Ensuring the Success of Germany's Energy System Transformation

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Agora Energiewende – Who we are

Think Tank with more than 20 Experts

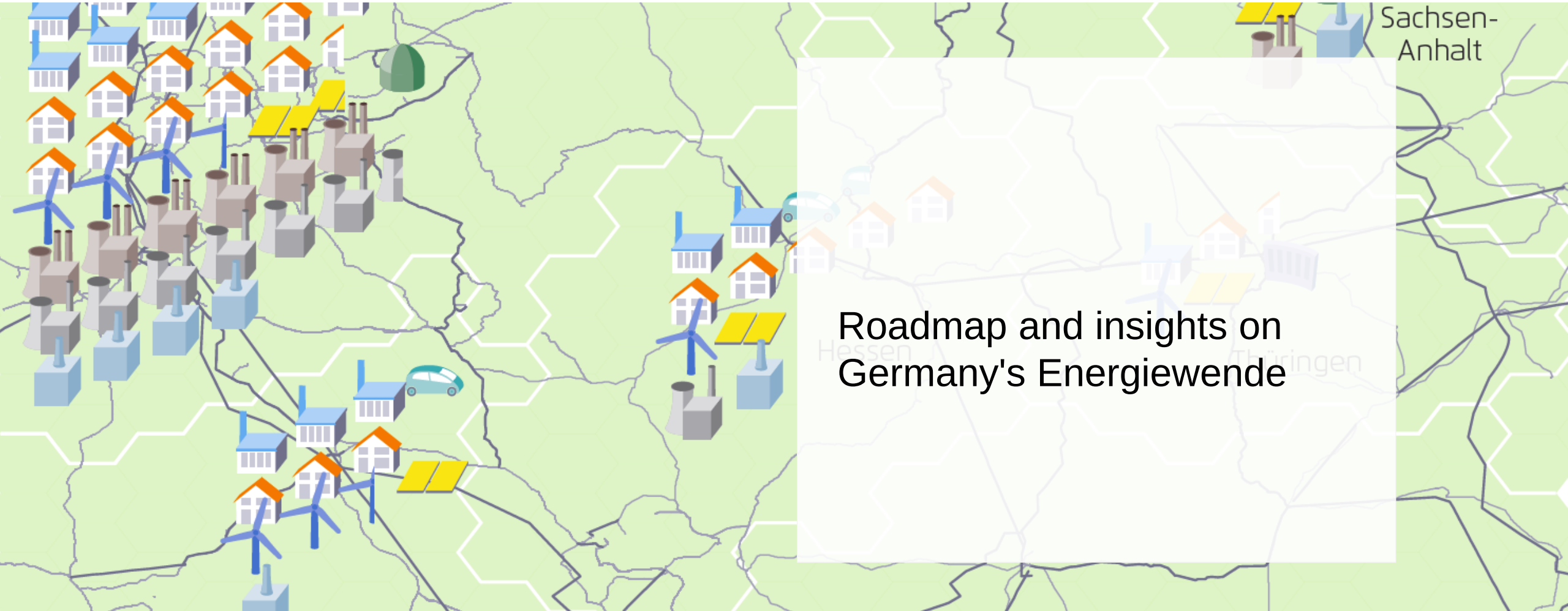
Independent and non-partisan

Project duration 2012-2021

Financed with 29 Mio. Euro by Mercator Foundation & ECF

Mission: How do we make the energy transition in Germany and worldwide a success story?

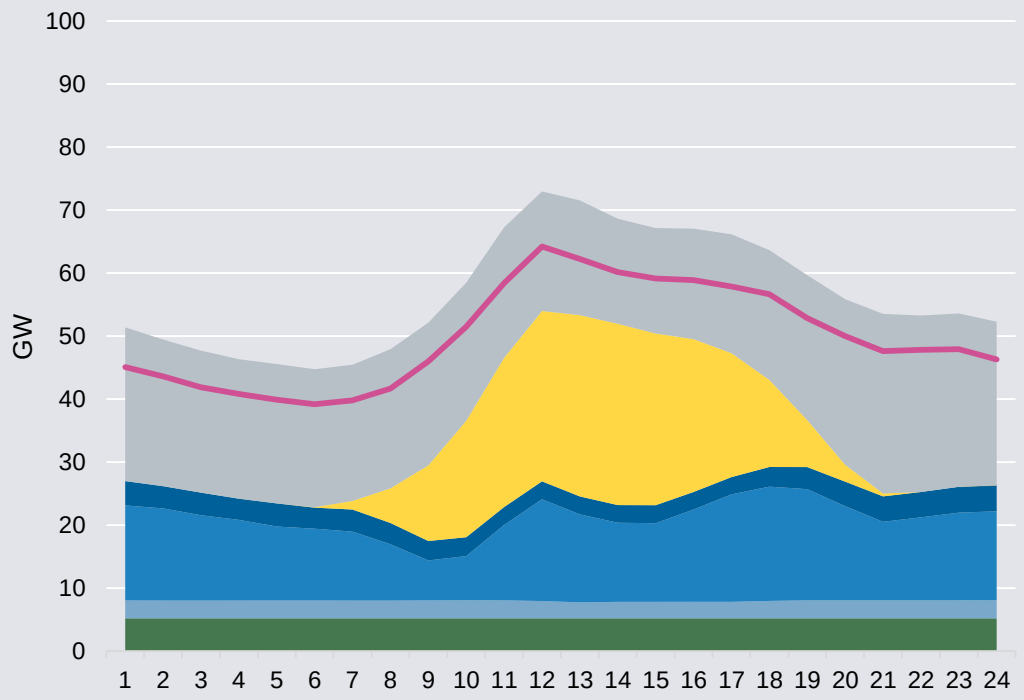
Methods: Analyzing, assessing, understanding, discussing, putting forward proposals, Council of Agora



Roadmap and insights on Germany's Energiewende

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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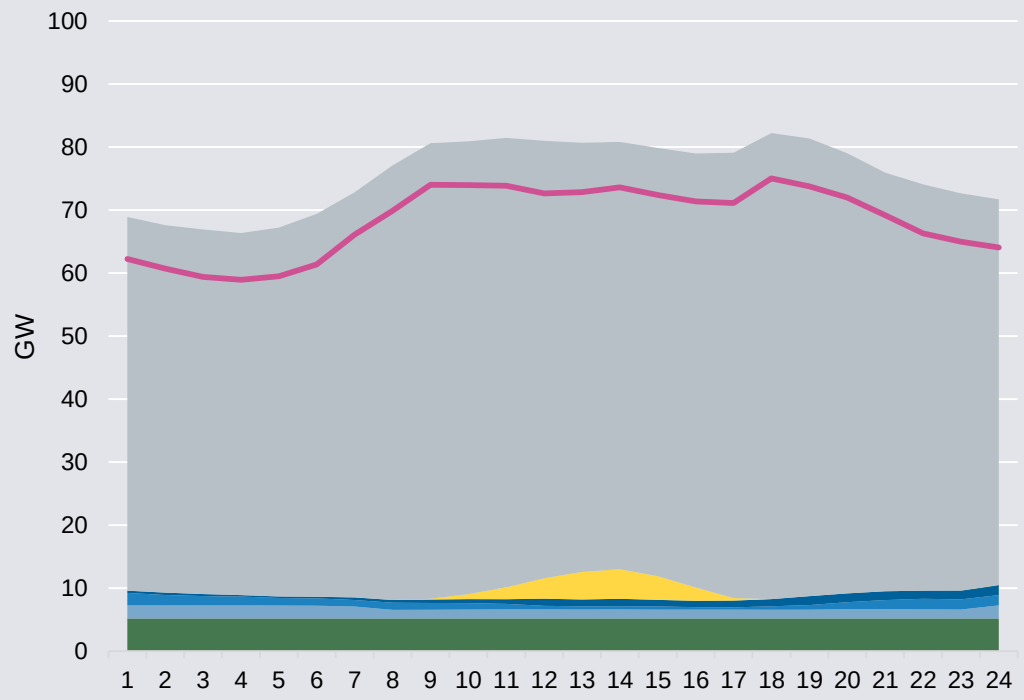
Power generation and use on 21 January 2016



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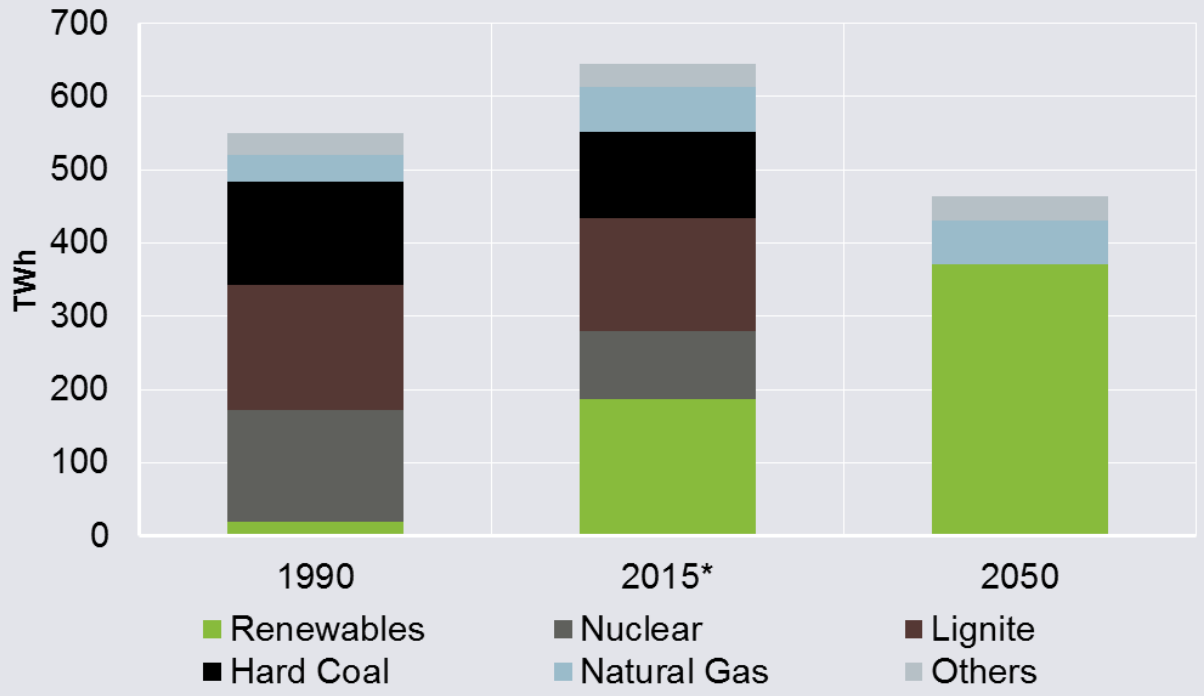
The Energiewende means fundamentally changing the power system

Gross electricity generation 1990, 2016 and 2050



AGEB (2016), BReg (2010), EEG (2014), own calculations * preliminary

Phase out of Nuclear Power
Gradual shut down of all nuclear power plants until 2022

