The German Energy Transition : recent trends and perspectives

REVision Conference 2017

D.Pescia

TOKYO, 8 MARCH 2017

Agora Energiewende – Who are we

Independent think tank with more than 20 energy policy experts

Independent and non-partisan

Project duration 2012-2021

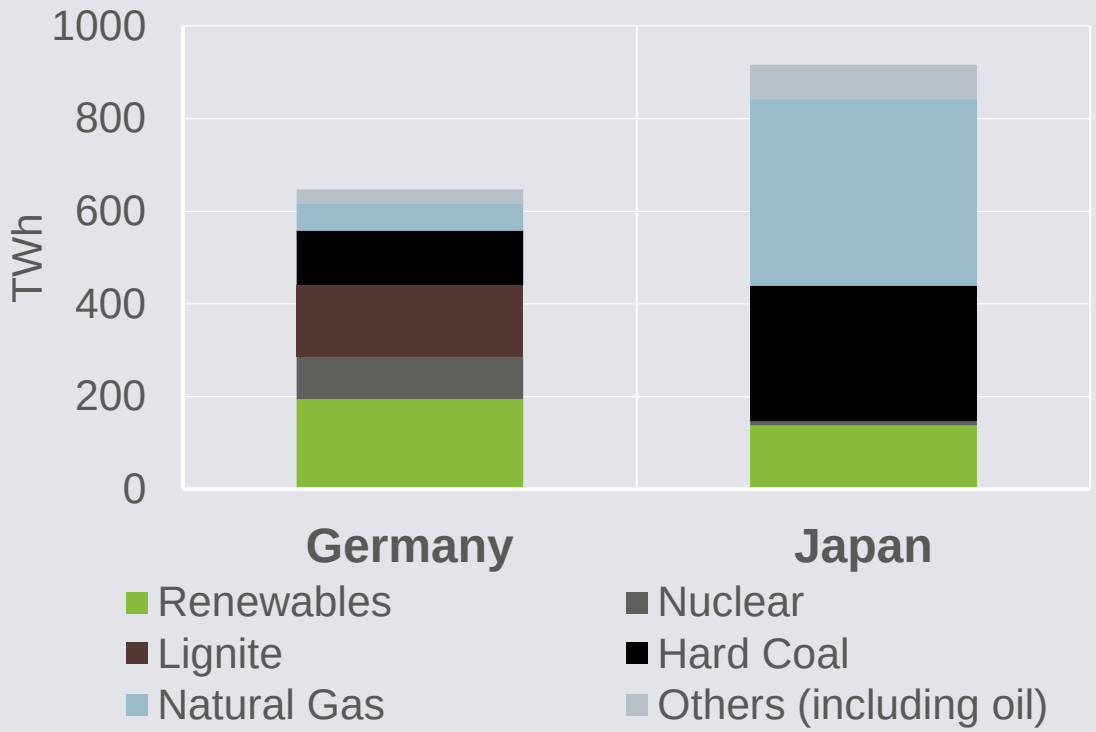
Financed by the Mercator Foundation and the European Climate Foundation

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

Methods : scientific assessments, dialogue, putting forward proposals

A comparative glance between the German and Japan power mixes shows several differences

Power generation (TWh) in Germany and in Japan (2015)



AGEB (2016), REI (2016) from METI/ANRE

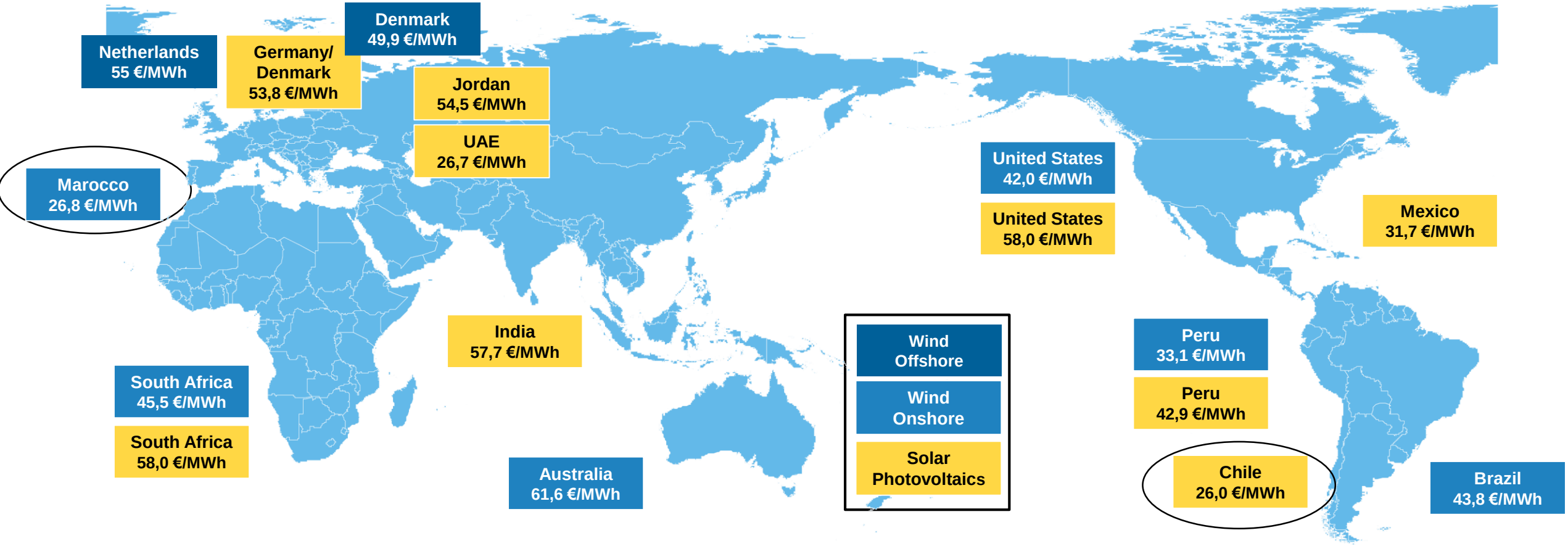
Comparative indicators between Japan and Germany (2015)

	JP	DE
Yearly power consumption [TWh]	916	597
Maximum peak load [GW]	181	84
Share of coal (hard coal and lignite) [% power production)	32%	42%
Share of nuclear [% power production]	1%*	14%
Share of vRES [% power production]	5%	18%
Total population [Million]	127	81
GDP [Billion $]	4 123	3 355

AGEB, REI, JEPIC, tradingeconomics

*29% before Fukushima accident

In 2016, renewable energy projects set low costs records around the globe : ►Wind Offshore: 49,9 €/MWh in Denmark ; Wind Onshore: 26,8 €/MWh in Marocco; ►Solar Photovoltaics: 26,0 €/MWh in Chile

