
FRAUNHOFER INSTITUTE FOR SOLAR ENERGY SYSTEMS ISE

Power generation in Germany – assessment of 2016



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www.ise.fraunhofer.de

www.energy-charts.de

Power generation in Germany – assessment of 2016

Update of 07 February 2017

The **third version** from 07 February 2017 takes into account the monthly power generation data published by the German Statistical Office (Destatis) up to and including November 2016, which was published at 07 February 2017.

The **second version** from 06 January 2017 takes into account the monthly power generation data published by the German Statistical Office (Destatis) up to and including October 2016, which was published at 06 January 2017.

The **first version** of 02 January 2017 takes into account the monthly power generation data published by the German Statistical Office (Destatis) up to and including September 2016. The data for October, November and December were extrapolated from adjusted hourly values from the European Energy Exchange EEX in Leipzig and hourly data from the four German TSOs (50 Hertz, Amprion, Tennet, TransnetBW). The tolerance range is greater for extrapolated values.

The data at Energy Charts is updated by the hour:

www.energy-charts.de

Power generation in the year 2016

Renewable energy: solar and wind

In 2016, roughly 37.5 TWh of electricity from **photovoltaic arrays** was fed into the grid. Production thus is 1.2 TWh or 3.3% lower than in 2015. The slight decrease compared to previous year is due to the different weather conditions and the small installation rate of only 1.2 GW. The target of the government was 2.5 GW. At the end of 2016, 40.85 GW PV were installed. Solar power production peaked at 28.5 GW and 47% of total electricity generation on 08 May 2016 at 1:00 PM. In May 2016, the monthly electricity production of PV systems was higher than that of nuclear power plants.

78 TWh were generated from **wind** in total, 1.2 TWh less compared to 2015. Monthly production of wind power peaked in February and was even higher than production of hard coal. For six months, the monthly production of wind was higher than the production of nuclear. Quarter hourly production peaked at 36.6 GW on 08 February 2016 at 09:45 PM,.

Onshore wind farms produced 66 TWh in 2016, 5 TWh less than in 2015.

Offshore wind farms raised their production from 8 TWh in 2015 to 12 TWh in 2016. In the North Sea they produced 10.7 TWh compared to 7.1 TWh in 2015. The offshore wind farms in the Baltic Sea produced 1.3 TWh (0.8 TWh in 2015). At the end of 2016, 45.5 GW wind onshore and 4.1 GW wind offshore were installed.

Taken together, **solar and wind power generators** produced 116 TWh in 2016, enough to put them in second place after lignite but ahead of hard coal and nuclear.

1 TWh = 1 terawatt-hour = 1,000 gigawatts-hours (GWh) = 1 million megawatt-hours (MWh) = 1 billion kilowatt-hours (kWh)

Power generation in the year 2016

Renewable energy: hydropower and biomass

Approximately 20.75 TWh were produced from **hydropower**, a level roughly unchanged year-over-year. The production during summer was high and from September to December quite low due to little rain.

Roughly 49 TWh of electricity was generated from **biomass**, 2 TWh more compared to the year before.

In total, **renewable energy sources** – solar, wind, hydropower, and biomass – produced approximately 185 TWh of electricity in 2016. There was no increase in production compared to 2015. Renewables thus made up around 33.9% of public net power supply. The share in gross power supply – including power plants in the processing sector, the mining sector, quarries, and excavation – is around 32%.

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Power generation in the year 2016

Non-renewable generation

The net power production from **nuclear plants** came in at around 80 TWh, 7.8% below the 86.8 TWh net in the previous year. The main reason for the decline is the shutdown of the reactor Grafenrheinfeld in Bavaria on 27 June 2015.

Lignite power plants generated 134.8 TWh net, some 4.6 TWh or 3.3% less than in 2015. They were forced to curtail production in particular at times of peak wind power generation during wind storms. Lignite power stations are still very inflexible in their response to high feed of renewable energies.

Net production from **hard coal** plants was posted at 100.0 TWh, 6.2 TWh (5.8%) lower than in 2015.

Gas power plants for public power supply generated some 45.2 TWh, 15.1 TWh (50%) above the level of the previous year. This new upward trend in power production from gas turbines is mainly caused by the low gas prices. In addition to power plants for public power supply, there are also power generation facilities in the mining and manufacturing sector for self supply. These units produced additional 20 to 30 TWh.

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Power generation in the year 2016

Export surplus

In 2016, the **export surplus** reached some 50 TWh, a level even higher than the previous record years of 2012, 2013, 2014 and 2015. Specifically, the level is 2 TWh (4%) above the record in 2015. The largest share of exports, 15 TWh, went to the Netherlands, and the Dutch passed on some of this electricity to Belgium and the UK. Switzerland came in second, and it also passed along most of the electricity to Italy. In third place came Austria, which also passes some of the electricity to its neighbor countries. Poland on the fourth place passed on some of the electricity from eastern Germany to southern Germany via the Czech Republic.

Germany imported less electricity from France compared to the previous years, mainly since several French nuclear power plants were switched off for safety reasons. Germany acts as transit country for French electricity and passes it to neighboring countries.

In **power trading** so far only numbers from January to November 2016 are available. During this period, 25.0 TWh were imported to a value of 926 million euros. The export amounted to 70.7 TWh and a value of 2.49 billion euros. In balance, the resulting export surplus was 45.8 TWh and revenues worth 1.56 billion euros. Imported electricity cost an average of 37.12 Euro/MWh compared to 35.21 Euro/MWh for exports.

The average volume weighted **day-ahead price** of electricity has fallen to 28.20 Euro / MWh and is adjusted for inflation at approximately the same level as of 2002.

