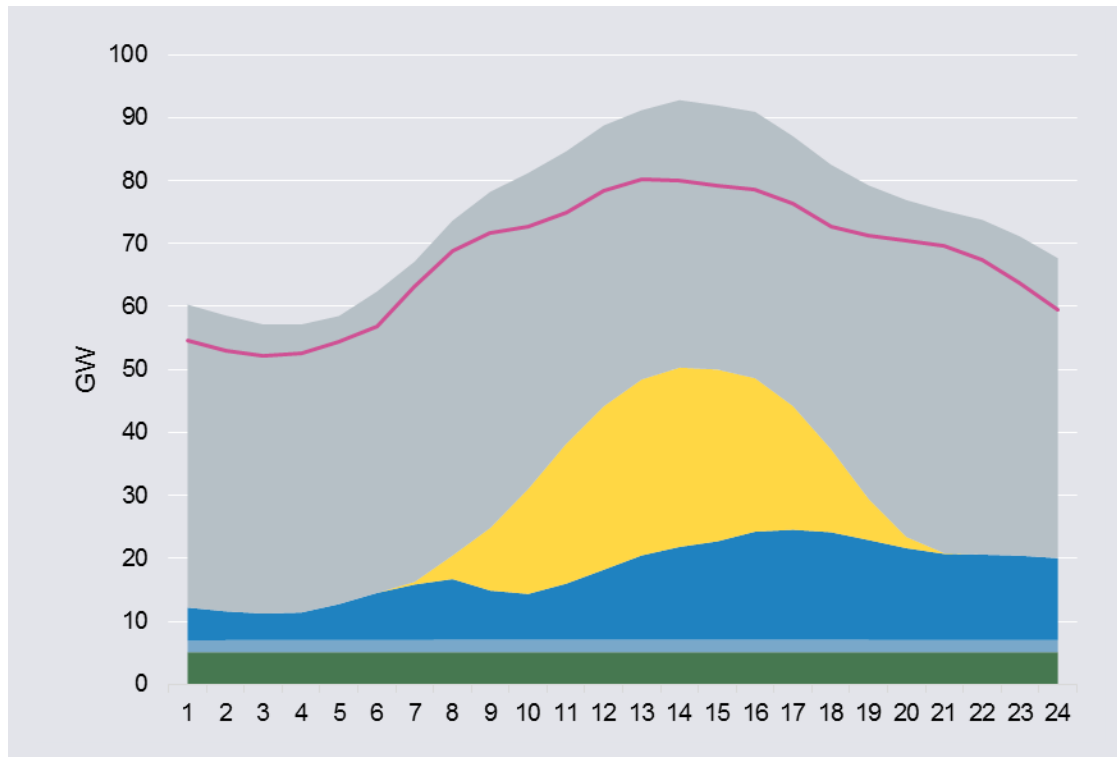


Agora Energiewende 2015



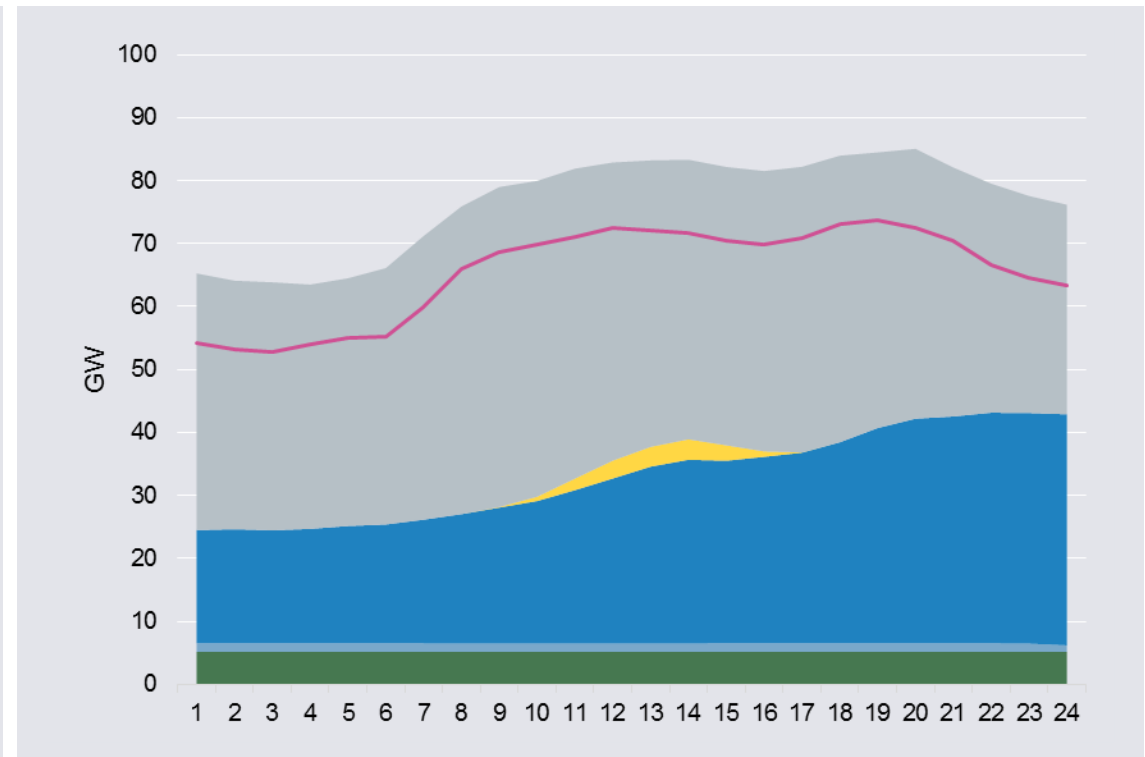
# Renewable energies 2015: Maximum capacity use of wind power plants at 92.5 percent, of solar energy plants at 73 percent at maximum feed-in