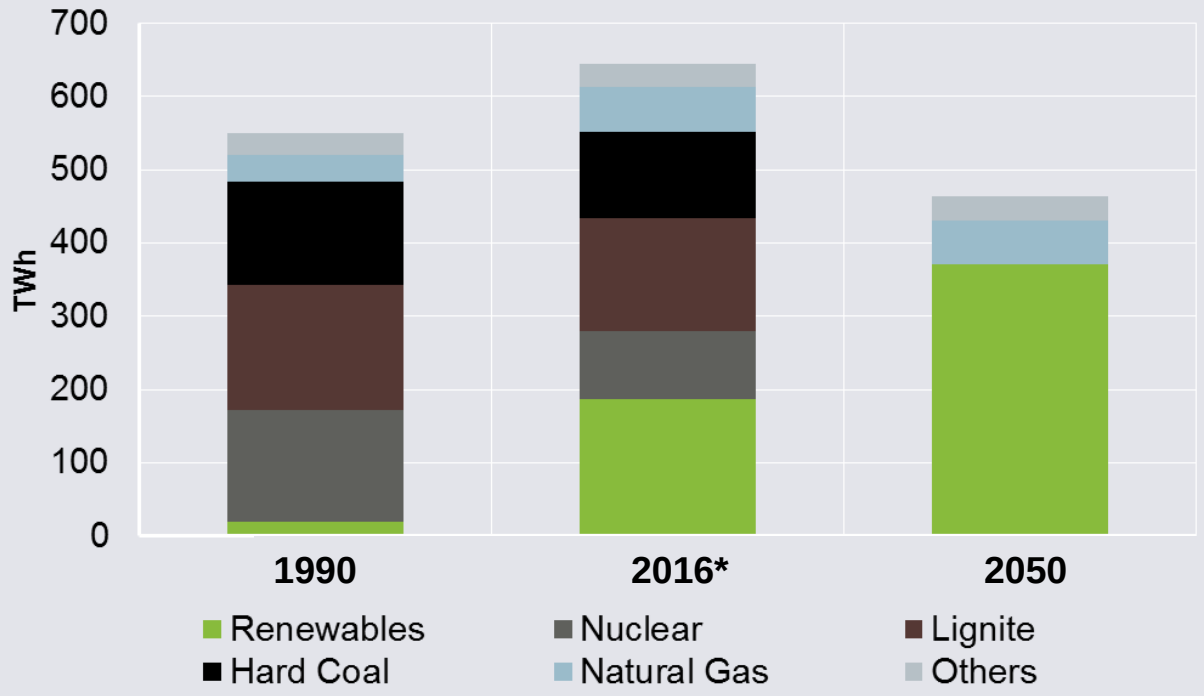


Fortum 2016; Sources: announcements by the investing companies and IEA report "Renewable Energy Medium-Term Market Report 2015" for US, Brazil, South Africa, Australia and Jordan. Values reported in nominal EUR, 1 EUR = 1,12 USD, 1 EUR = 75,3 INR, 1 EUR = 9.48 SEK. United States values calculated excluding 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.

The Energiewende in the power sector in a nutshell

The German Energiewende is a long-term energy strategy with clear mid-term and long-term targets. It means fundamentally changing the power system from coal/nuclear to renewables.

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, following a clear plan per plant

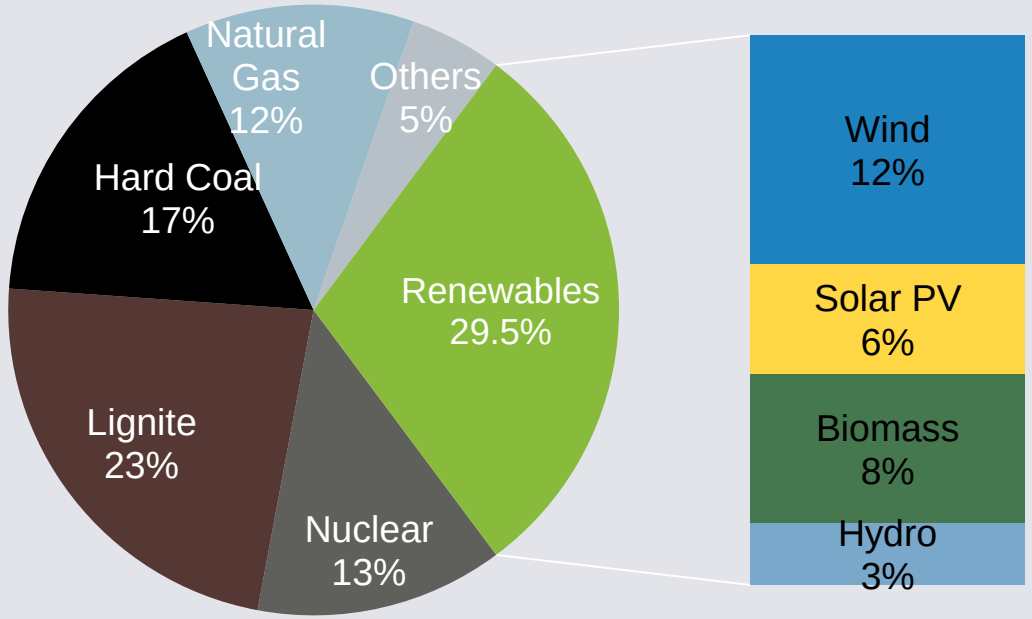
Reduction of Greenhouse Gas Emissions
Reduction targets below 1990 levels:
- 40% by 2020; - 55% by 2030; - 70% by 2040;
- 80% to - 95% by 2050

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

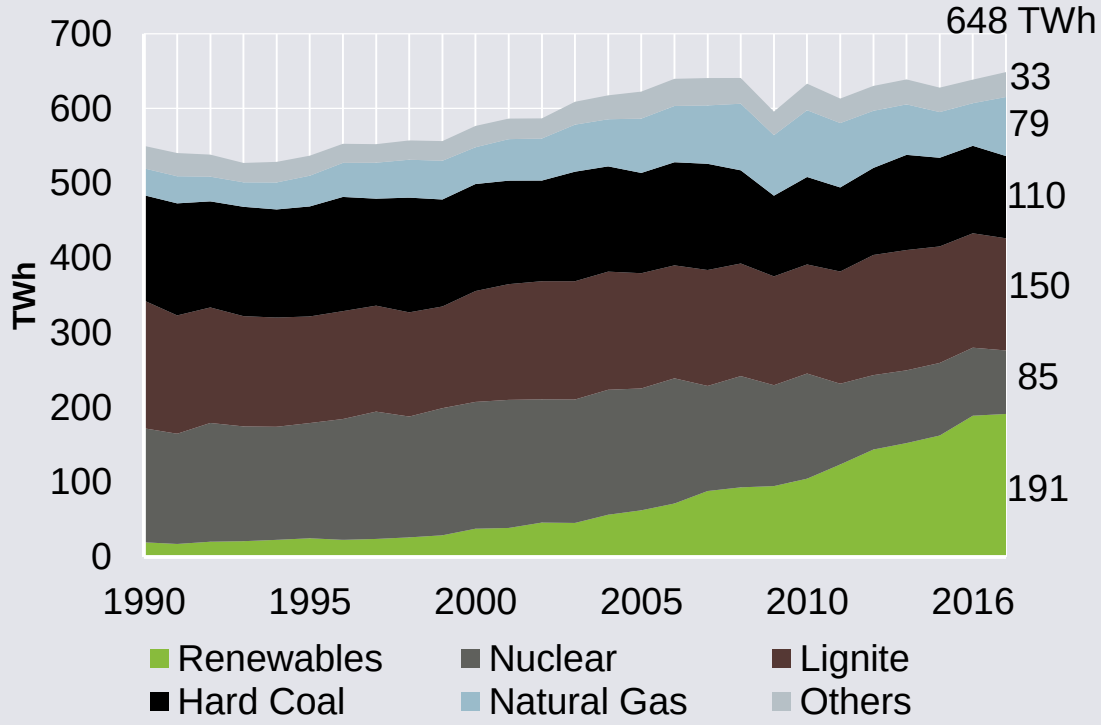
Renewables are the most important source in the German power system – followed by lignite and hard coal