The **market value factor** for PV was at 92.6% and for wind 86.4% of the average market price of electricity.

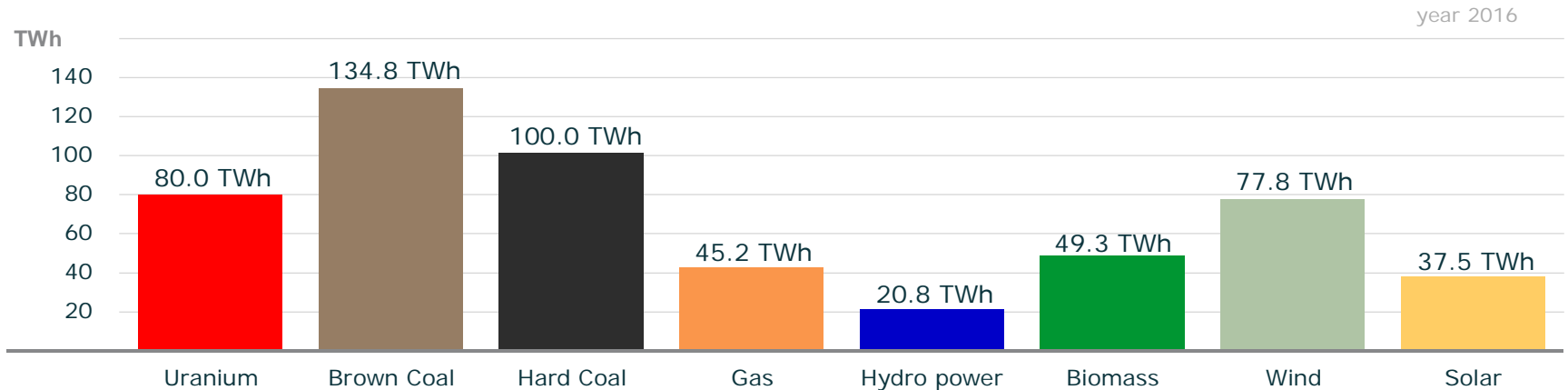
For additional information and graphics, visit: www.energy-charts.de

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Net power generation for the public power supply

Year 2016

Electricity production in 2016



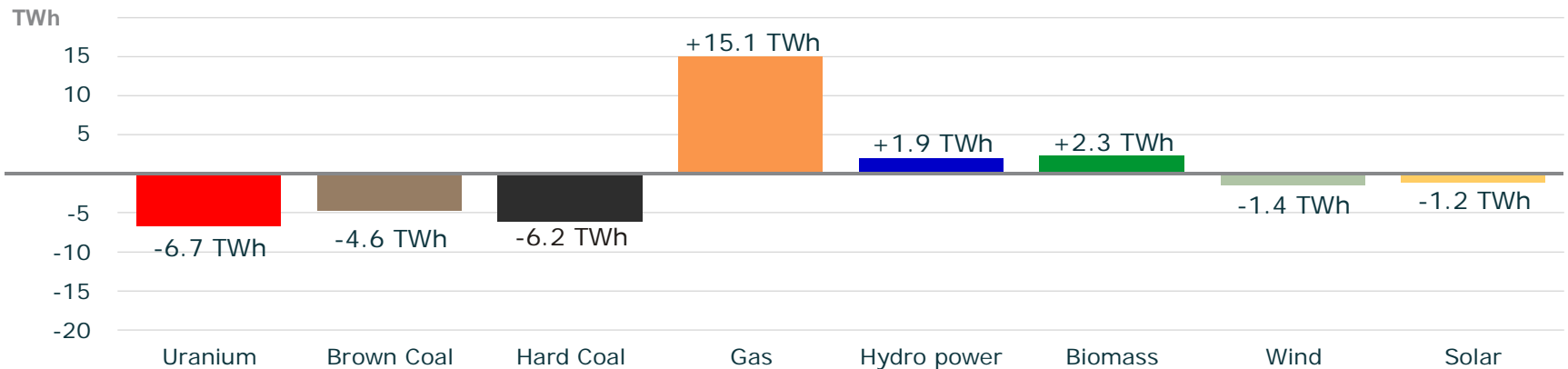
The graph shows net power generation from power plants for the public power supply. Electricity from power plants in the processing sector, mining, quarries, and excavation is not included.

Graphic: B. Burger, Fraunhofer ISE; data: DESTATIS and the EEX power exchange in Leipzig, with adjustments