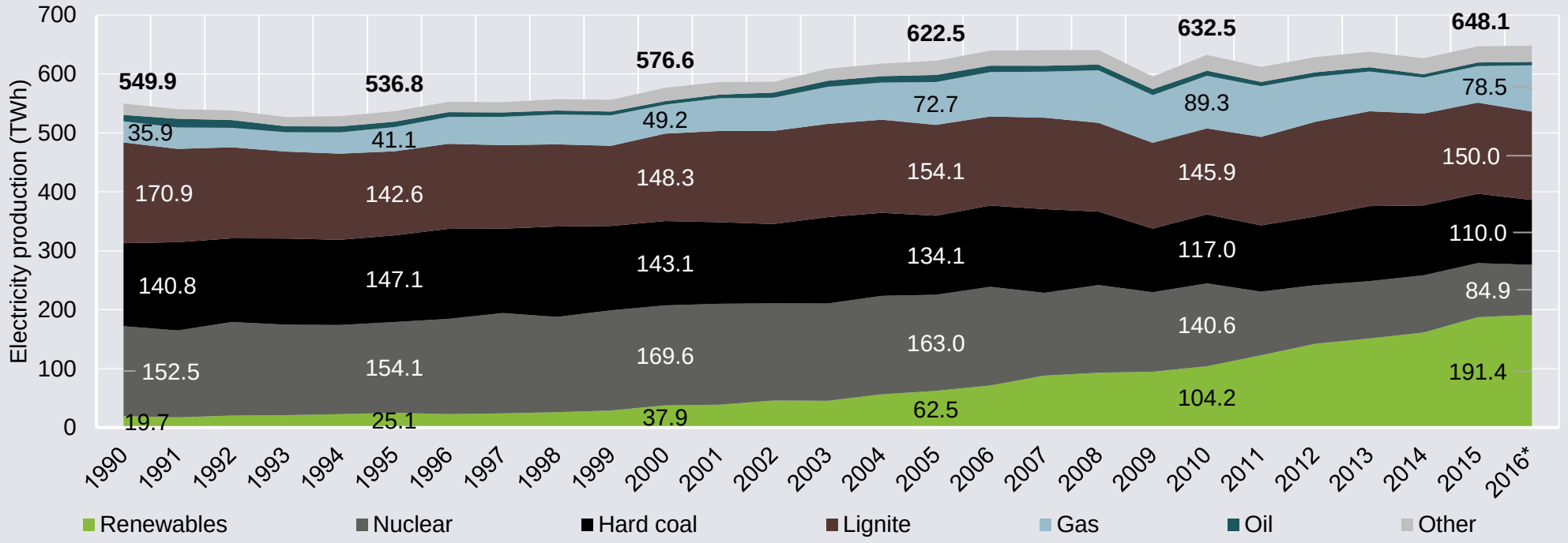
Reduction of Greenhouse Gas Emissions
Reduction targets below 1990 levels:
- 40% by 2020; - 55% by 2030; - 70% by 2040;
- 80% to - 95% by 2050

Development of renewable energies
Share in power consumption to increase to:
40 - 45% in 2025; 55 - 60% in 2035; ≥ 80% in 2050

Increase in efficiency
Reduction of power consumption compared to 2008 levels: - 10% in 2020; - 25% in 2050

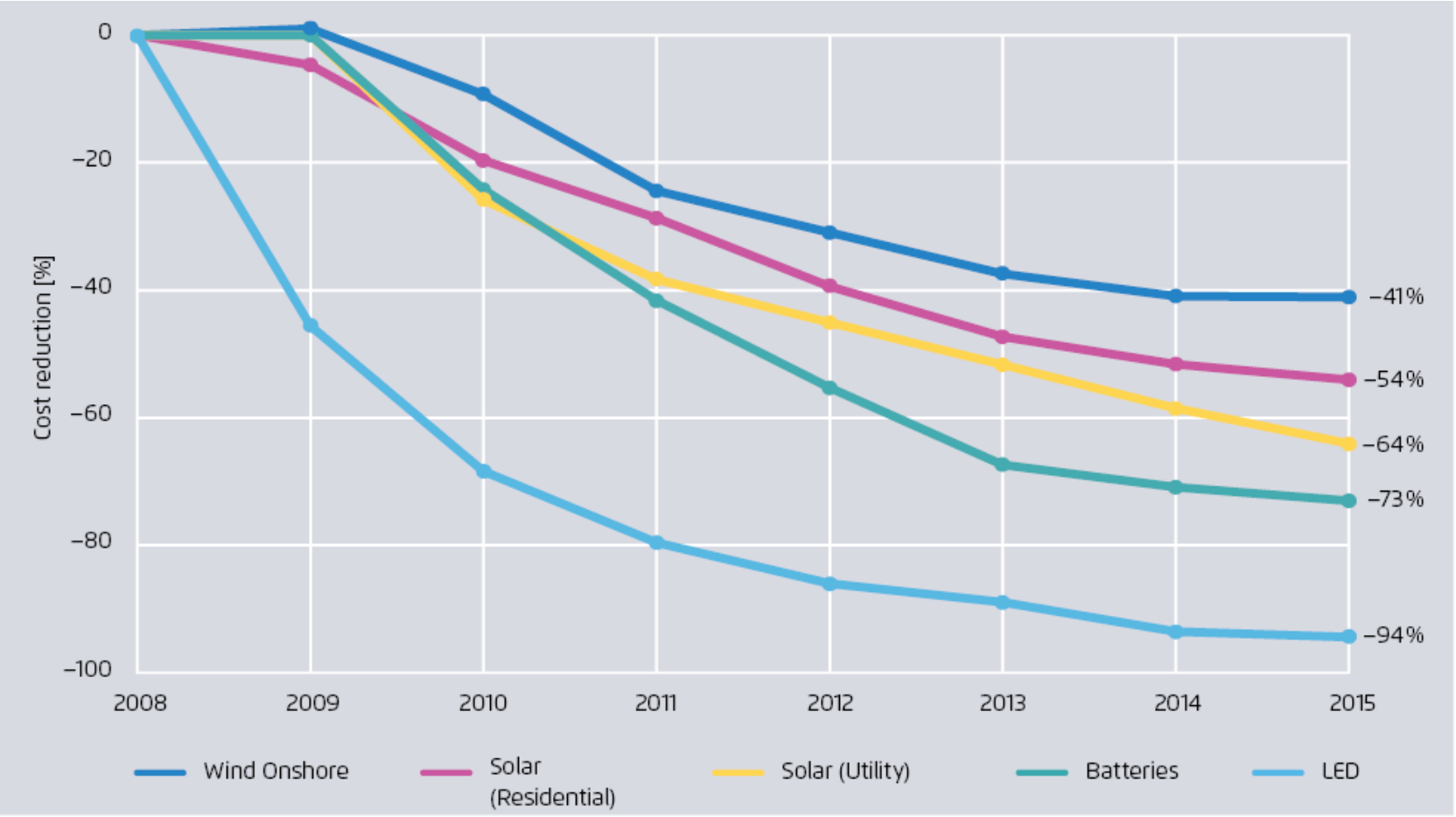
Phase one, 2000-2016: Renewables quintuple; nuclear power falls by half; but: fossil fuel energy sources (coal, gas) remain constant

Power production, 1990-2016



AG Energiebilanzen 2016a

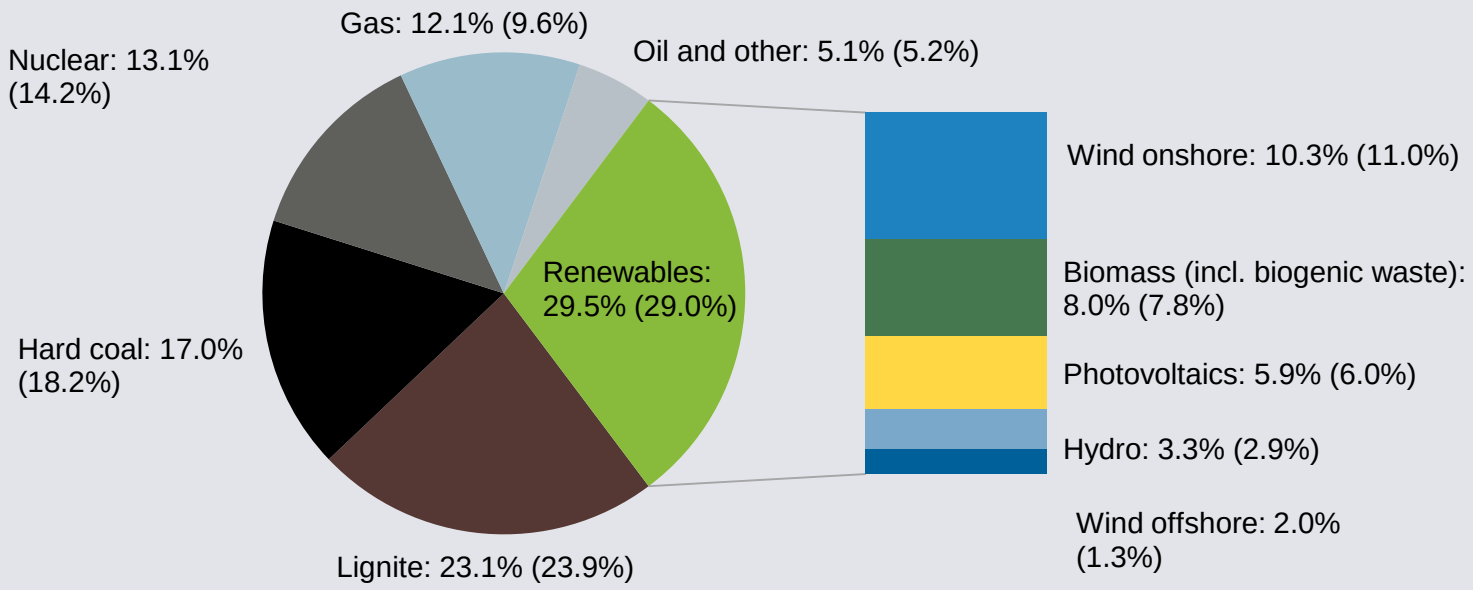
The cost of most important energy transformation technologies have decreased dramatically, Solar and Wind are competitive



Source: US DoE (2015)

Power mix 2016: Renewables make up largest share; gas is the biggest winner, hard coal is the biggest loser compared to 2015

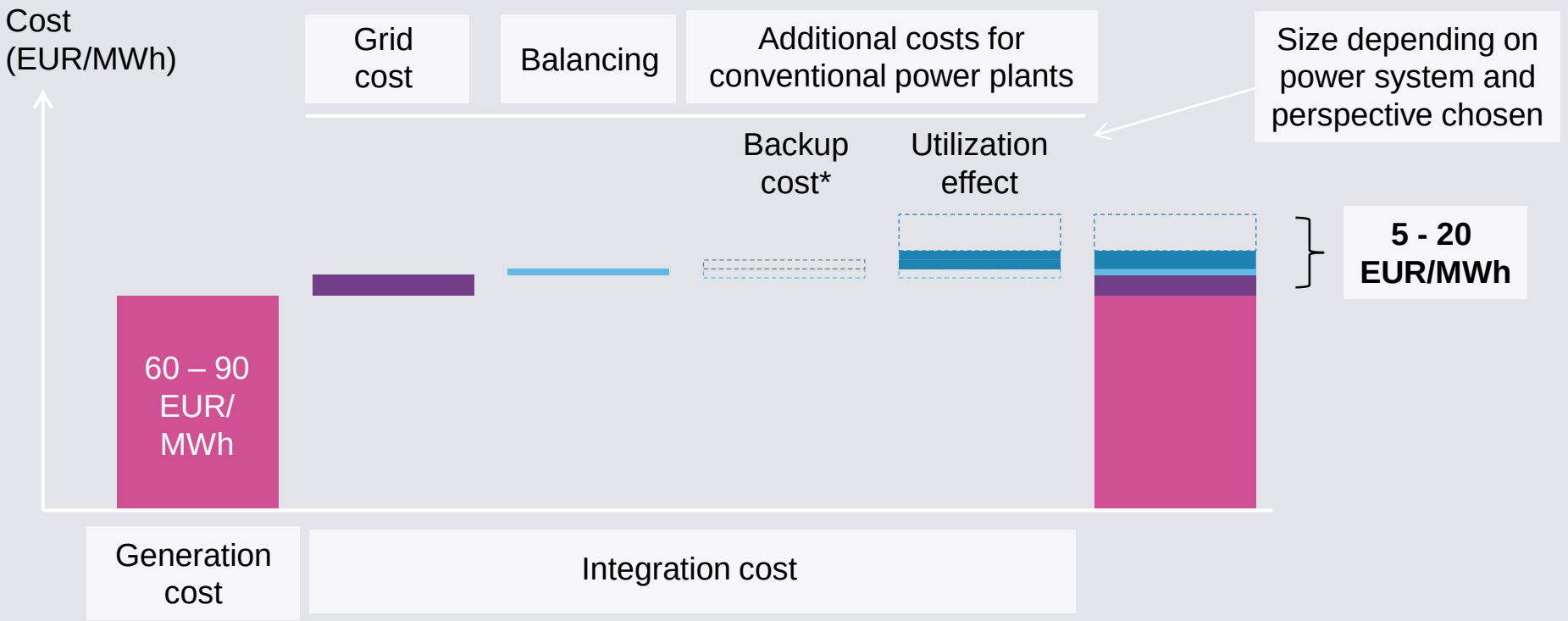
2016 power mix (2015 values in brackets)