Share in gross electricity generation by fuel 2016



AGEB (2016) * preliminary

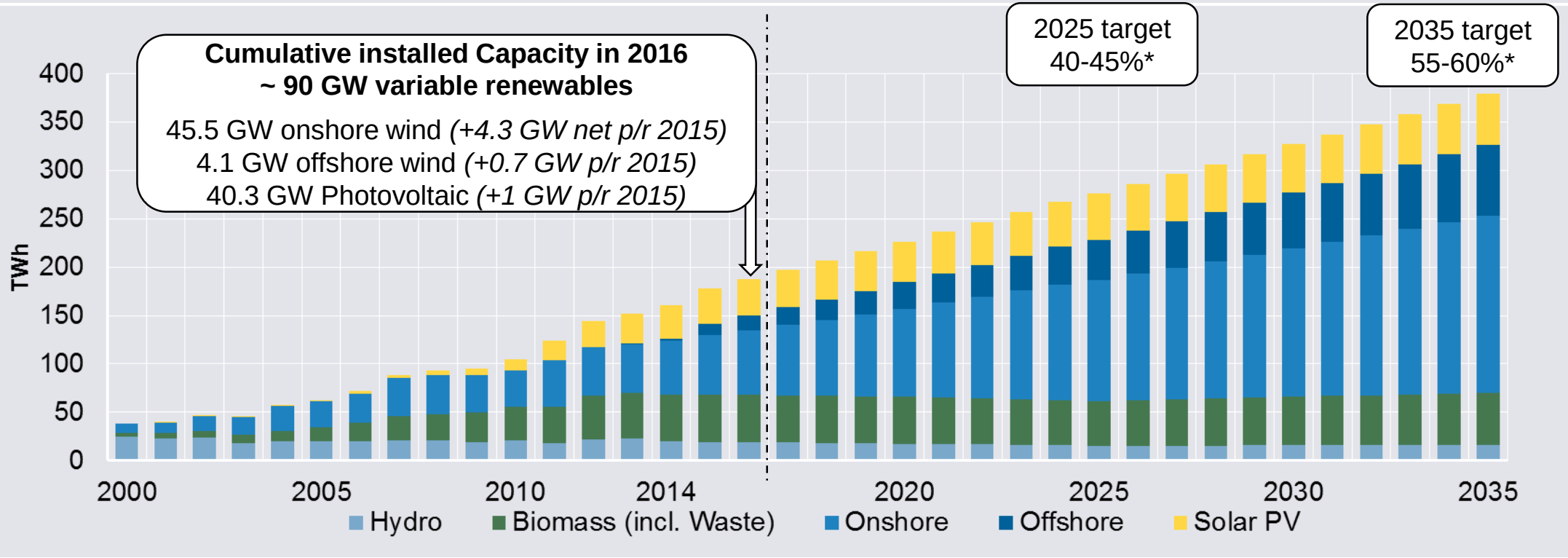
Gross electricity generation by fuel 1990 - 2015



AGEB (2016) * preliminary

The key insight for the Energiewende:
重要なのは風力と 太陽光！(It's all about wind and solar!)

Gross electricity generation of renewable energies 2000 - 2035

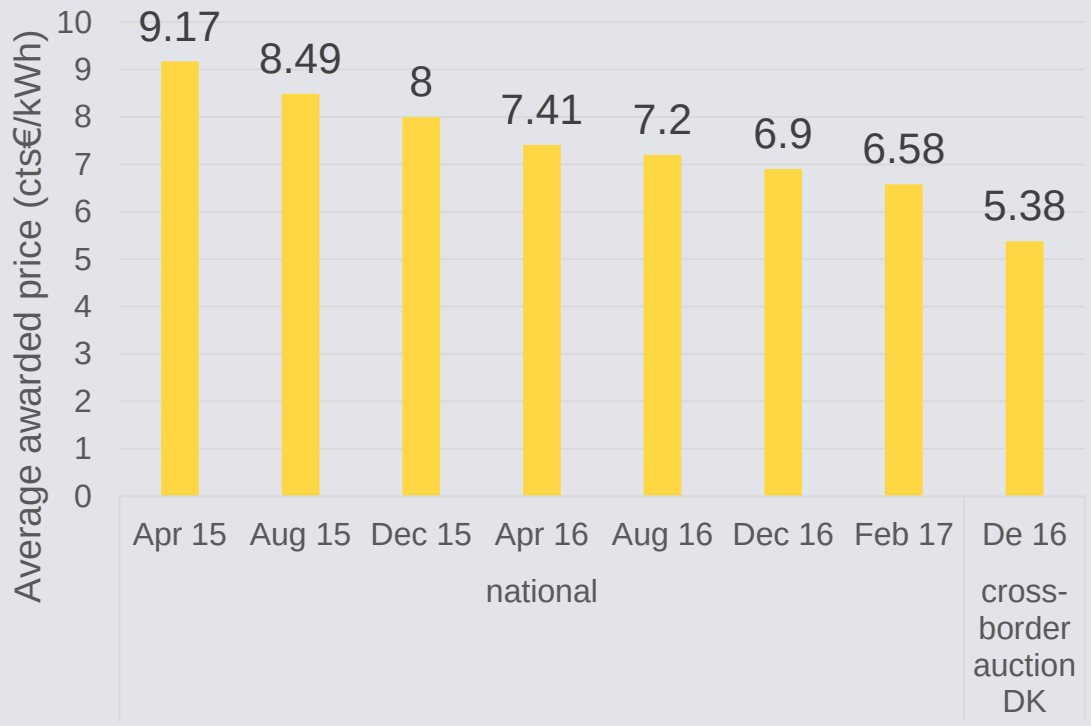


2000 - 2014: AGEB (2015a); 2015 - 2035: own calculation on basis of BNetzA (2014)/BNetzA (2015b)

* Share of gross power consumption

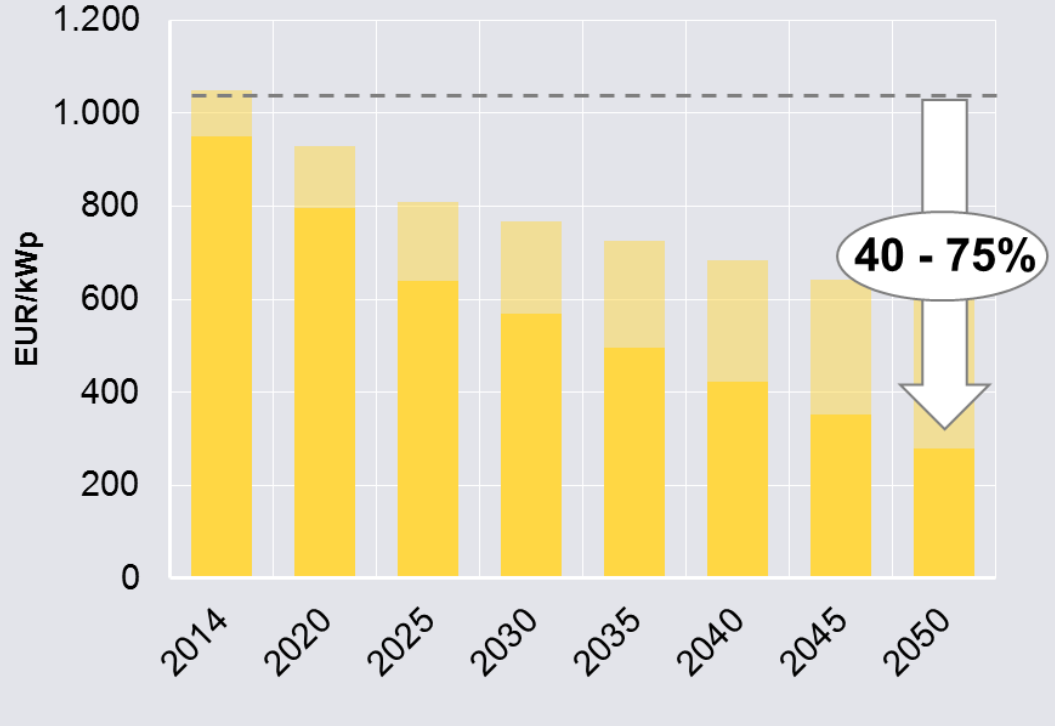
Costs for renewables continue to sink – remuneration for solar in Germany decreases from 9.2 ct per kWh to 5.4 ct per kWh in December 2016 in DE/DK auction.
The end of the cost digression is not yet reached!