Absolute change in net power generation

Year 2016 compared to year 2015

Absolute change in net power generation in 2016 compared to 2015

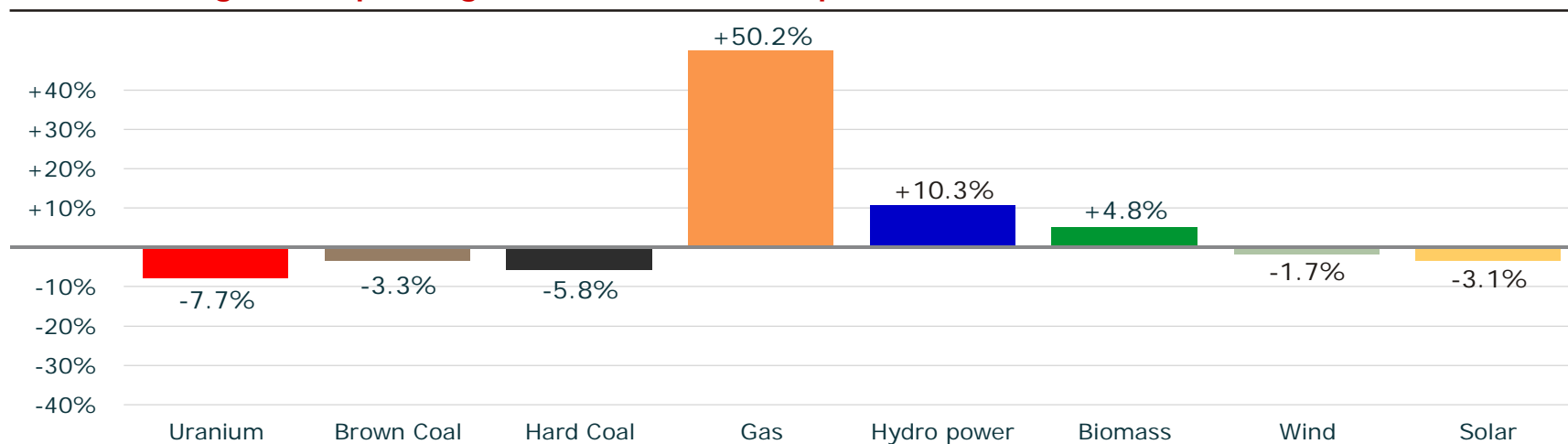


Graphic: B. Burger, Fraunhofer ISE; data: DESTATIS and the EEX power exchange in Leipzig, with adjustments

Relative change in net power generation

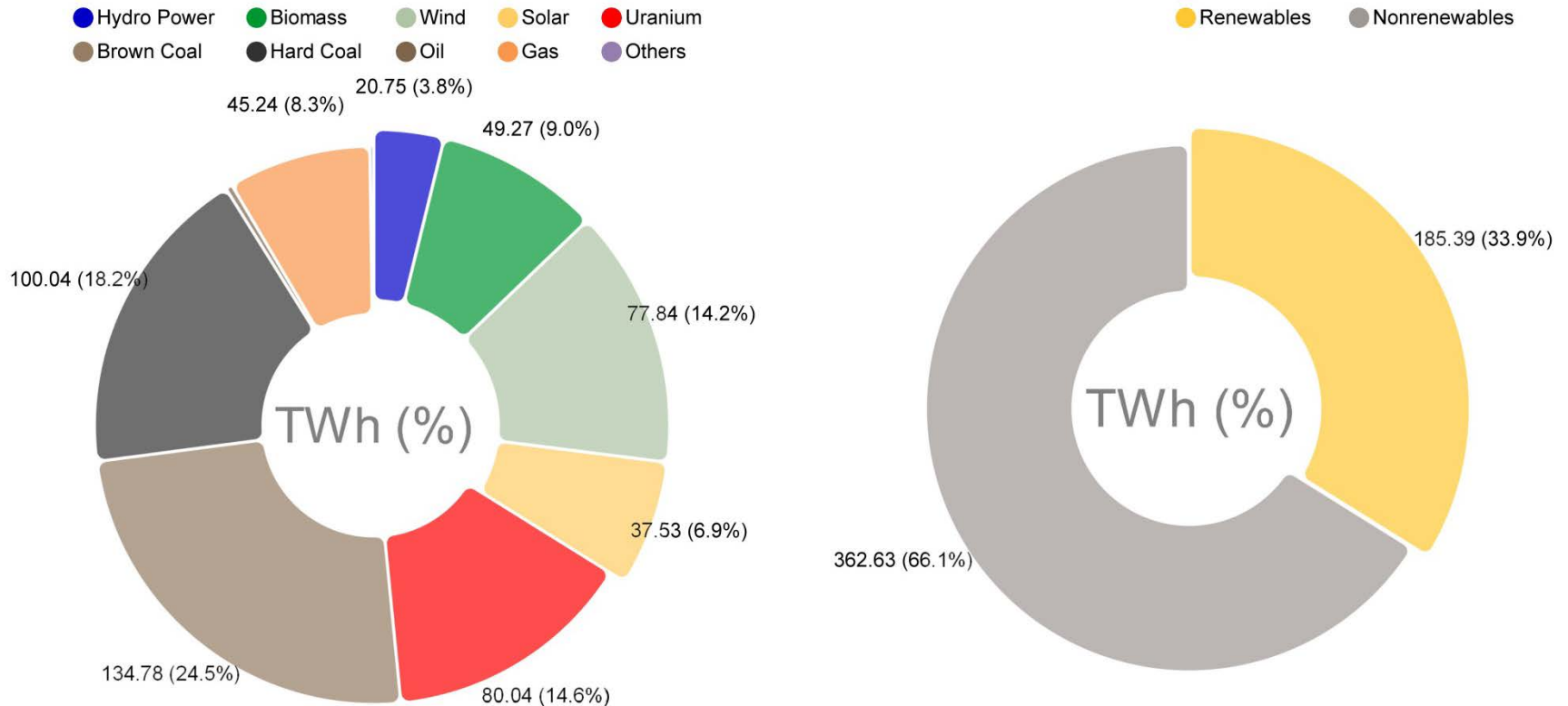
Year 2016 compared to year 2015

Relative change in net power generation in 2016 compared to 2015



Graphic: B. Burger, Fraunhofer ISE; data: DESTATIS and the EEX power exchange in Leipzig, with adjustments