AG Energiebilanzen 2016a

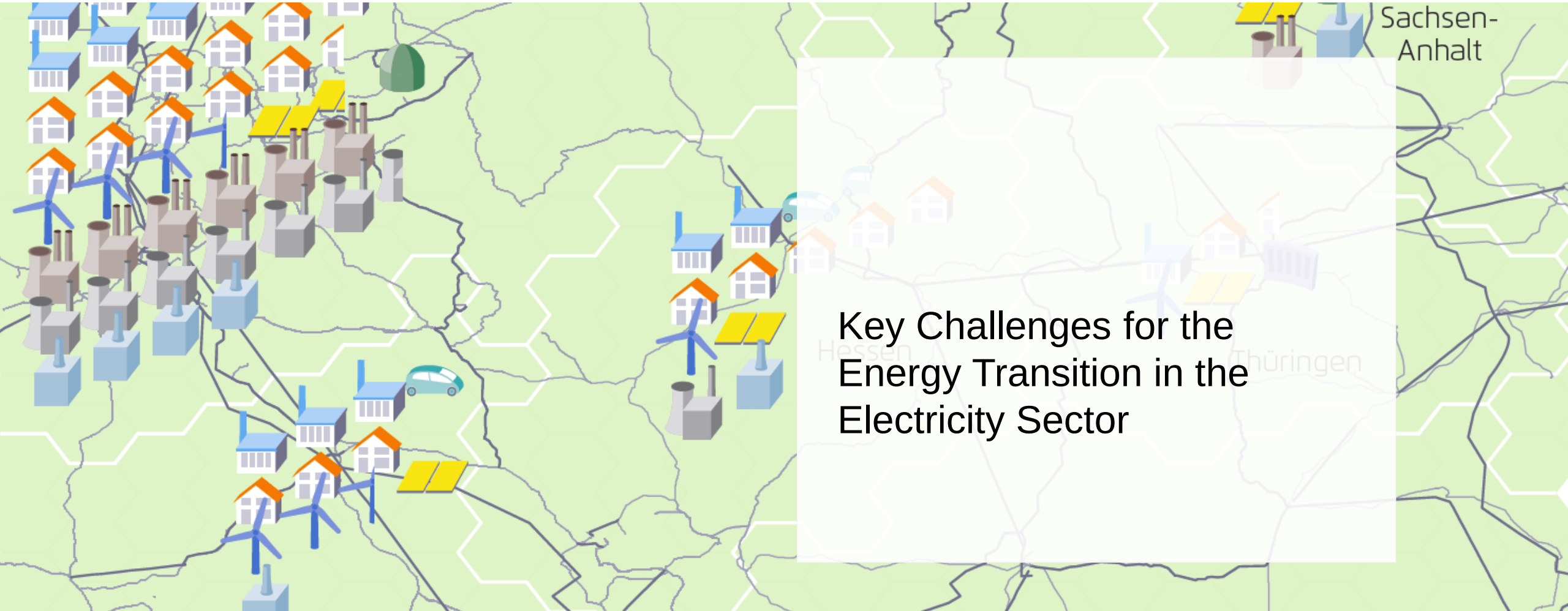
The integration cost of wind and solar (5 to 20 EUR/MWh) do not change the picture

Components of integration costs



Agora Energiewende (2015a)

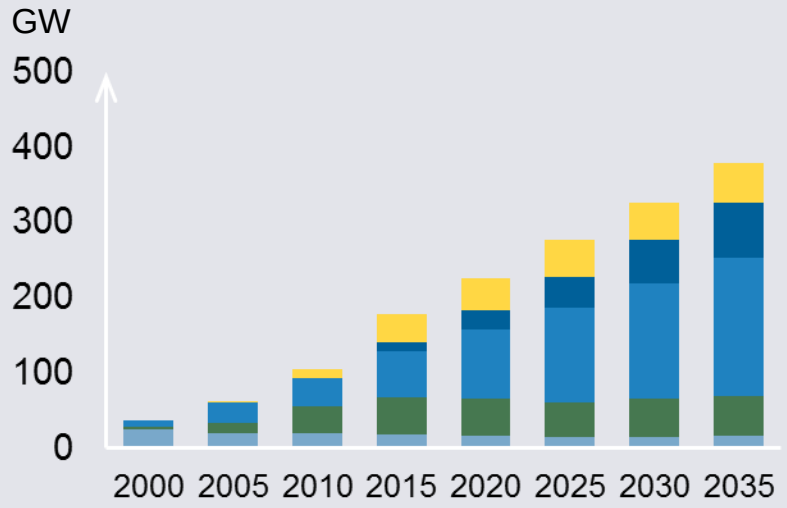
* part of utilization effect



Key Challenges for the Energy Transition in the Electricity Sector

With wind and solar, the new power system will be based on two technologies that completely change the picture

Gross electricity generation of renewable energies 2000 - 2035

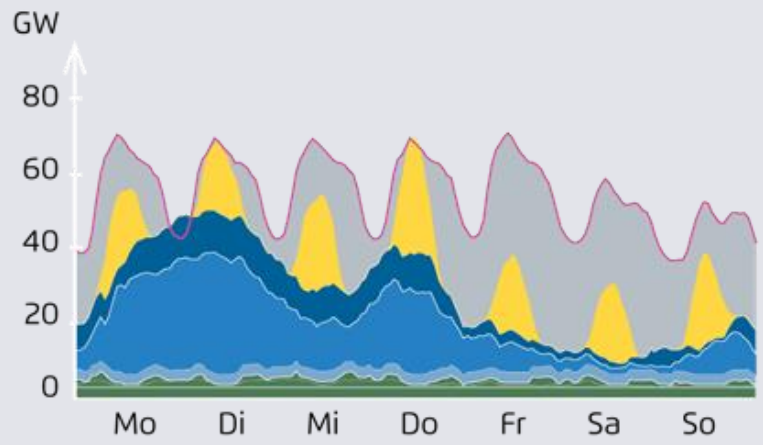


AGEB (2015a), BNetzA (2014), BNetzA (2015b), own calculations

Specific characteristics of Wind and Solar PV

1. Intermittent
2. High capital costs
3. Very low variable cost

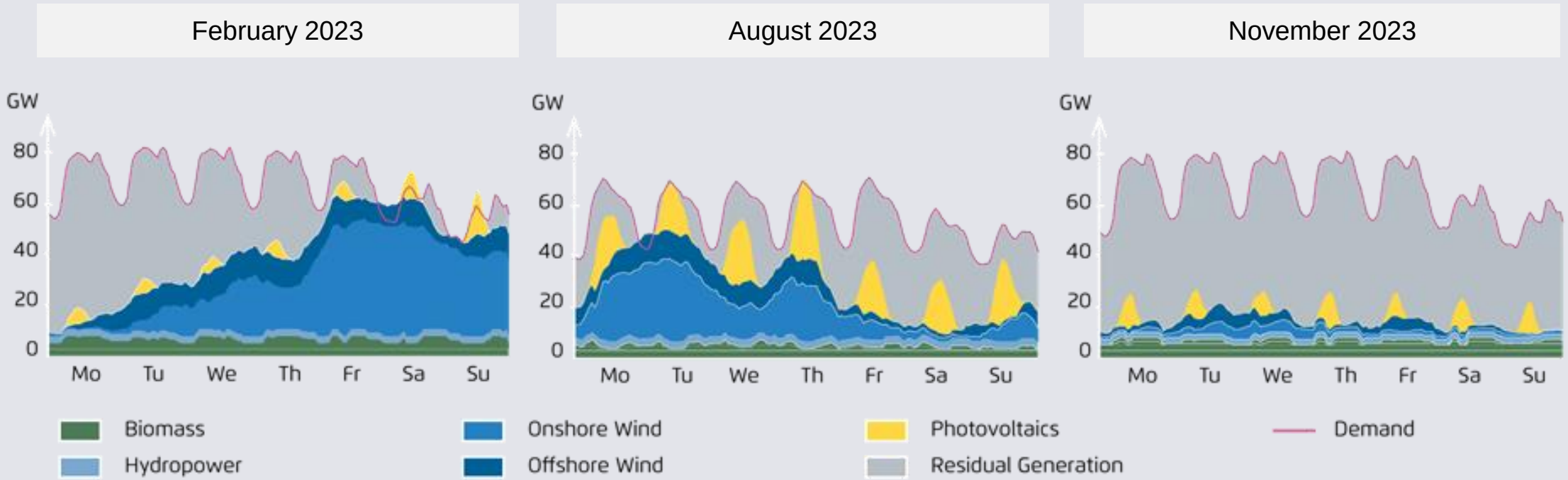
Electricity generation and consumption in a sample week 2023



Fraunhofer IWES (2013)

The power system and power markets will need to cope with a highly fluctuating power production from wind and solar