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



BNetzA 2016

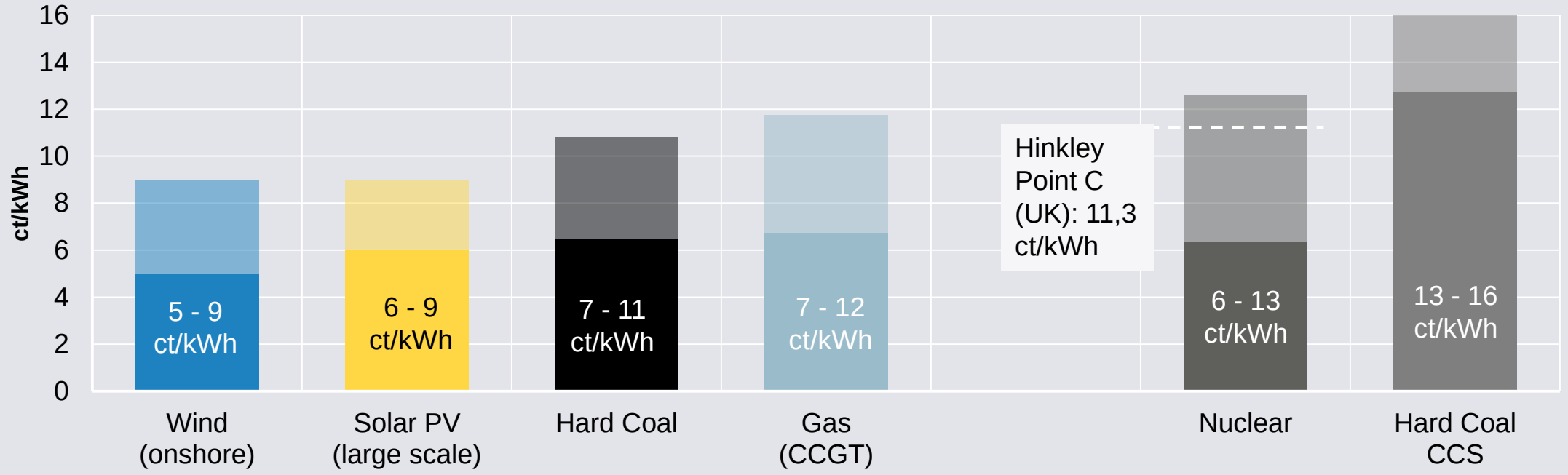
Expected cost decrease for large-scale PV systems 2014-2050



Fraunhofer ISE

Wind energy and solar PV are the world the cheapest low-carbon options and already cost competitive to newly built fossil power plants

Range* of levelized cost of electricity (LCOE) 2015



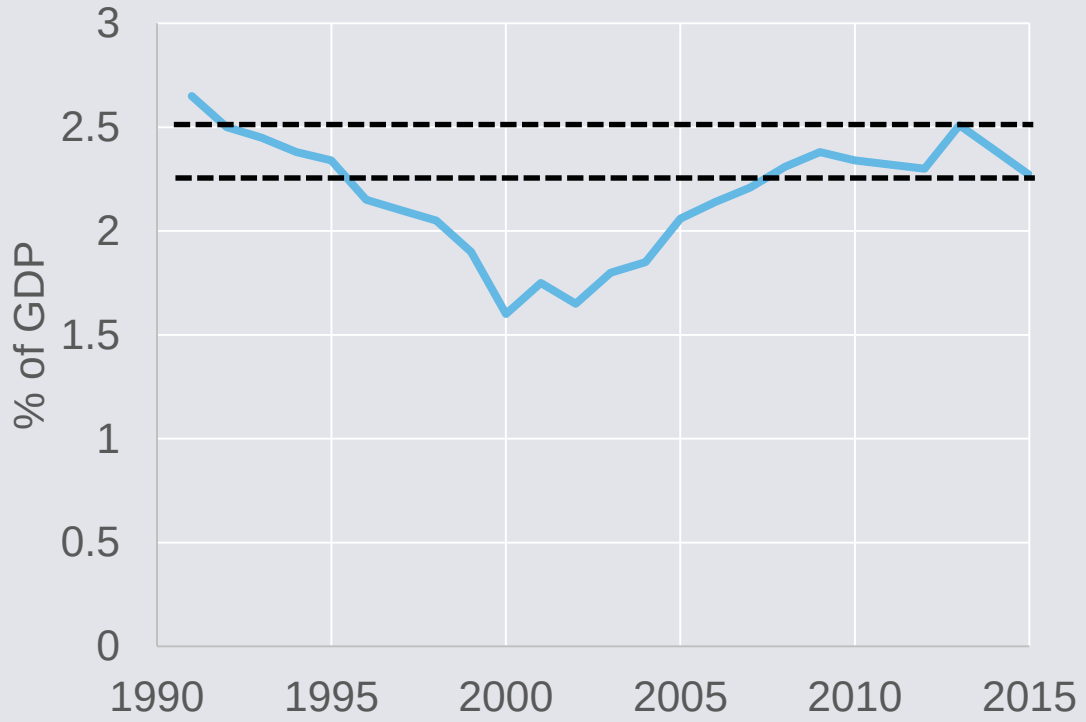
Agora Energiewende (2015e)

* based on varying utilization, CO_2-price and investment cost

Development of electricity prices and costs

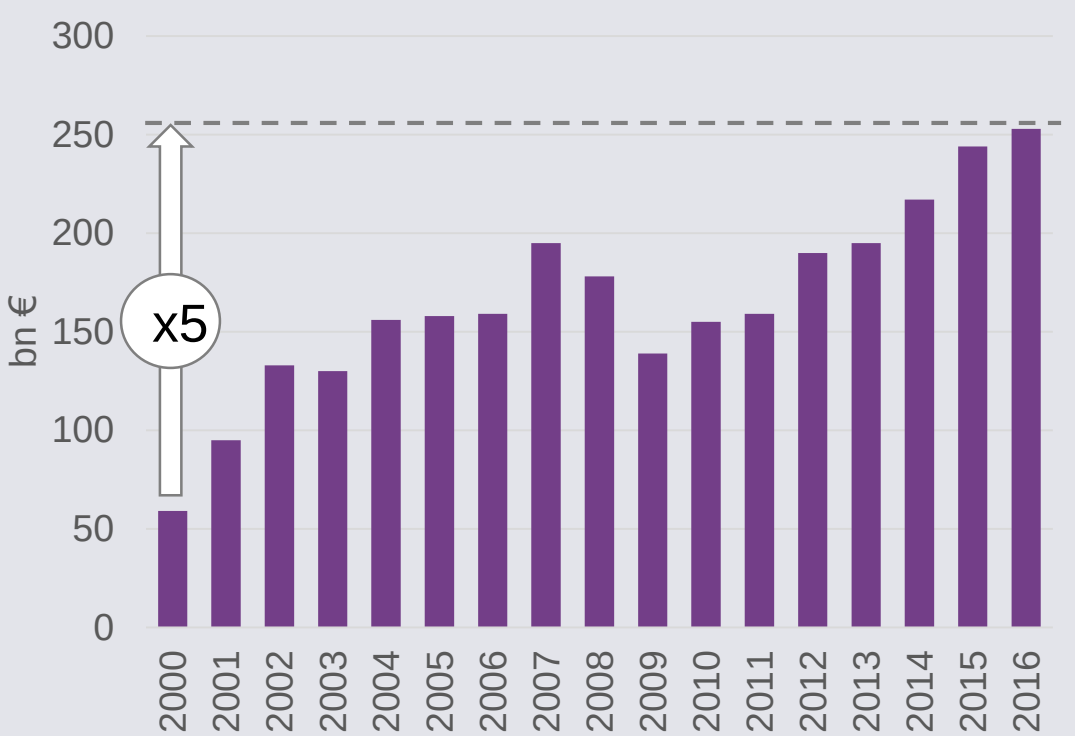
Since 2008, Germany has spent annually between 2.3% and 2.5% of annual GDP on its power supply. Since 2000, Germany increased its export surplus by factor four