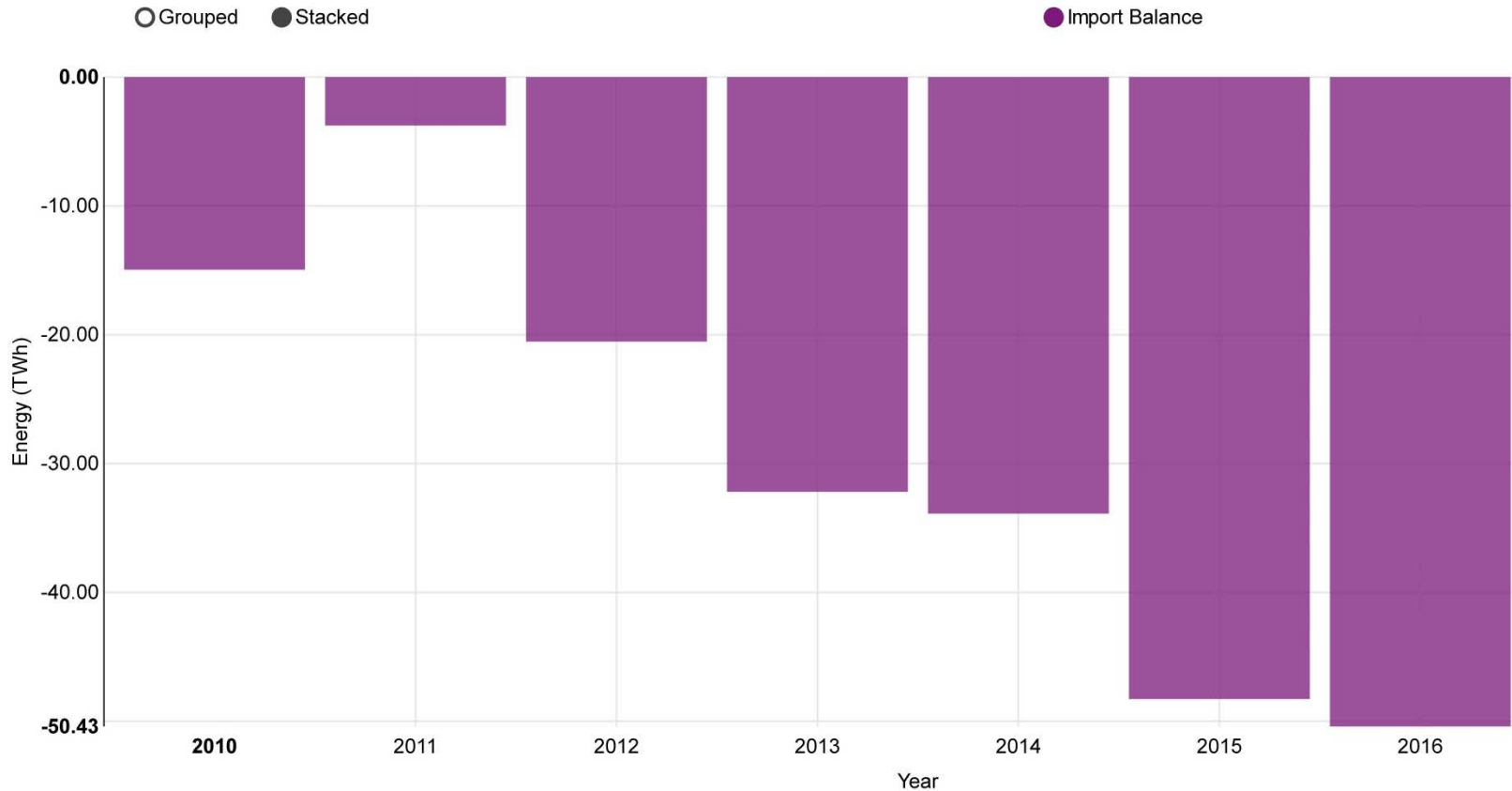
German net power generation for public power supply Year 2016



Graphic: B. Burger, Fraunhofer ISE; data: DESTATIS and the EEX; source: www.energy-charts.de/energy_pie.htm