Electricity generation* and consumption* in three sample weeks, 2023

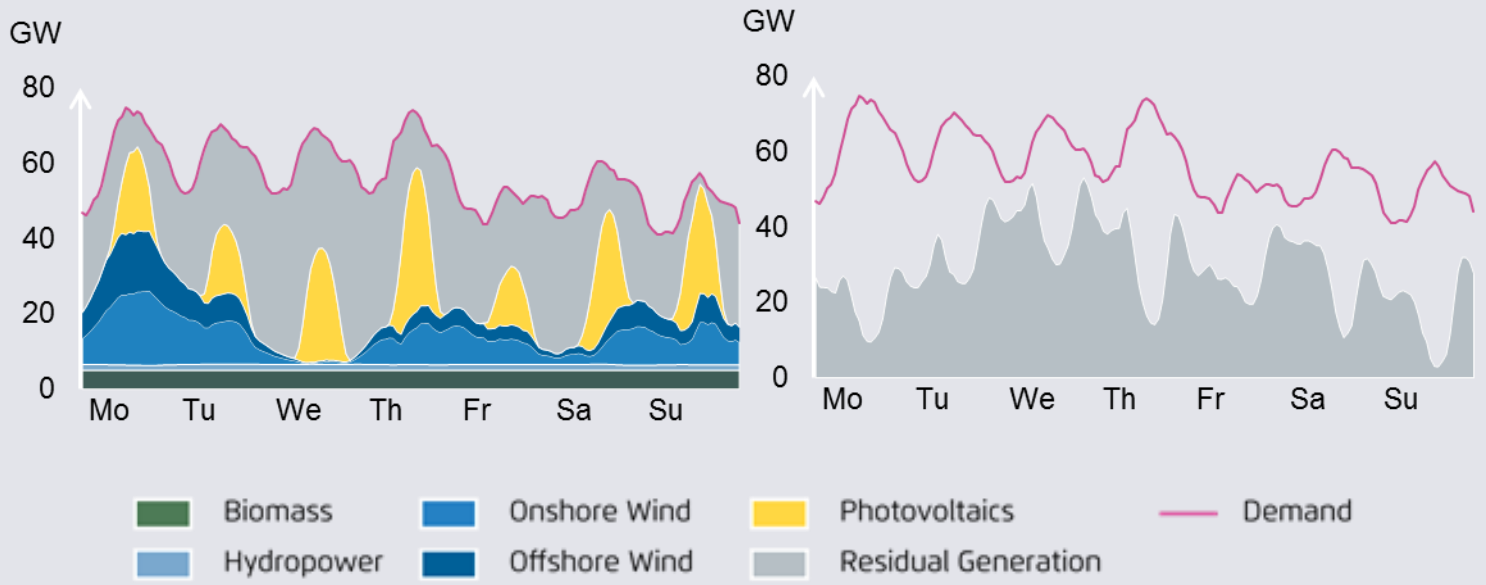


Fraunhofer IWES (2013)

* Modelling based on 2011 weather and load data

Flexibility is the paradigm of the new power system – baseload capacities are not needed any more

Electricity generation and consumption in a sample week with 50% RES share



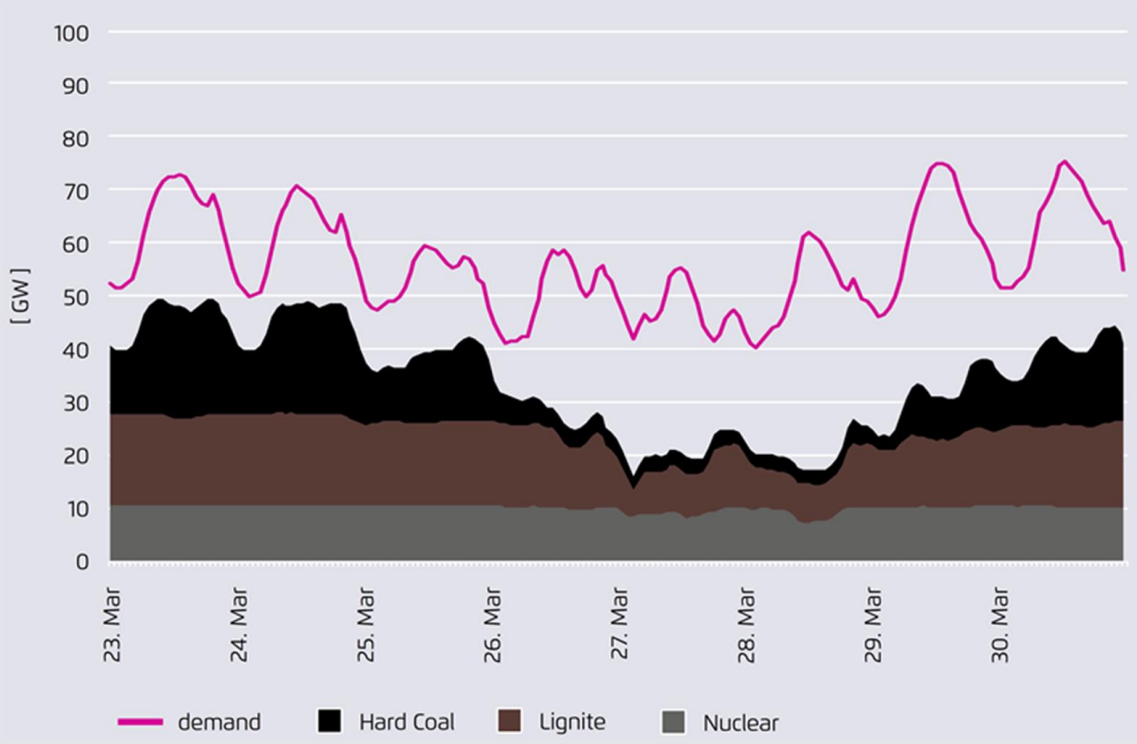
Key flexibility options

- Flexible fossil and bioenergy power plants (incl. CHP)
- Grids and transmission capacities for exports/imports
- Demand Side Management
- Storage technologies (Batteries, Power-to-Gas)
- Integration of the power, heat and transport sectors (power-to-heat, electric cars)

Own calculations on basis of Agora Energiewende (2015b)

Example of Germany: Coal power plants do provide significant operational flexibility

Power generation from nuclear, hard coal and lignite power plants and demand in Germany, 23 to 30 March 2016



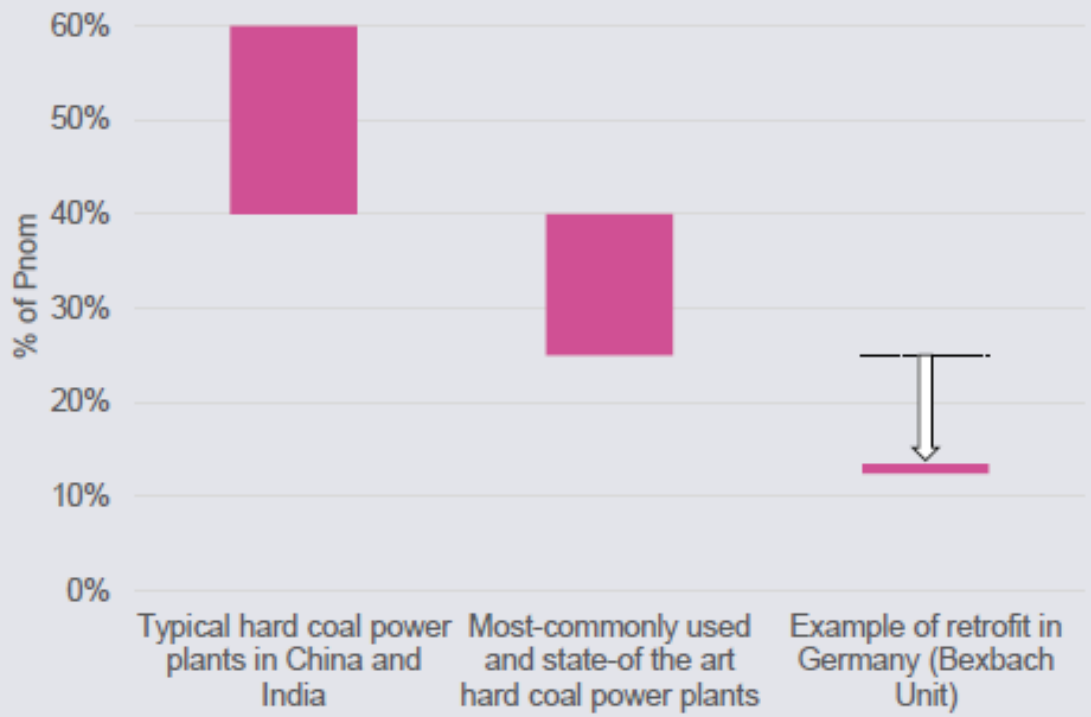
Agora Energiewende (2017)

In Germany, hard coal power plants are providing significant operational flexibility to the power system.

They are adjusting their output on a 15 min. basis, and even 5 min or lower.

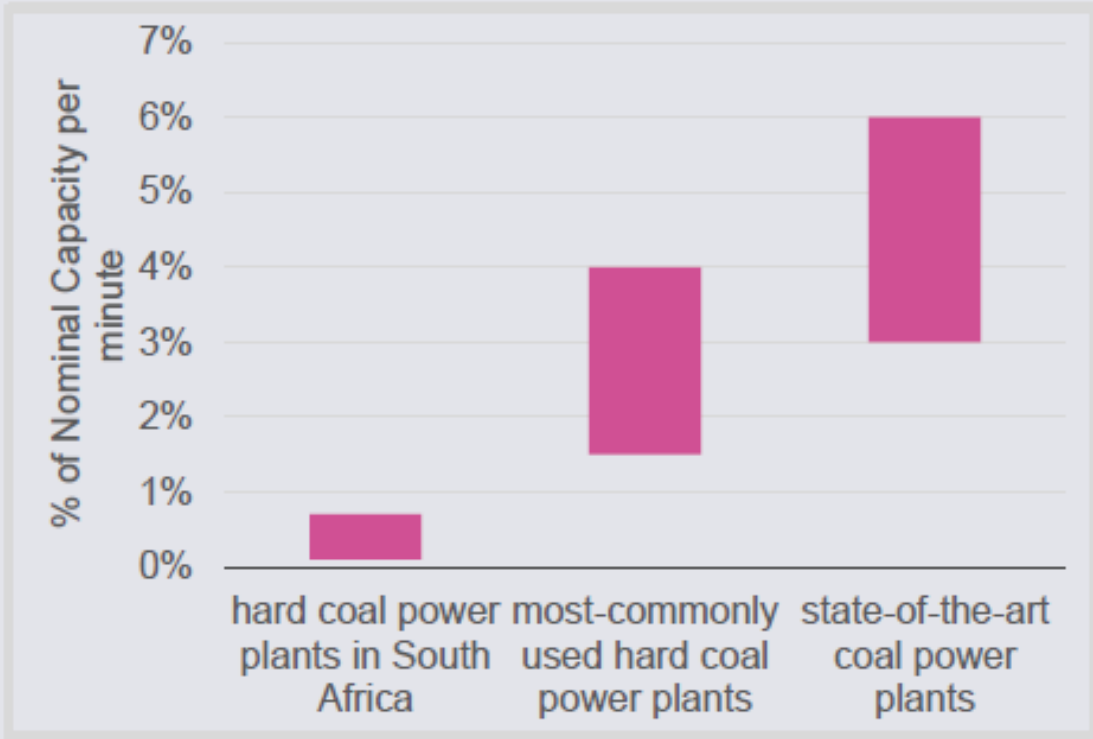
State-of-the-art-design improves significantly the flexibility characteristics of fossil-fuel power plants

Minimum load of different hard coal power plants (as a percentage of nominal capacity)