Max. solar power feed-in on 21 April, 1pm: 28.5 GW



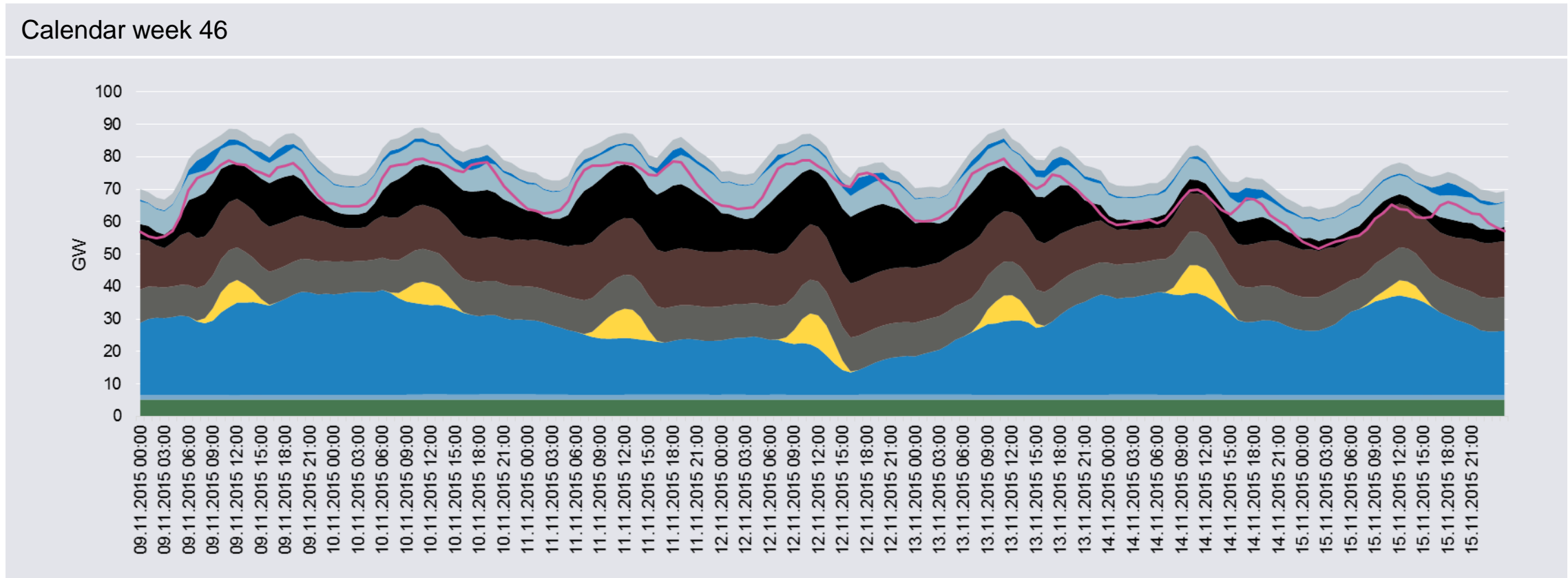
Agora Energiewende 2015

Max. wind power feed-in on 21 December, 11pm: 36.7 GW



Agora Energiewende 2015

# Typical week: high wind power and flexible thermal power plants



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# Thank you for your attention!

Questions or Comments? Feel free to contact me:  
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Agora Energiewende is a joint initiative of the Mercator  
Foundation and the European Climate Foundation.