German power export surplus

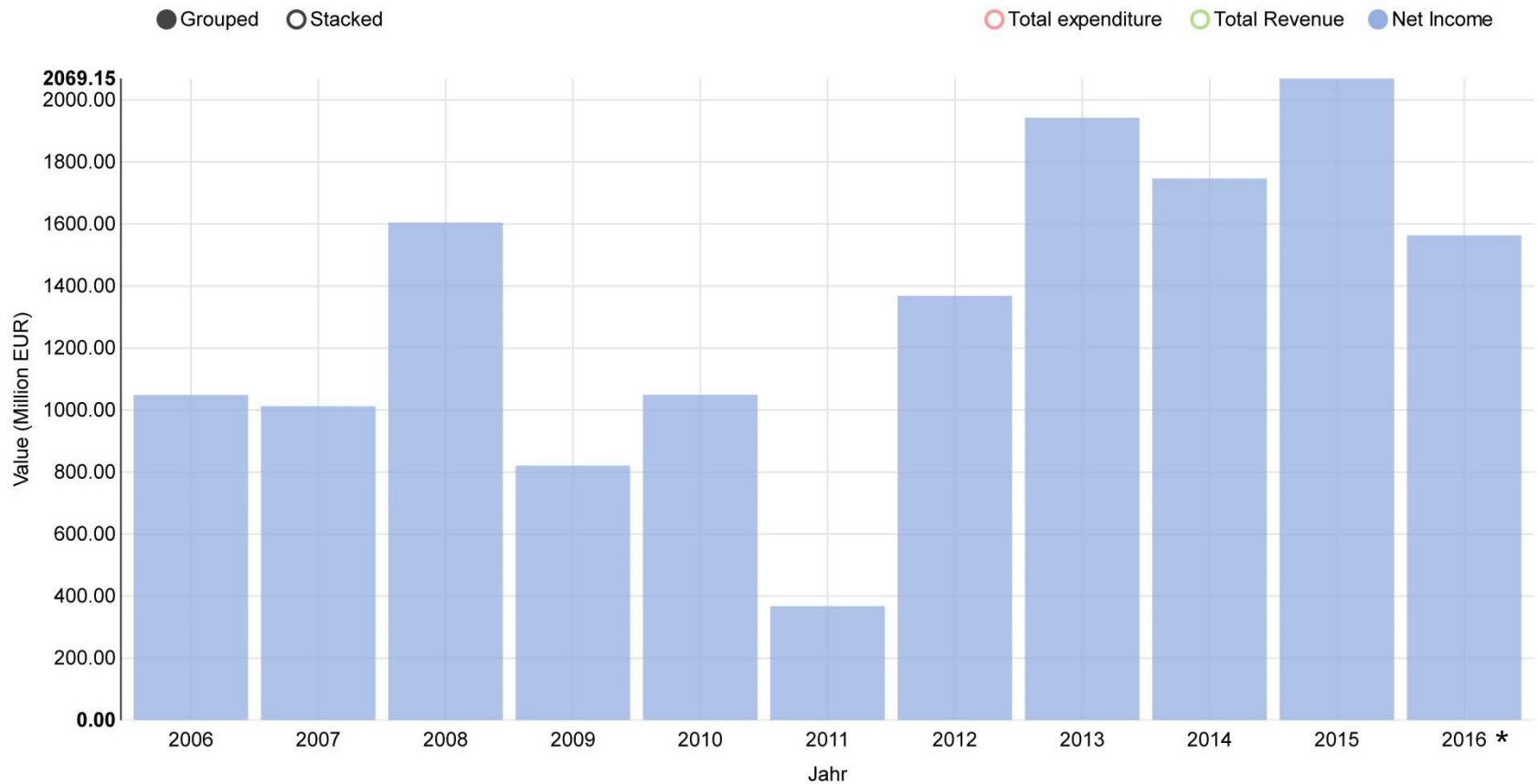
Year 2010 - 2016



Graphic: B. Burger, Fraunhofer ISE; data: TSOs and ENTSO-E; source: www.energy-charts.de/energy.htm

German power trading

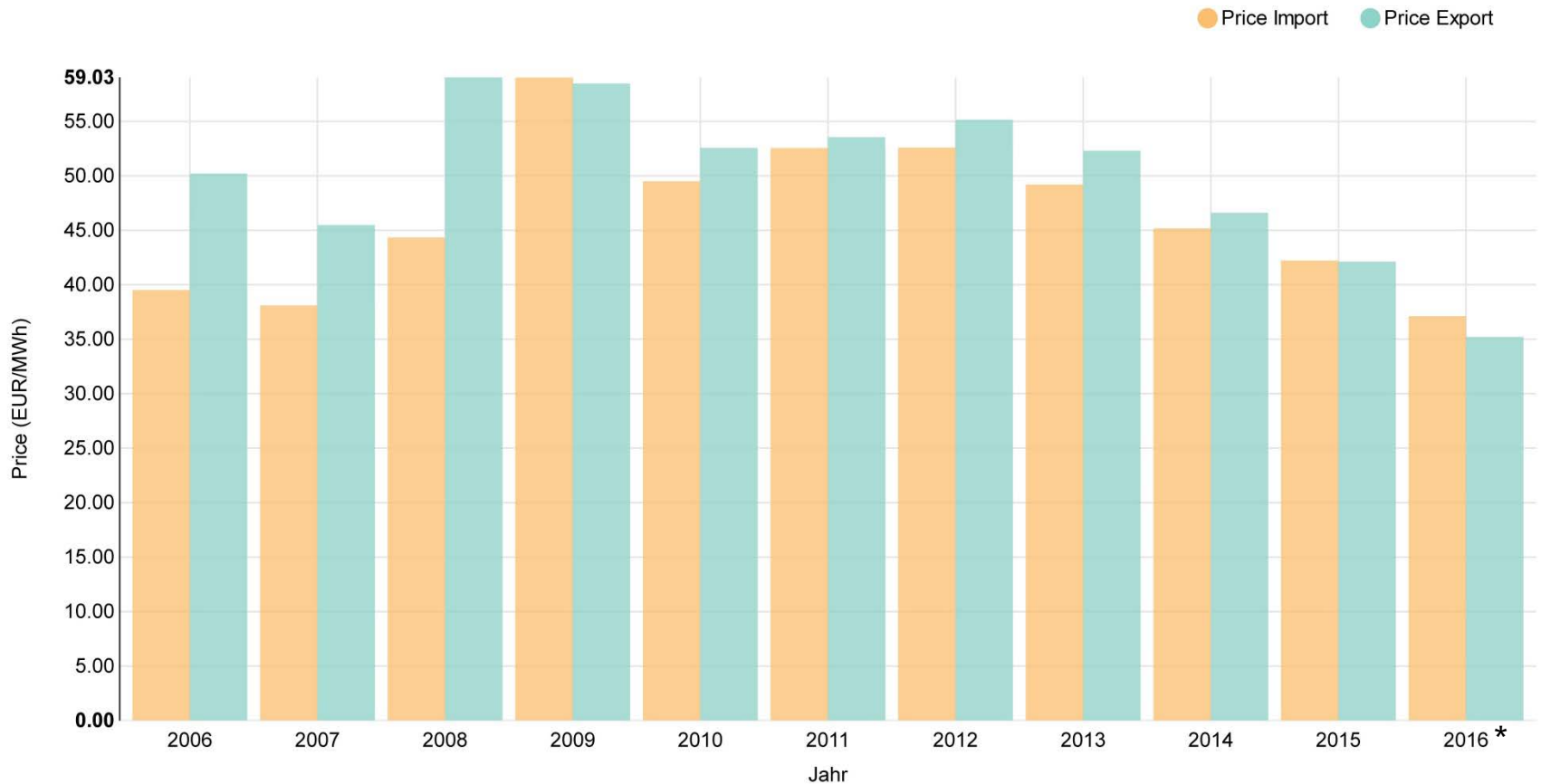
Net income in millions of euros



*Data of 2016 only from January to November; source: www.energy-charts.de/trade.htm