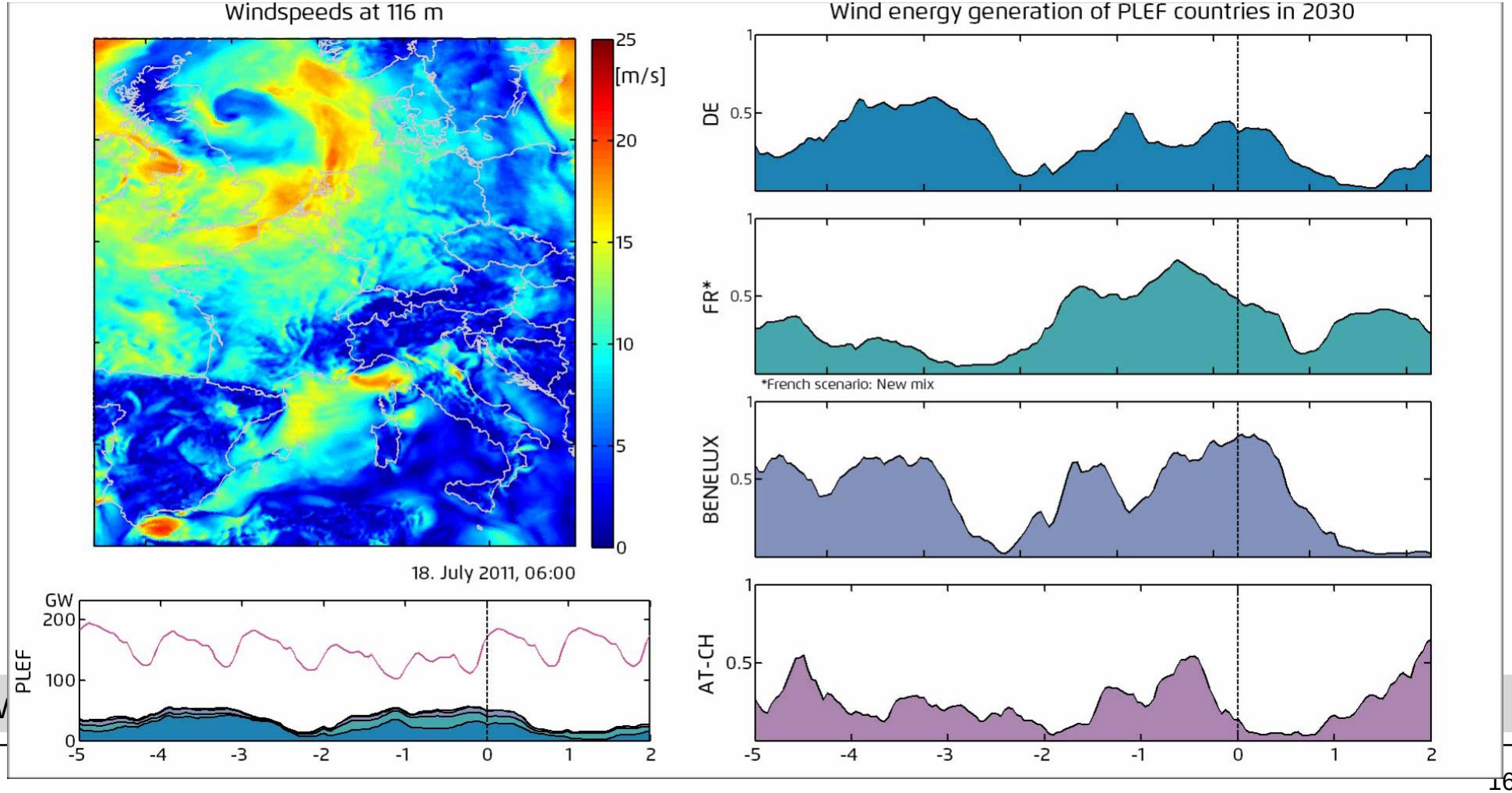
DEA, NREL, Fichtner

Ramp rates of hard coal power plants in South Africa compared to most-commonly used and state-of-the-art designs



Prognos, Fichtner

Flex option II: The Grid - Volatility of wind power and solar PV is significantly reduced when measured across larger areas



European power market integration mitigates flexibility requirements through geographical smoothing

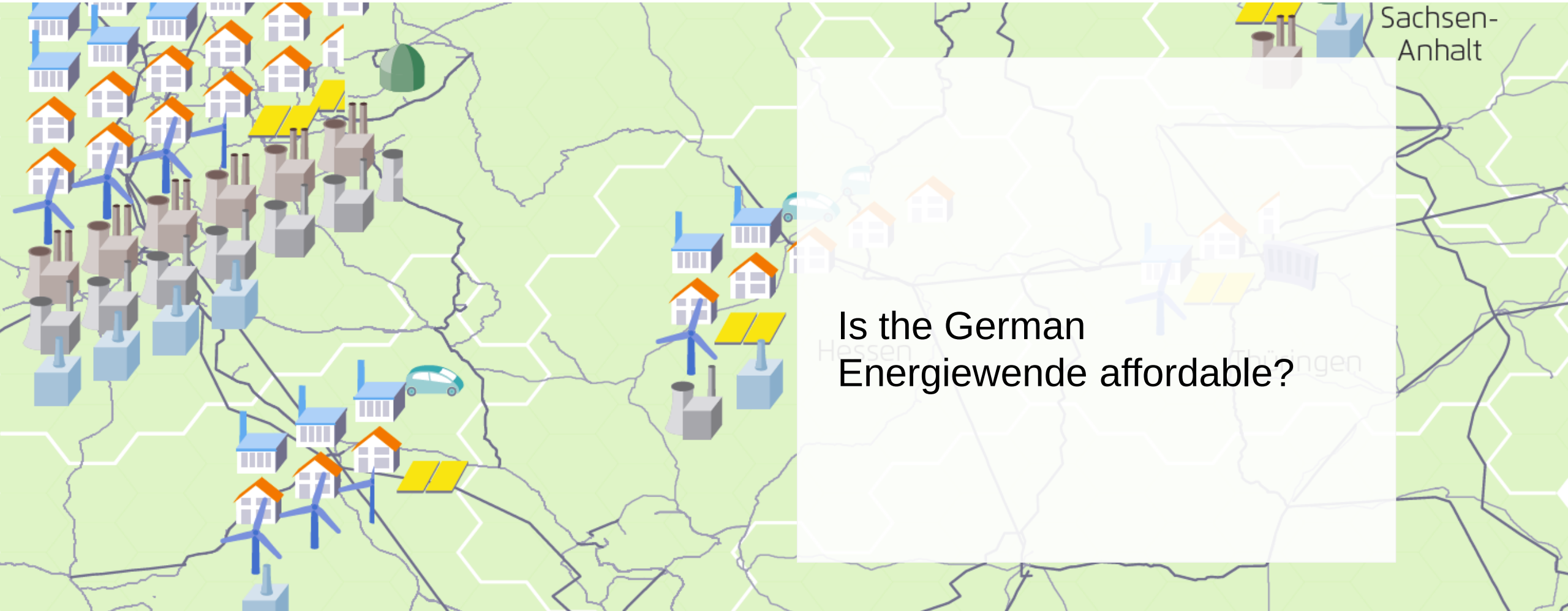
Wind onshore generation in May 2030 at different levels of aggregation

Fraunhofer IWES (2015)

* One pixel is equivalent to an area of 2.8 x 2.8 km

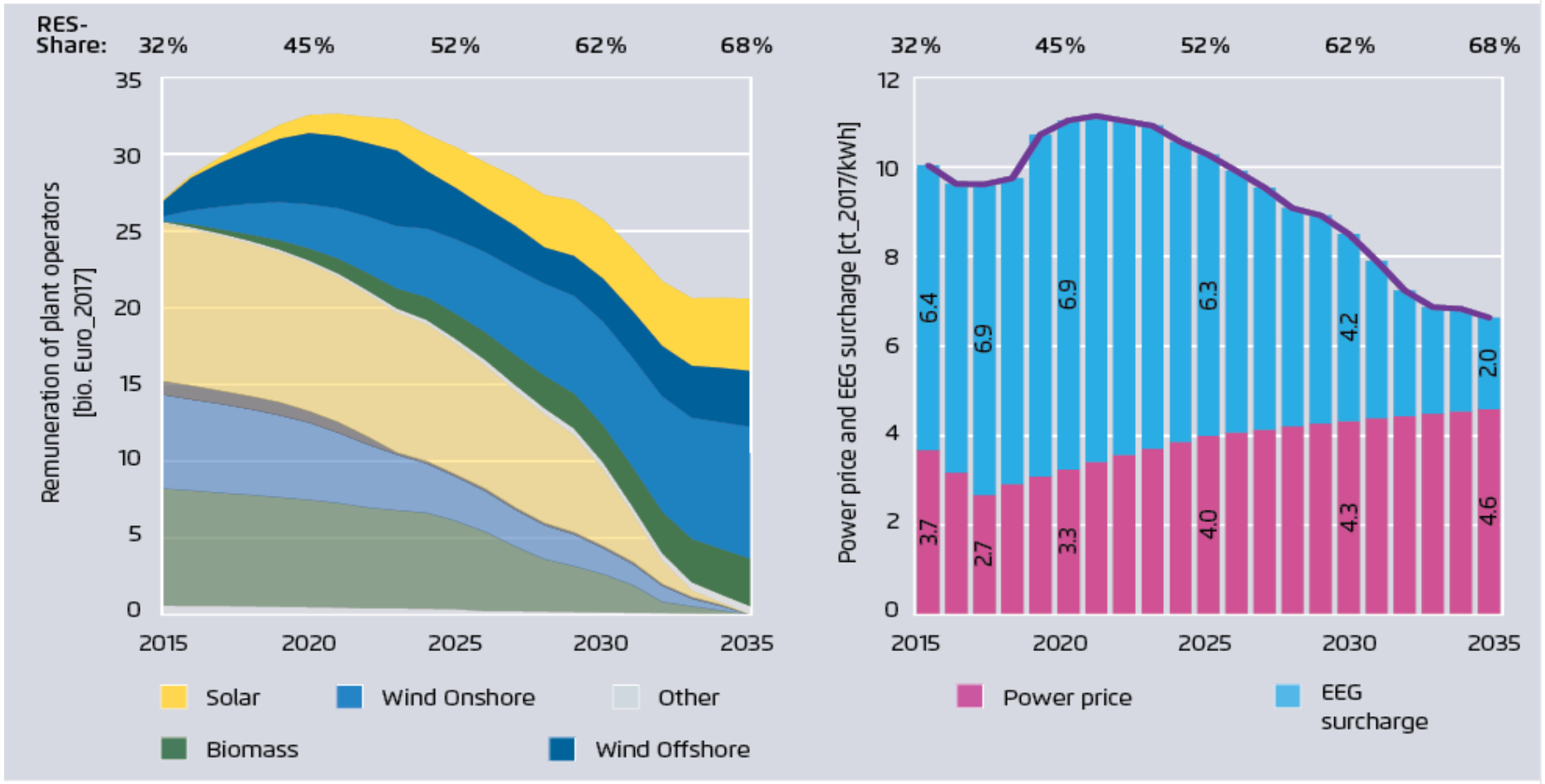
Instantaneous total wind power output is much less volatile and lacks extremely high and low values

Largest hourly wind ramp is 10% of installed capacity in Europe, 21% in France, and up to 90% on local level



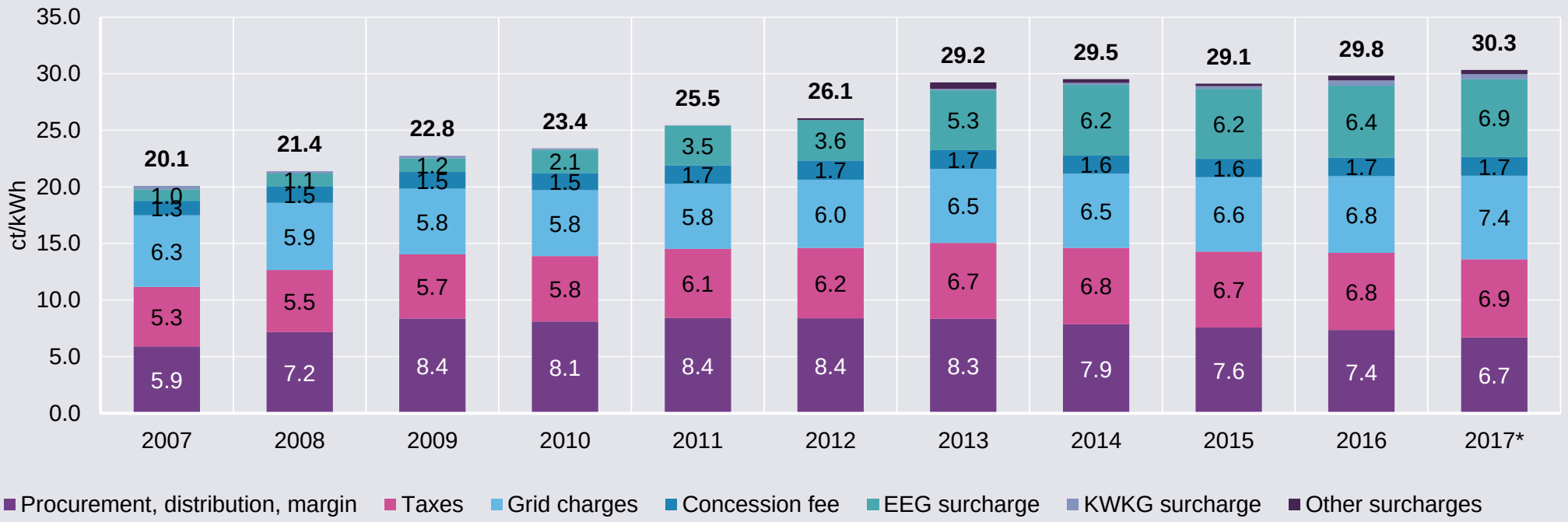
Is the German Energiewende affordable?