Evolution of the expenditure for electricity supply in Germany in percentage of annual GDP



EWK (2016)

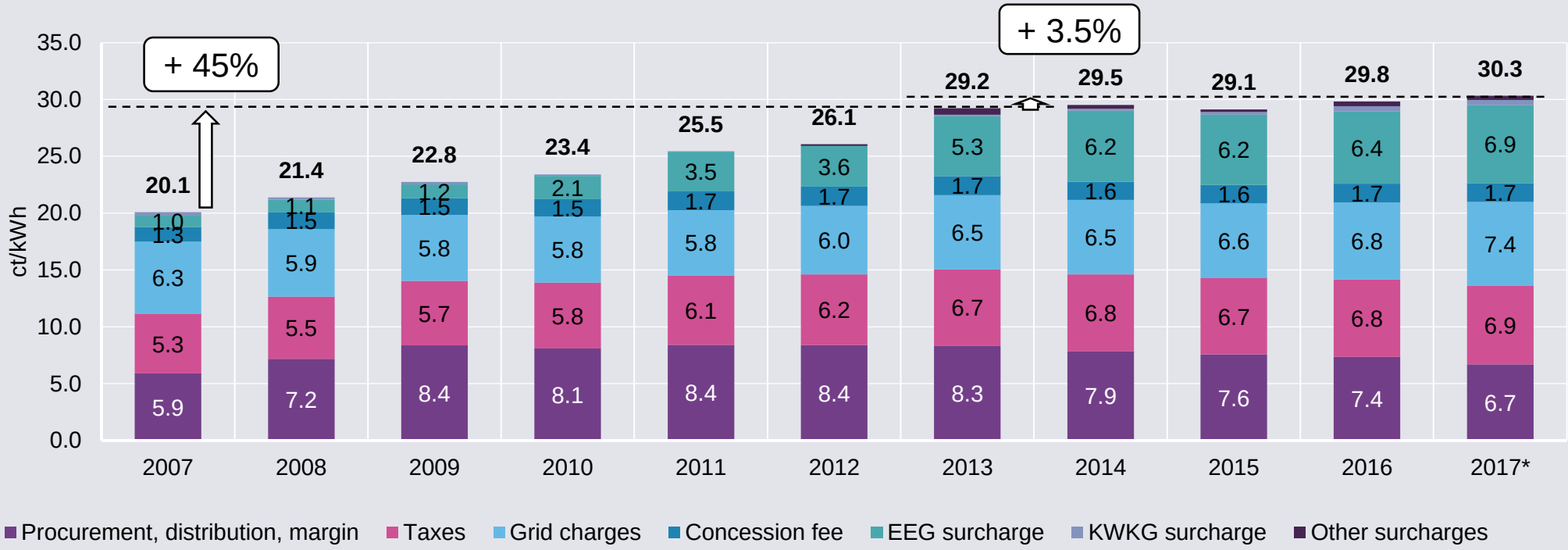
External trade surplus 2000 - 2016



Destatis (2017)

After years of increases, electricity prices for German households have been relatively stable since 2013

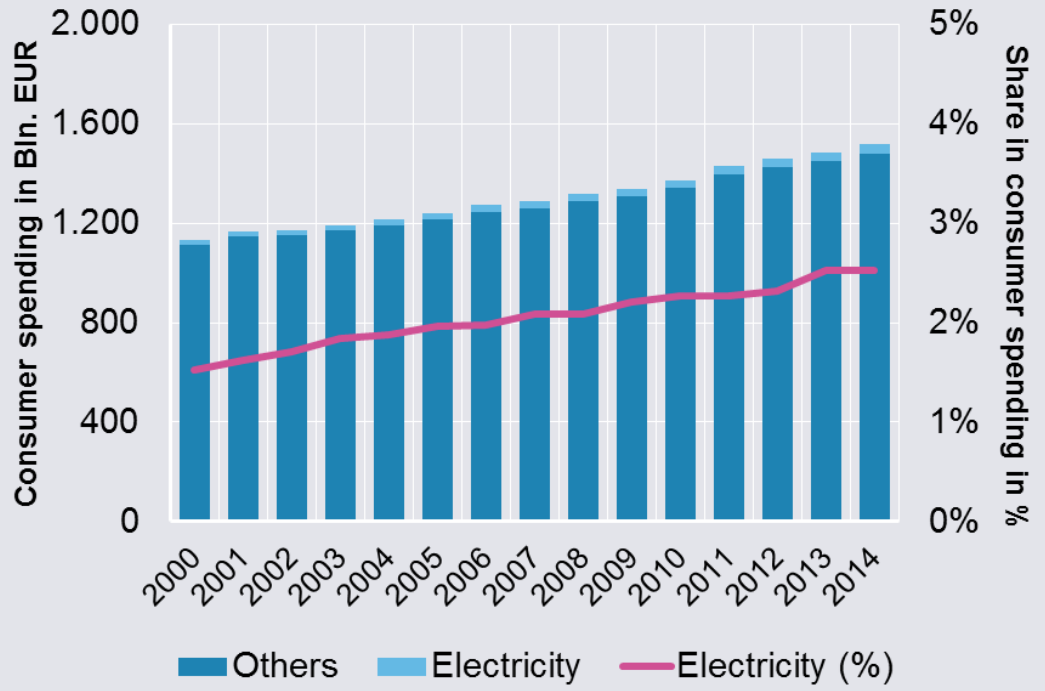
Average electricity prices for a 4-person household (3500 KWh annual use), 2007-2017



BNetzA 2016, *own estimates

Private households spend about 2.5 percent of their total spendings on electricity. Due to higher efficiency, annual electricity bills are similar to those in other industrial countries

Private household spending 2000 - 2014



Destatis (2015a)