German power trading

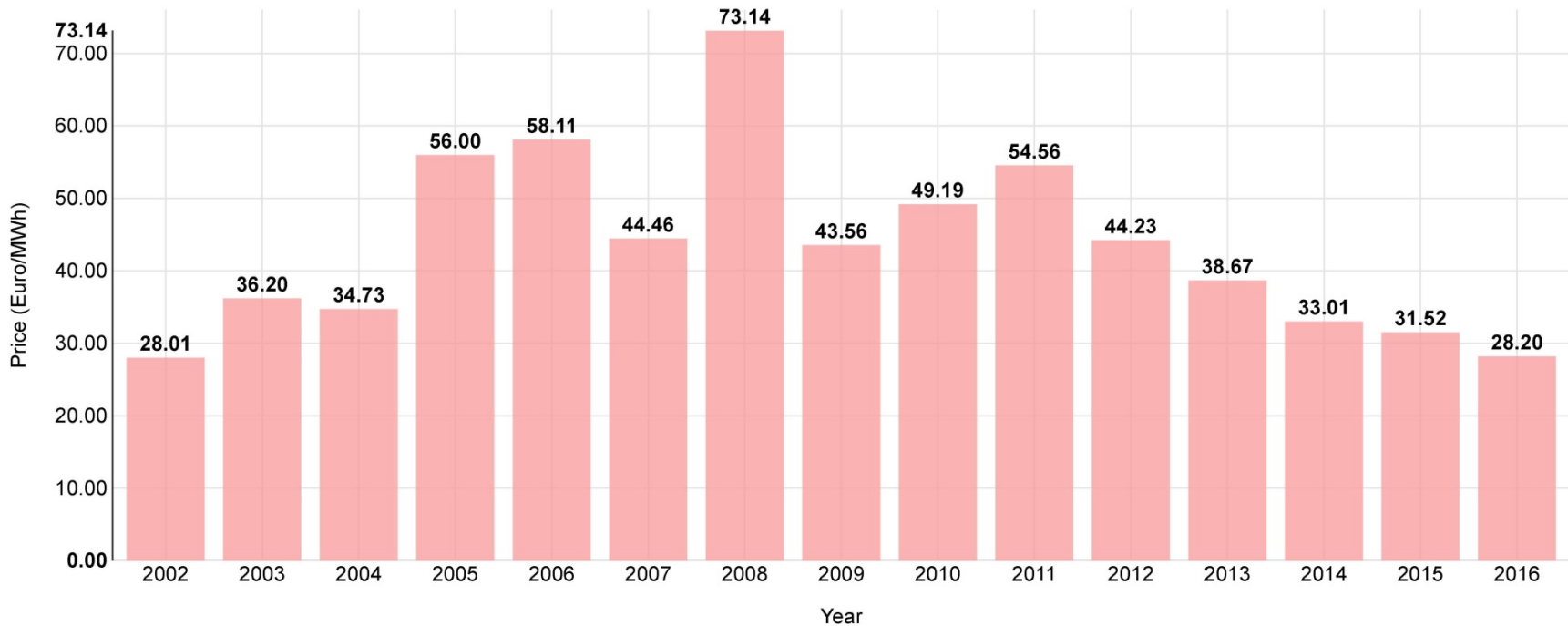
Volume weighted average prices in Euro/MWh



*Data of 2016 only from January to November; source: www.energy-charts.de/trade.htm