The initial investments in the energy transition are paying off after 2023 – in 2035 the EEG-surcharge is a lot lower than in 2015, but the share in renewables is double (around 60%)



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

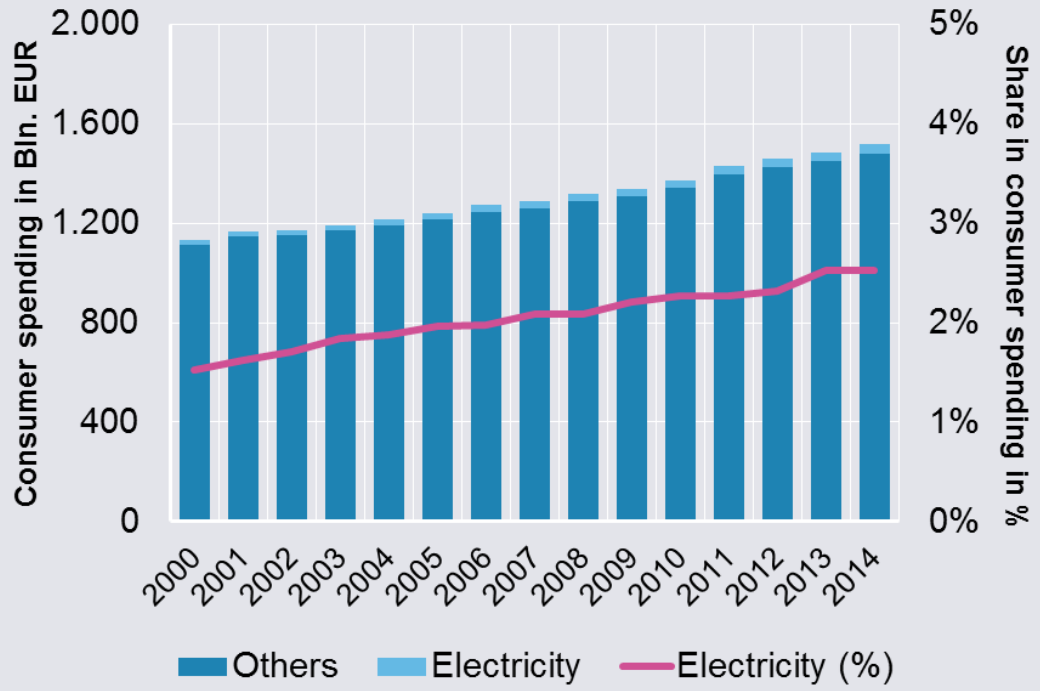
Average electricity prices for a 4-person household (3500 KWh annual use), 2007-2017



BNetzA 2016, *own estimates

Private households spend about 2.5 percent of their spending on electricity – due to higher efficiency, annual electricity bills are similar to those in other industrial countries

Private household spending 2000 - 2014



Destatis (2015a)

Annual electricity bills of private households 2014

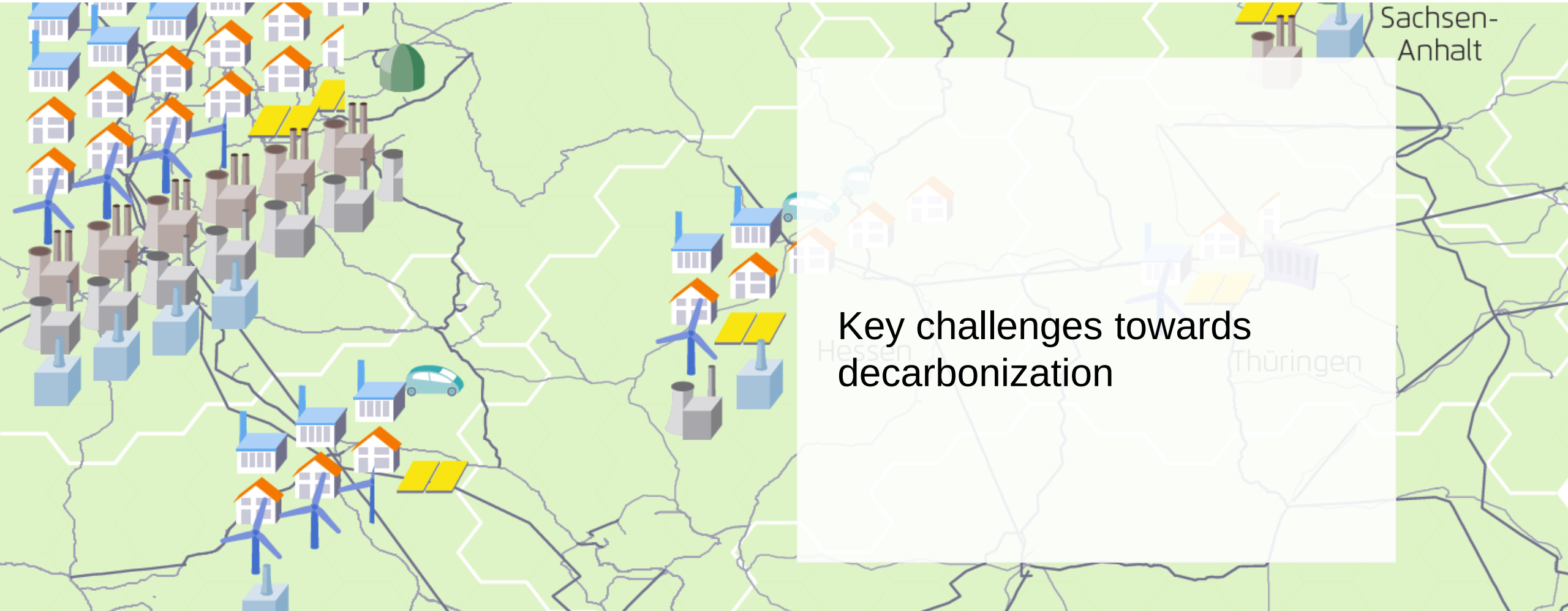
	Annual Electricity Consumption	Electricity Price	Annual Electricity Bill
	kWh	*ct/kWh*	*EUR*
Denmark	3,820	29	1,121
USA	12,294	9	1,110
Germany	3,362	29	987
Japan	5,373	18	971
Spain	4,038	23	912
Canada	11,303	8	851
France	5,830	14	834
Great Britain	4,143	17	717
Italy	2,485	23	580
Poland	1,935	15	291

World Energy Council (2015), own calculations

For industry as a whole, energy costs account in average for about 2% of total production value

Share of energy cost in gross production value in the industrial sector 2005 - 2012

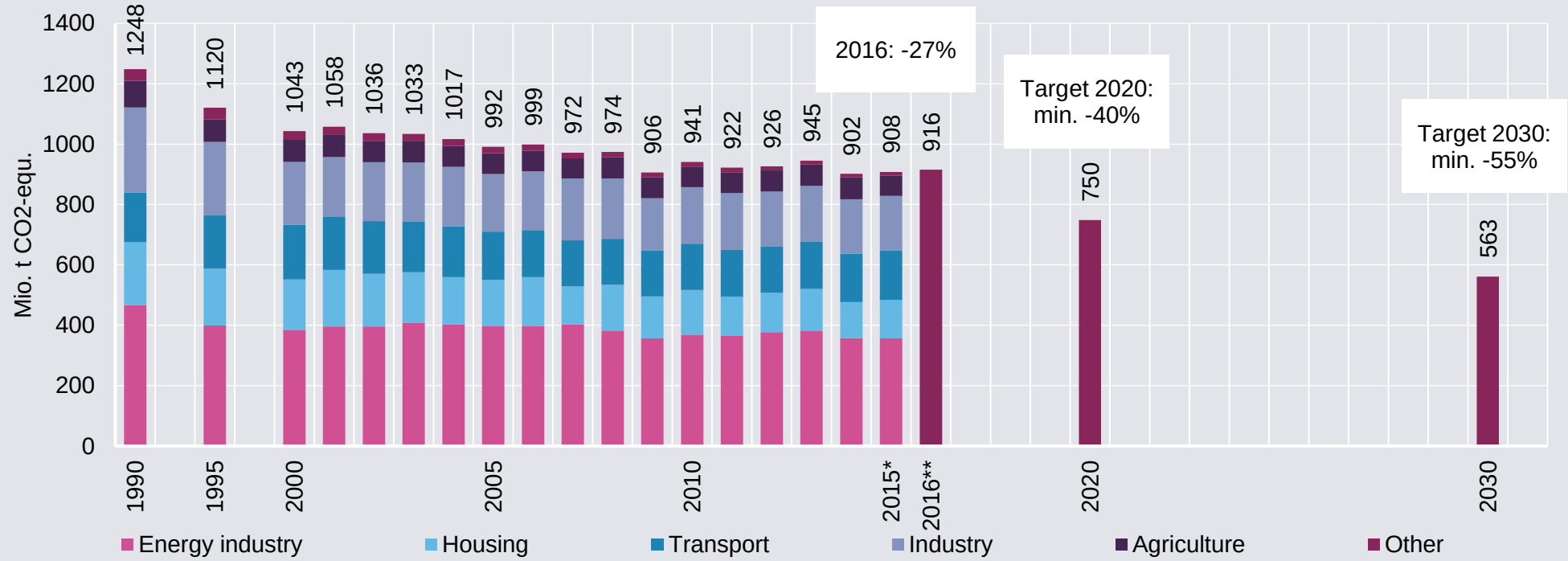
Destatis (2014)



Key challenges towards decarbonization

Greenhouse gas emissions rise again in 2016 (+8 mio. t CO_2 equ.); despite growth in Renewables, energy sector emissions stable