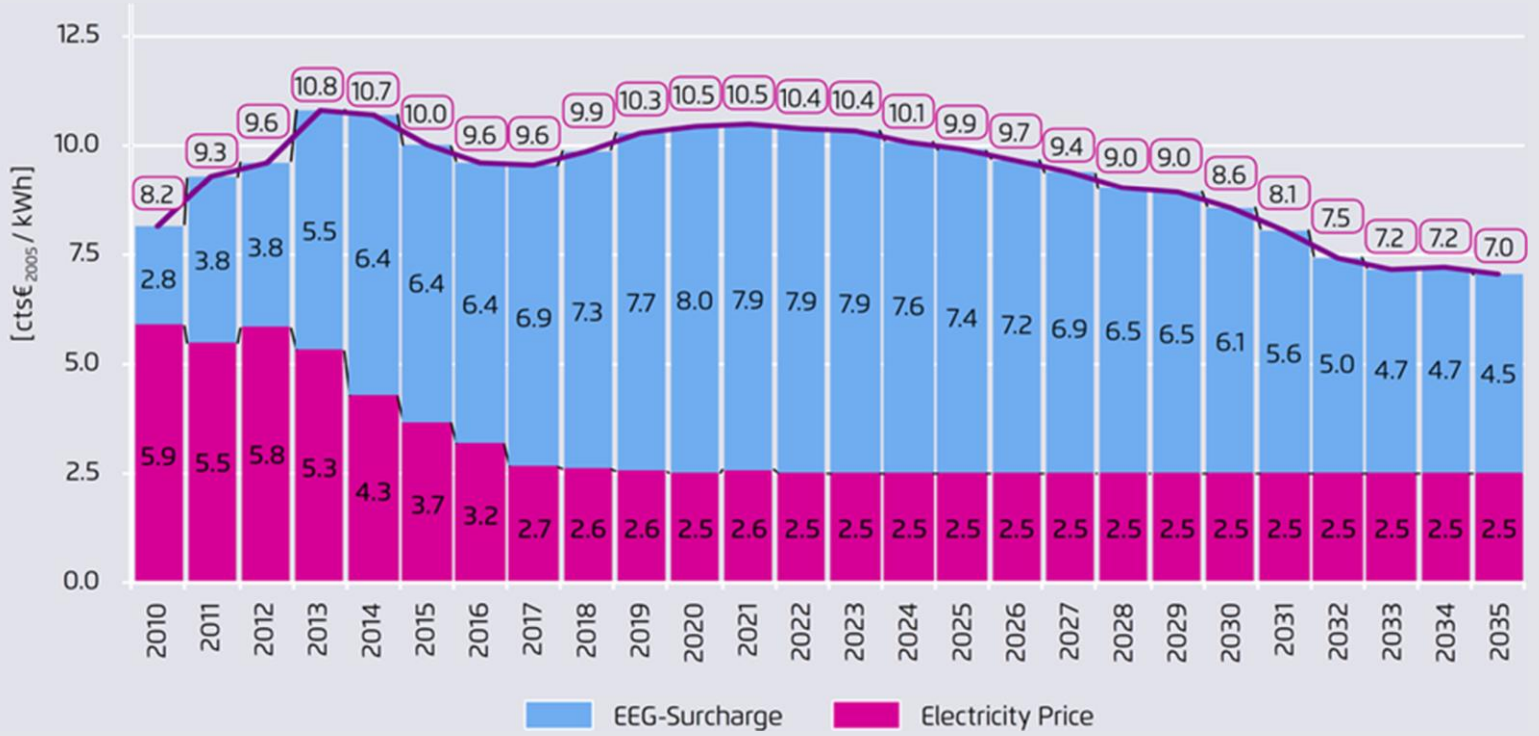
Annual electricity bills of private households 2014

	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

As an early mover, Germany developed renewables when they were still expensive, inducing costs that will be borne by German consumers the years to come. This contributed however to falling prices worldwide.

Sum of wholesale electricity price (pink) and EEG surcharge (blue), 2010 - 2035



This initial investment will pay off after 2023, when the German consumers will stop paying the FIT for the oldest (and most expensive) renewable capacities installed before 2014)

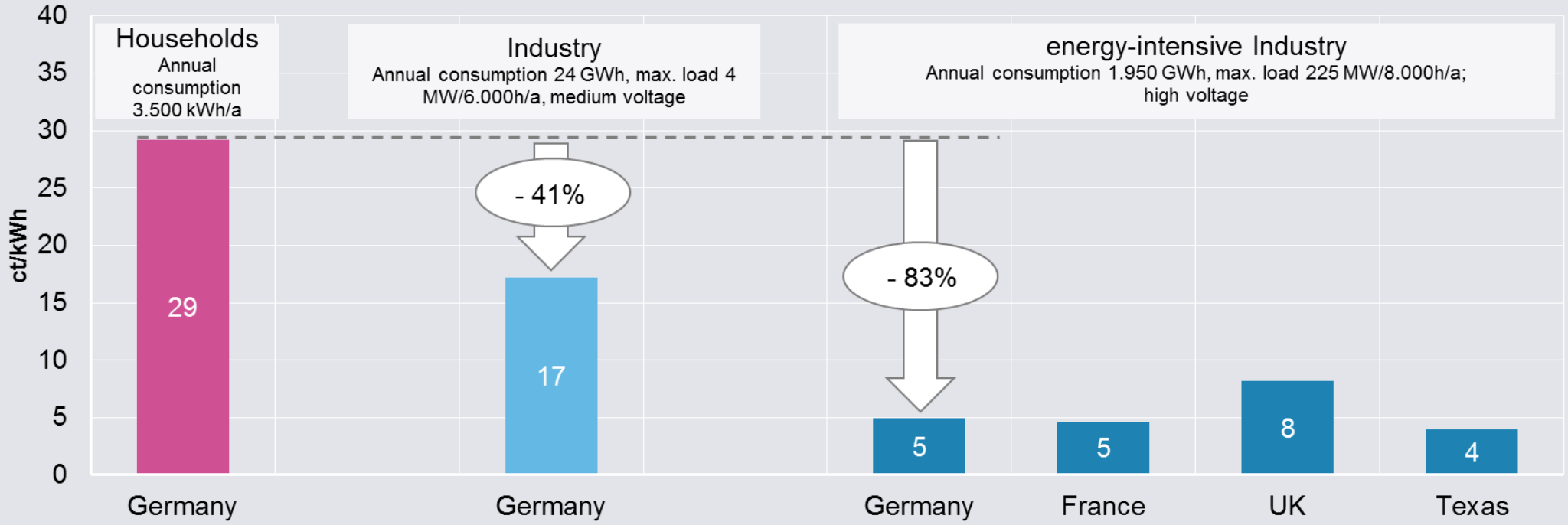
If Germany would built “overnight” its total current installed capacities, the EEG surcharge would reach only about 2 to 3 cts€/kWh. This early investment contributed to falling prices worldwide.

in 2035 the EEG-surcharge will be a lot lower than in 2015, but the share in renewables is doubled (around 60%)

Agora Energiewende based on Öko-Institut (2016); Forecast as of 2017

Energy intensive industries are largely exempt from taxes and levies to safeguard their competitiveness