EPEX day ahead spot price

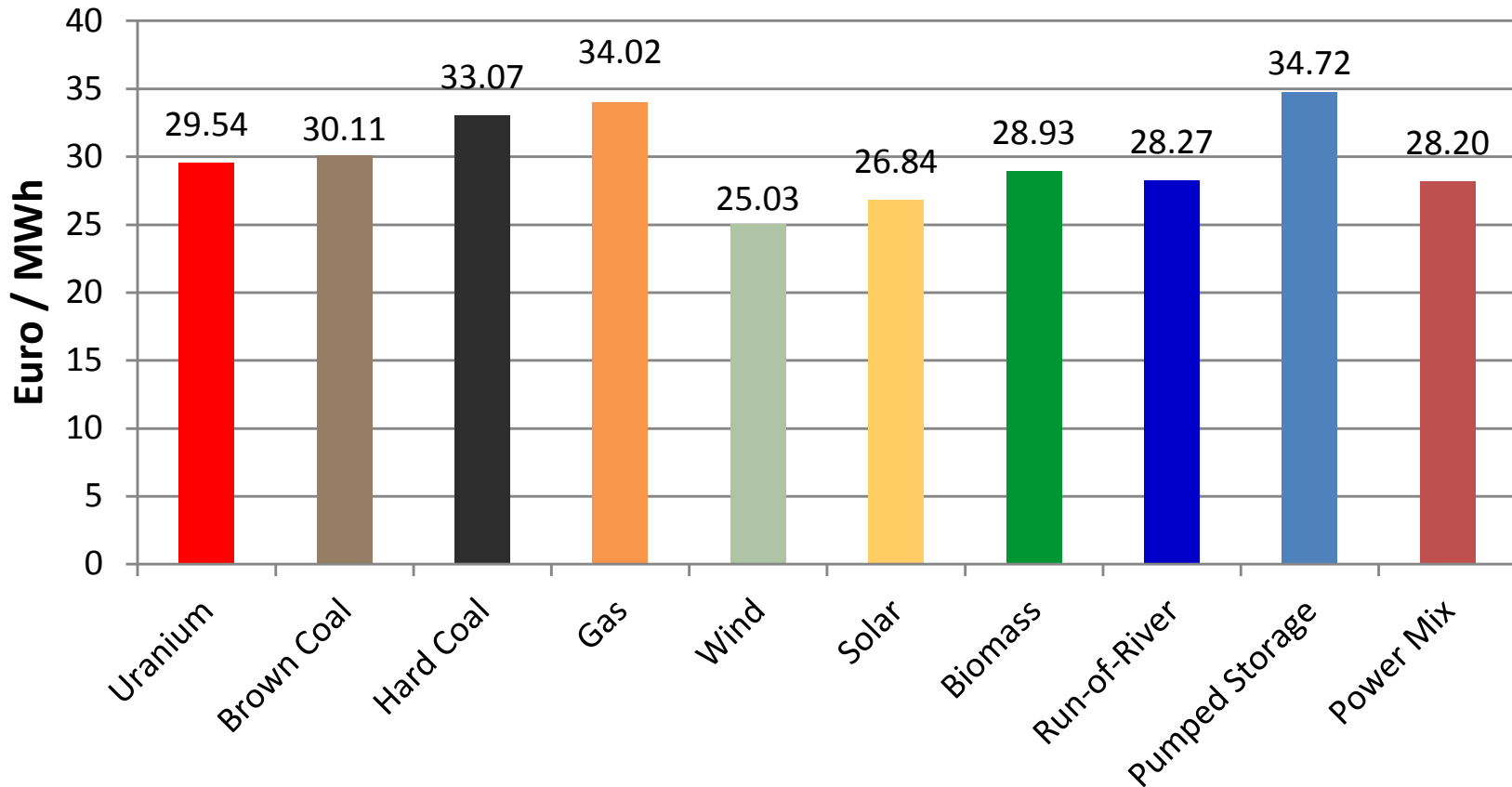
Weighted by volume, inflation-adjusted, for prices from November 2016



Graphic: B. Burger, Fraunhofer ISE; data: EPEX; source: www.energy-charts.de/price_avg.htm