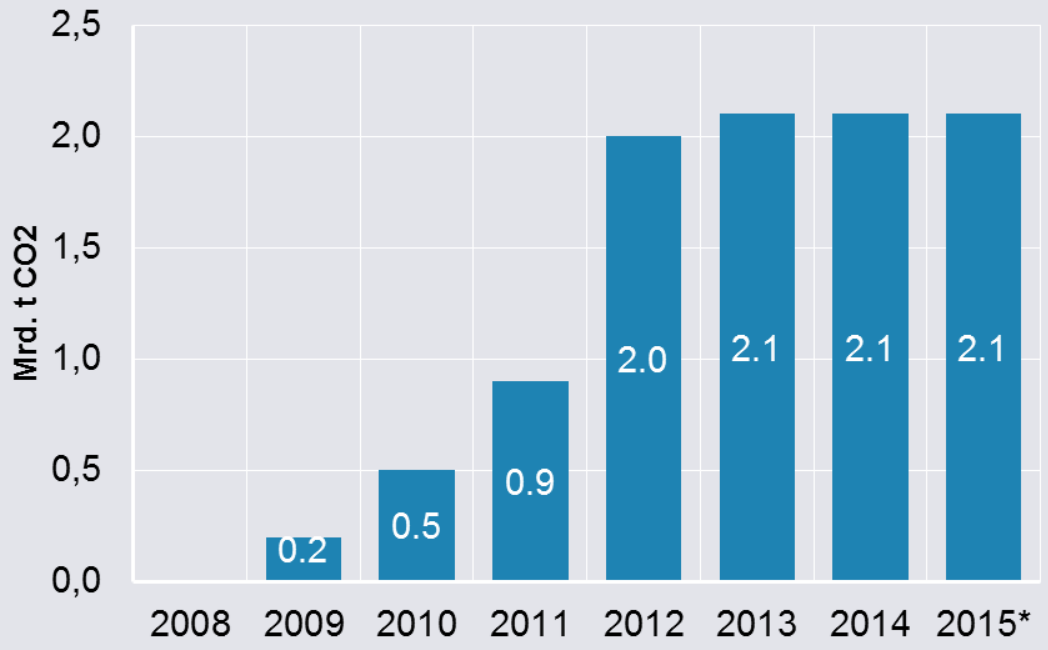
Greenhouse gas emissions by sector, 1990–2016, together with reduction targets for 2020 and 2030



UBA 2016, eigene Schätzungen

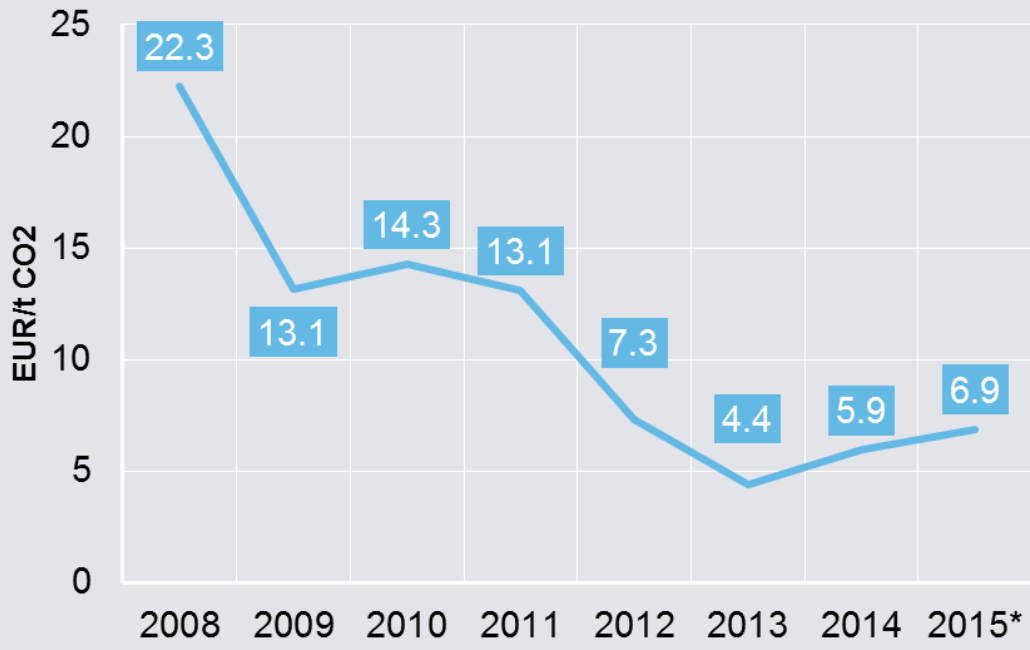
The key problem: The EU Emissions Trading system is facing huge excess certificates, leading to persistently low CO_2 prices

Cumulated excess certificates in the EU ETS 2008 - 2015



Agora Energiewende (2015c) * preliminary

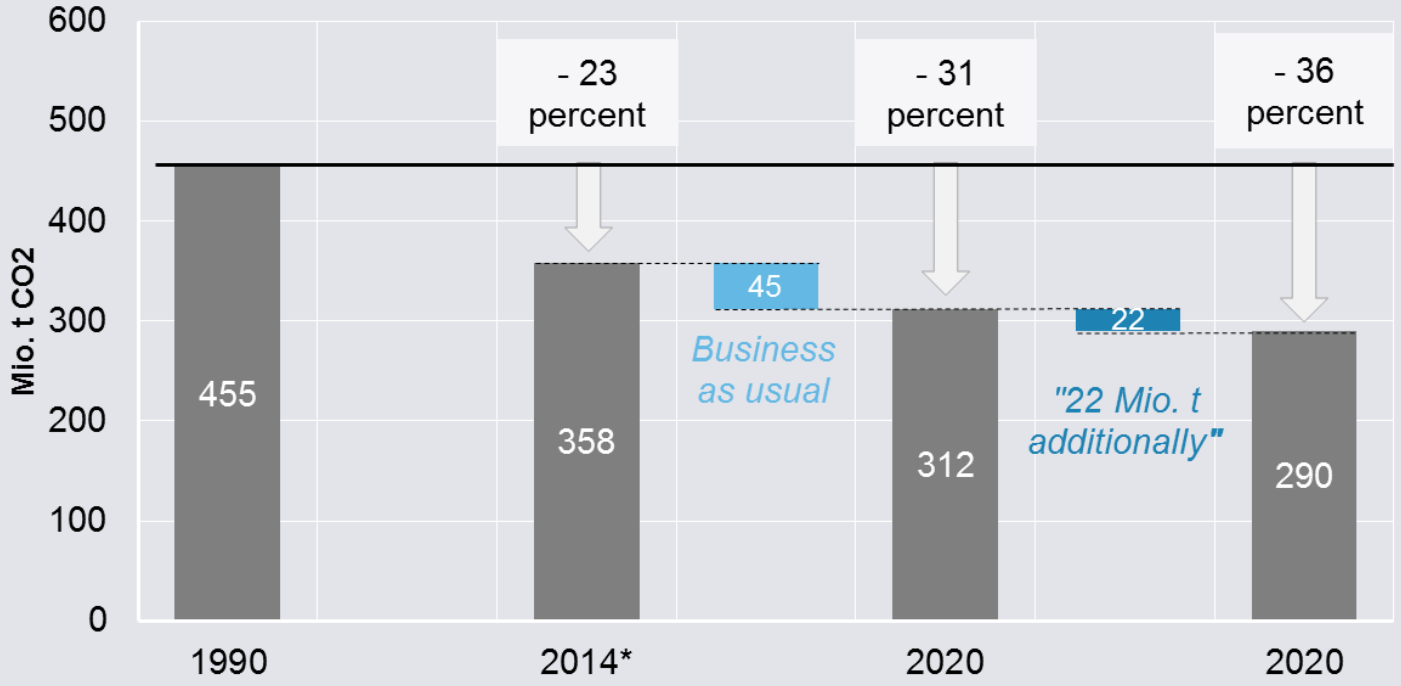
Price for CO_2 allowances 2008 - 2015



DEHSt (2015) * preliminary

As the ETS reform is coming too late for Germany to meet its 2020 climate target, from 2017 on 2.7 GW of old lignite power plants will be put into a “coal reserve” – but what will follow?

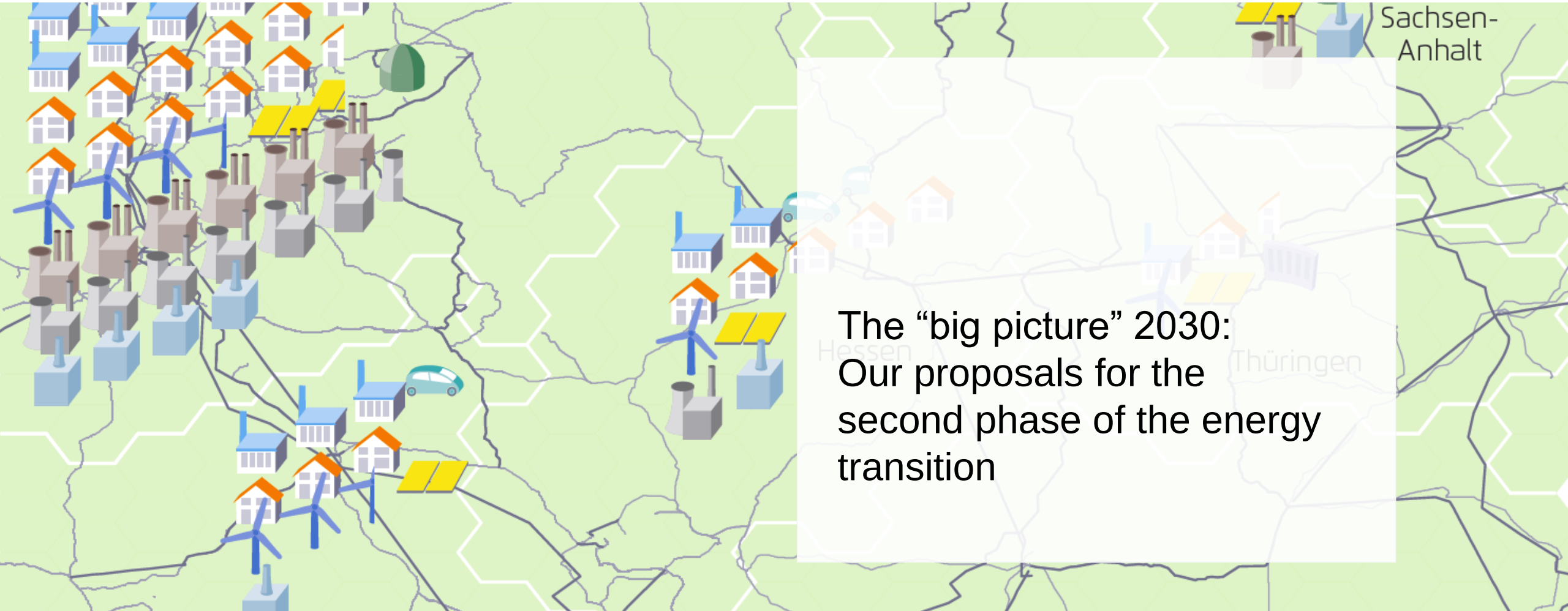
Expected development of CO_2-emissions in the electricity sector according to the German government 1990 - 2020



"22 Mio. t additionally"