Average end consumer prices for different consumer groups, 2013

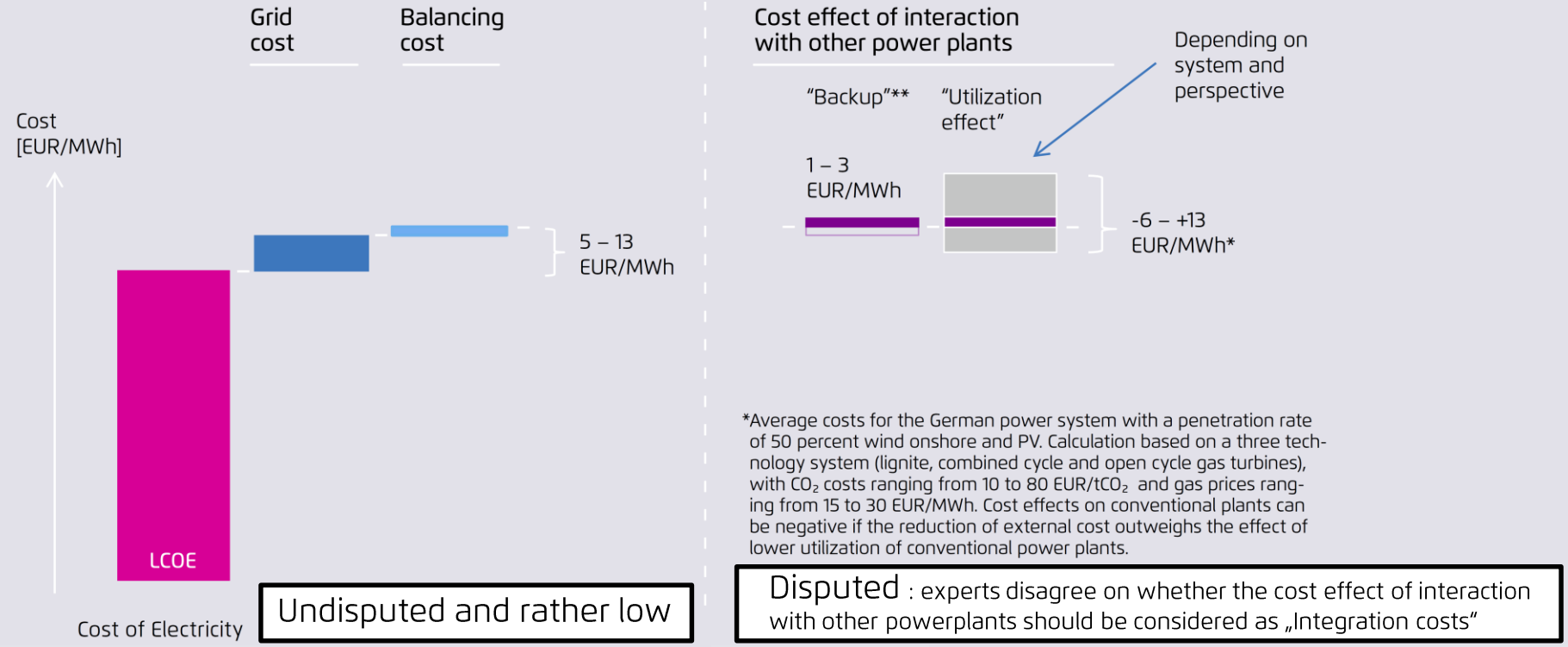


BMWi (2014)

4 Key To Dos for a system based on wind and solar

To do #1: Smartly integrate wind and solar in your power system – if you do it right, the integration costs are not very high (0.5 to max 2.0 cts/kWh)

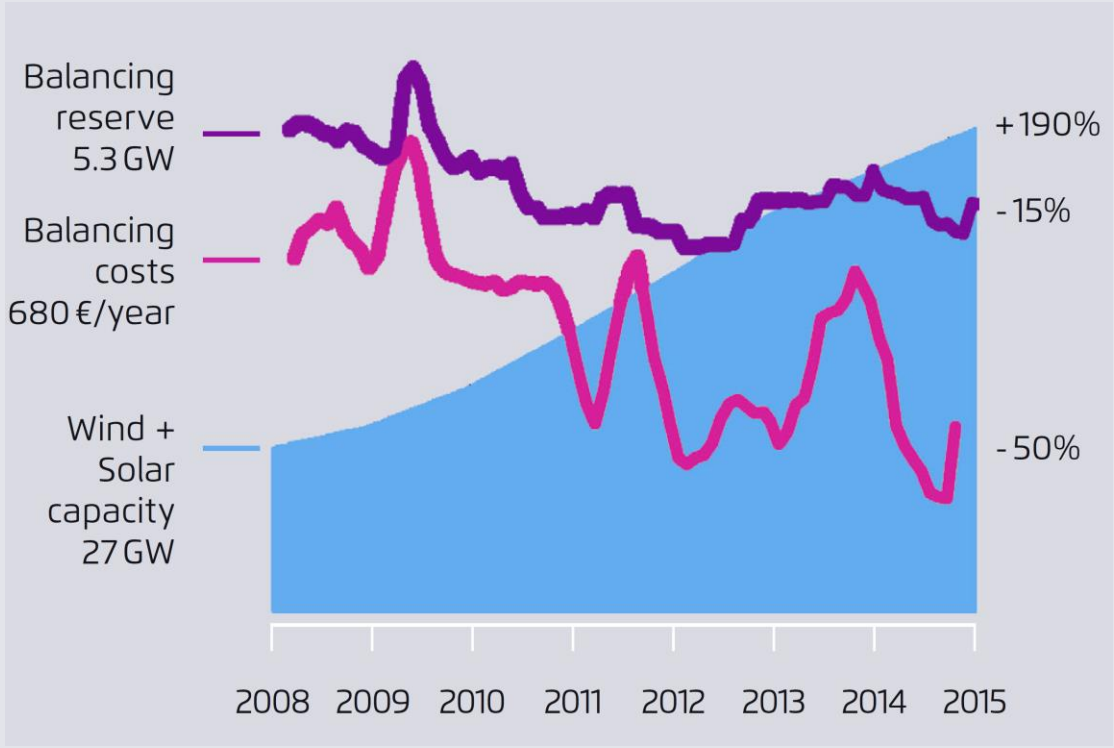
Overview of components discussed under „integration costs“



Agora Energiewende (2015)

Example -> In Germany, balancing costs have declined over the last seven years : improvements on the balancing market have outweighed the impact of increasing renewables.

Balancing reserve and cost development in Germany since 2008



Adapted from Hirth et al. (2015)

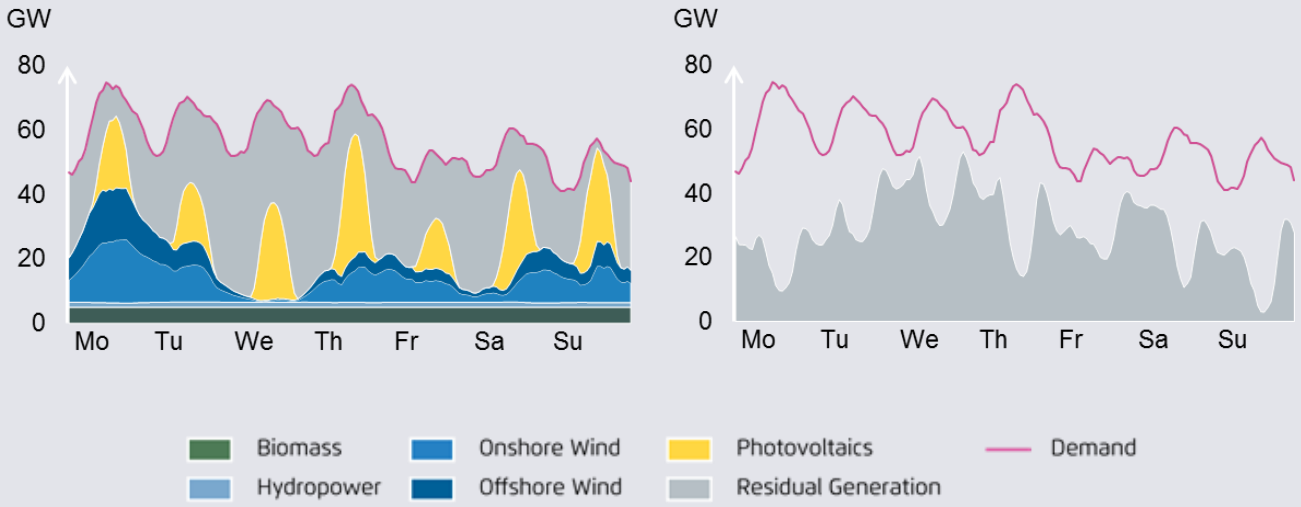
Since 2008, vRES capacity has been multiplied by three in Germany, while balancing costs have decreased by 50% over the same period.