Day-ahead market values, weighted by volume

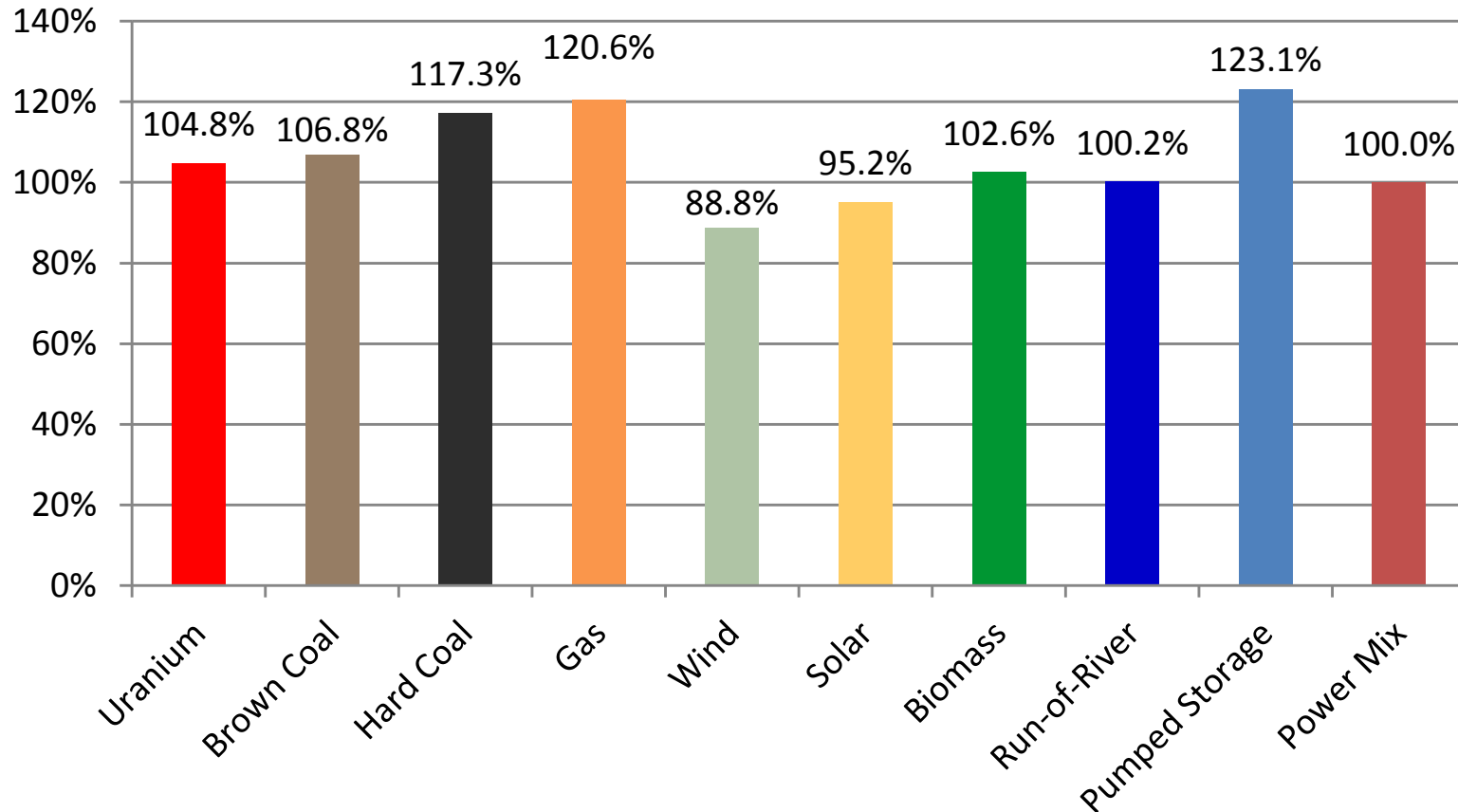
Year 2016



Graphic: B. Burger, Fraunhofer ISE; data: EPEX

Relative day-ahead market values, weighted by volume

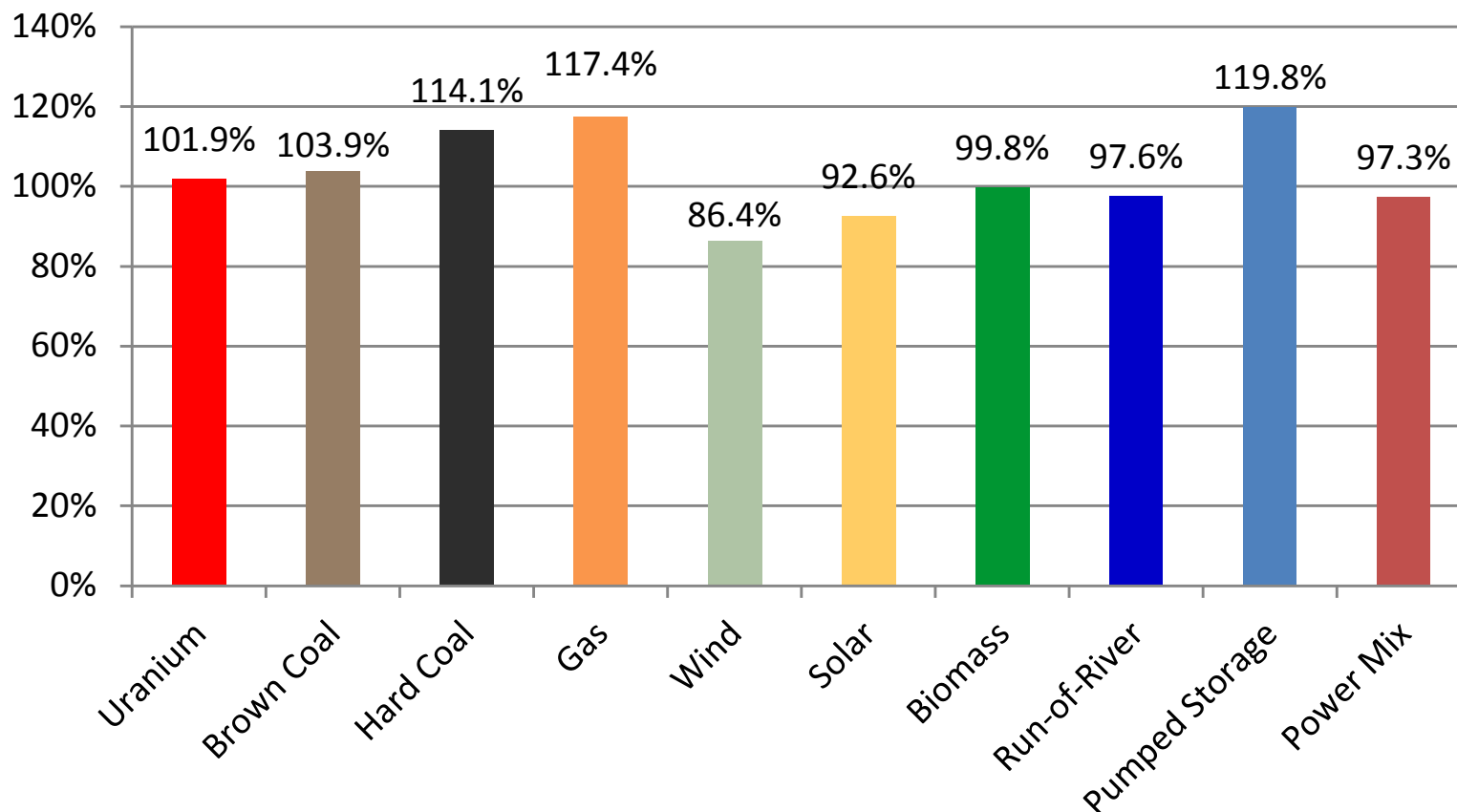
Year 2016



Graphic: B. Burger, Fraunhofer ISE; data: EPEX

Market value factors

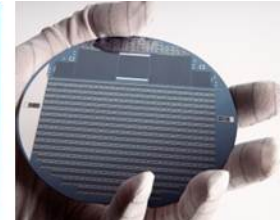
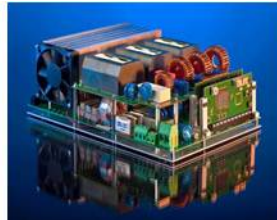
Year 2016



Graphic: B. Burger, Fraunhofer ISE; data: EPEX

Thank you for your Attention!

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