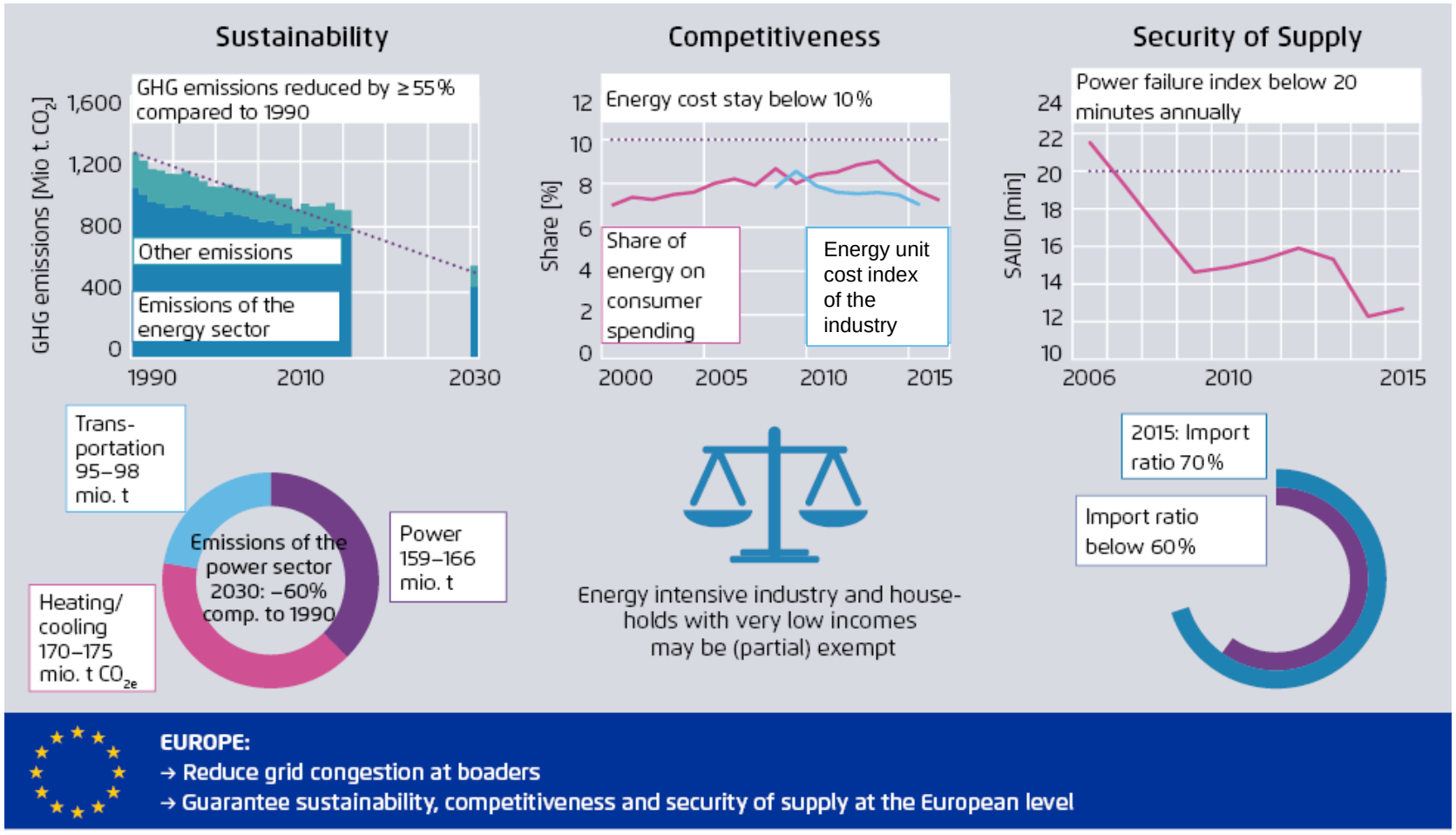
Capacity reserve (2.7 GW lignite)	11.0 - 12.5 Mio. t
Additional lignite reduction (if necessary)	1.5 Mio. t
CHP-Promotion	4 Mio. t
Various Efficiency Activities	5.5 Mio. t
Summ	**22 Mio. t**

BMUB (2014), BReg (2015), own calculations



The “big picture” 2030: Our proposals for the second phase of the energy transition

Perspective 2030: Make the goals of the „energy policy target triangle“ tangible



Own illustration based on BMWi (2017), BMUB (2016), Destatis (2016a), Expertenkommission zum Monitoringbericht „Energie der Zukunft“ (2016)

Sustainability:

→ Reduce power sector emissions by minimum of 60%

Competitiveness:

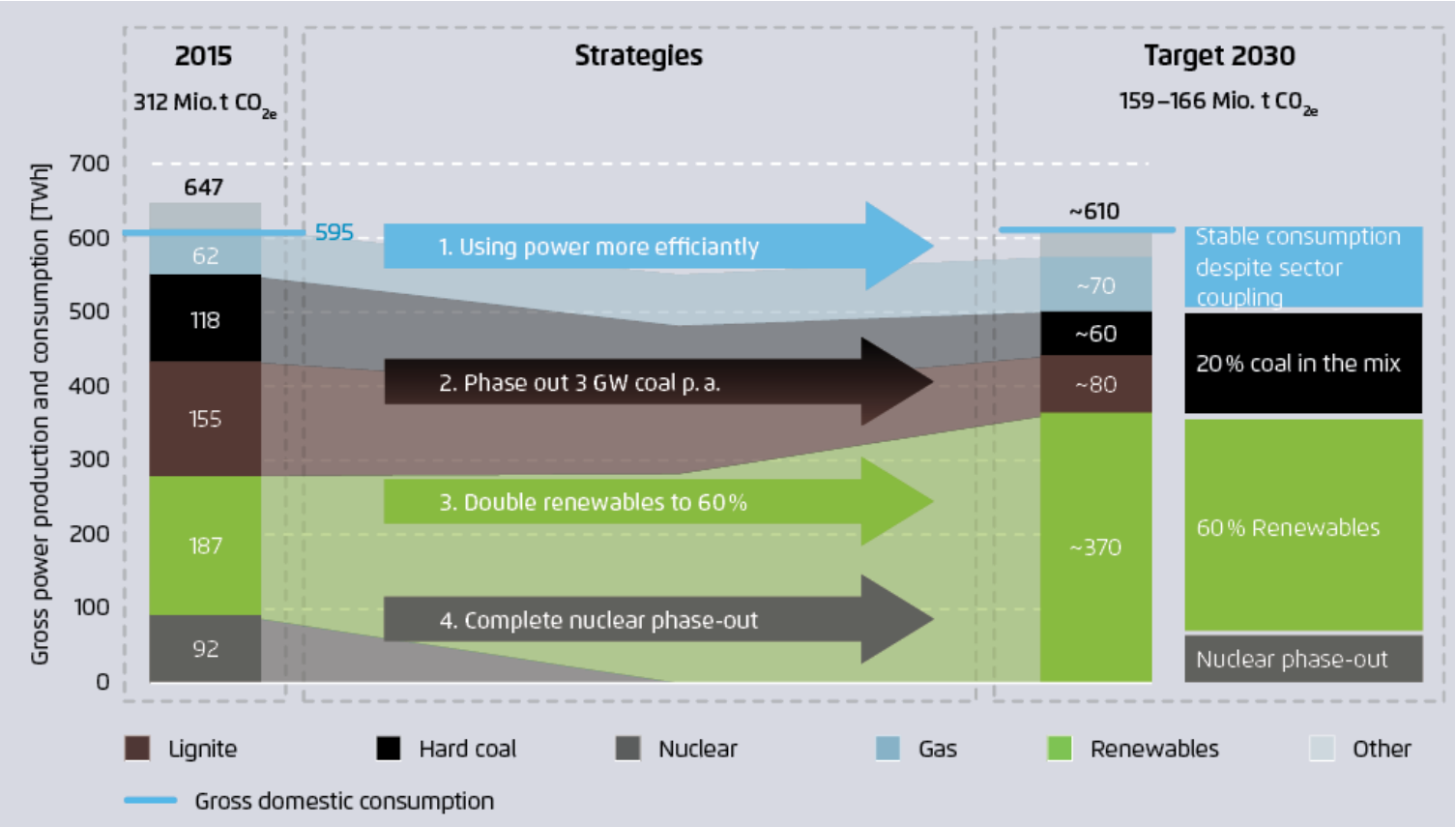
→ Keep total energy cost below 10% for industry and households

Security of supply:

→ SAIDI stays below 20 minutes

→ Import dependency reduced

Power transformation 2030: Keep power demand level despite sector integration, reduce coal use by 50%, double RES share to 60%, complete nuclear phase-out



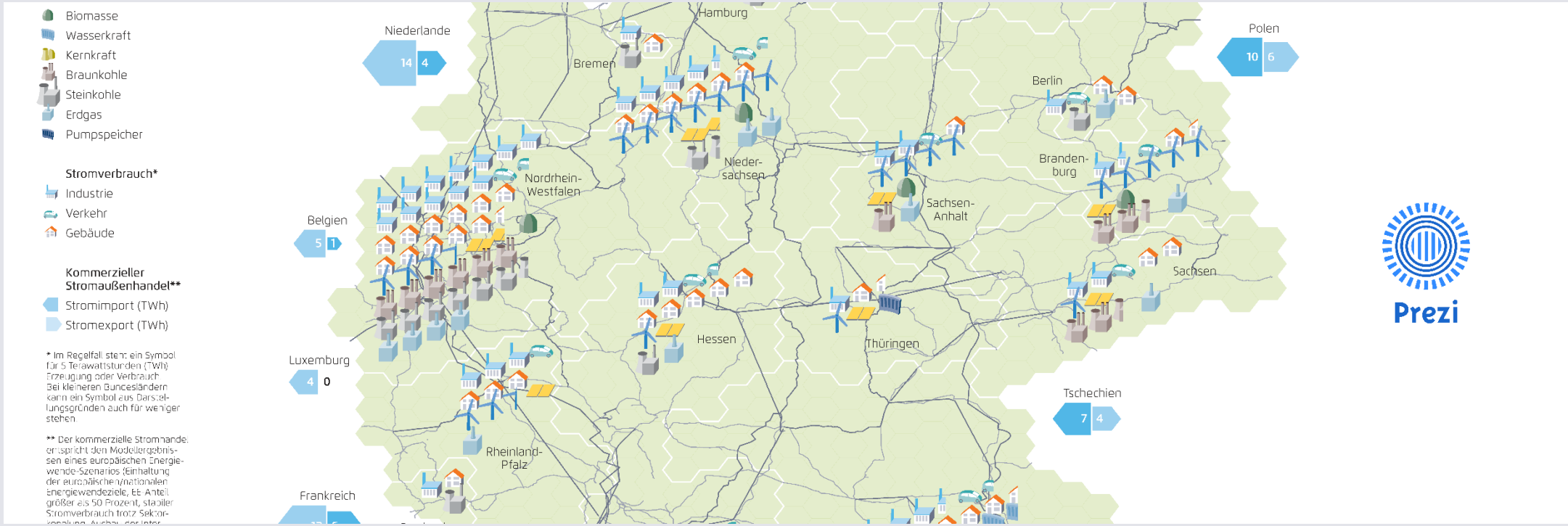
AGEB (2017a), BMUB (2016), own calculations based on Agora Energiewende (2016a), EWI/Prognos/GWS (2014a), UBA (2017c)

Power sector transformation: second phase to be implemented with four strategies:

- Efficiency first: demand stable despite 10M electric vehicles, 5M heat pumps
- Coal phase out consensus
- Doubling of Renewables share
- Completion of nuclear phase out

Germany 2030 – how the energy system will look like

Stromsystem 2030



Agora Energiewende

More information and studies available at our website www.agora-energiewende.org

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Questions or Comments? Feel free to contact me:

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