Other factor have overcompensated the VRE expansion (depressing the requirement for balancing reserve requirement) :

- TSO cooperation
- More competitive balancing power markets
- Improvement of forecasts
- More liquid spot markets
- Economic recession

To do #2: *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



Own calculations on basis of Agora Energiewende (2015b)

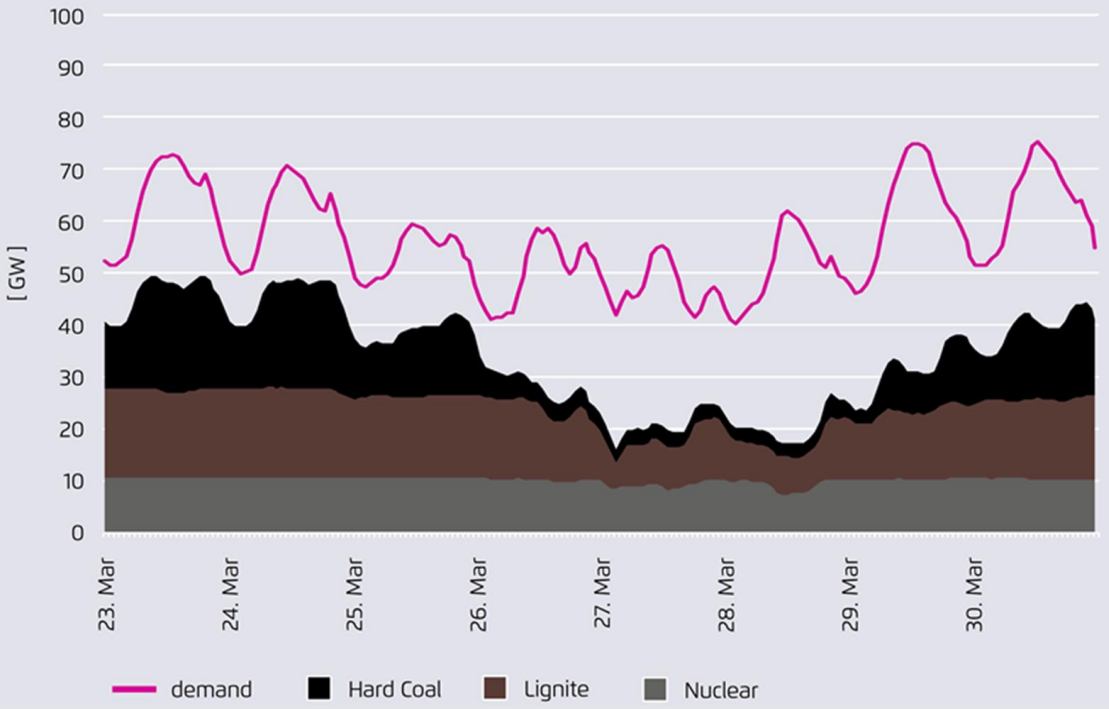
Key flexibility options

- → 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)

Make the power markets more flexible : the electricity price on short-term markets (day-ahead, intraday, balancing) must reflect the real time value of power

Example -> in Germany, baseload power is an obsolete concept. It is not compatible anymore with integrating more wind and PV in the power system.

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



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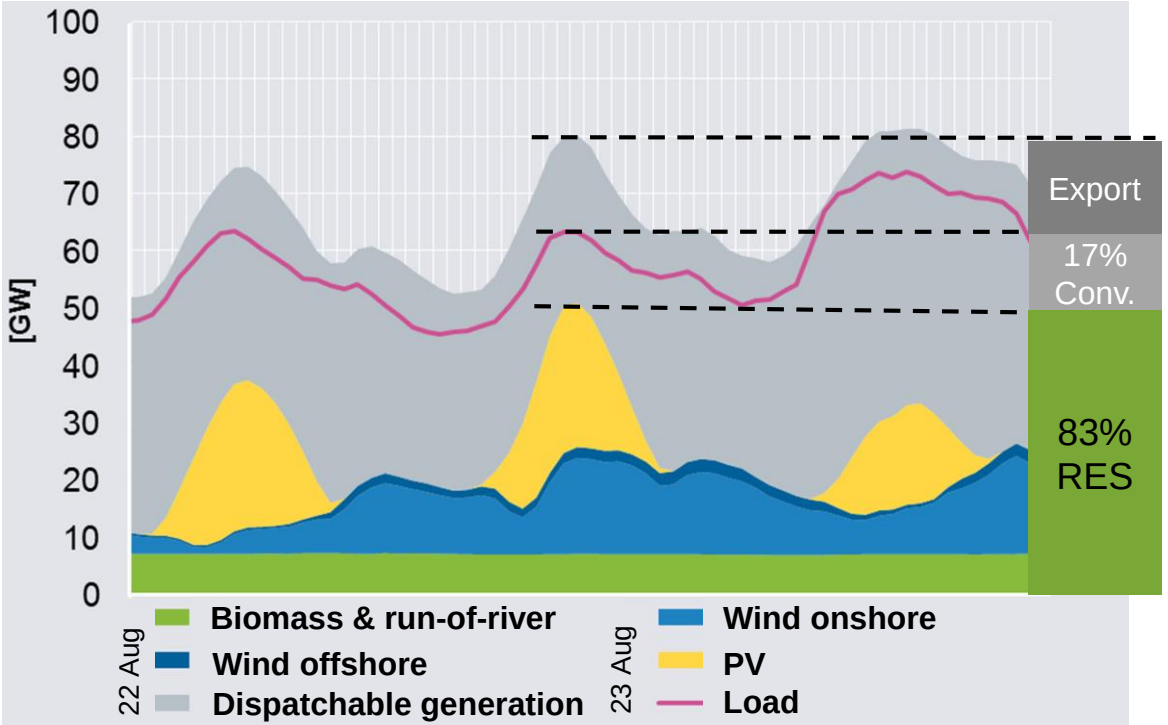
Electricity generation in Germany 22-24 August 2015



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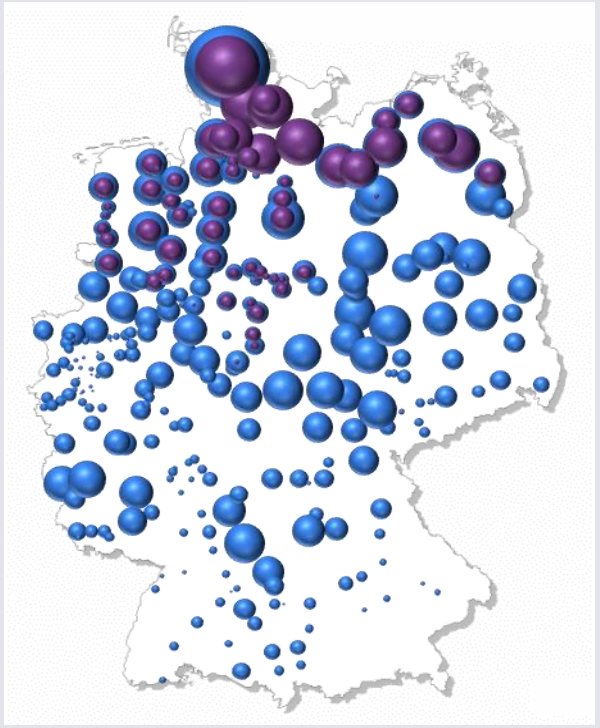
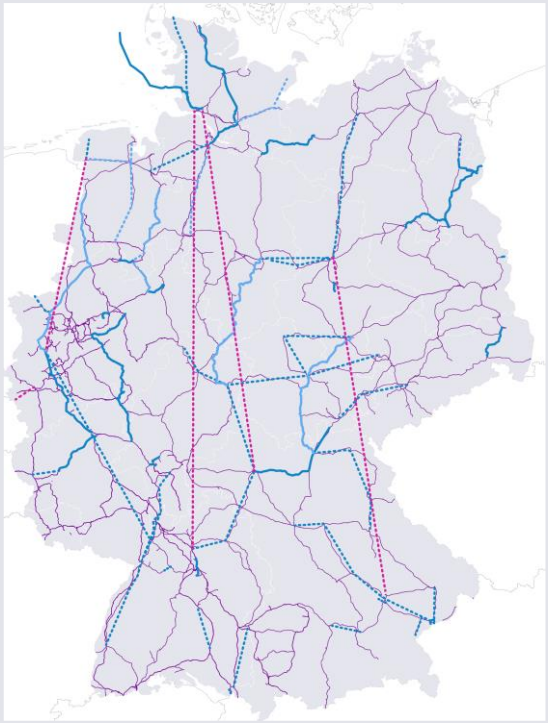
To do #3 : Better utilize your existing grid, incentivize “state-of-the-art” grid development AND promote regional markets, as a new framework for decentralization

Installed wind capacity (103 GW, Scenario „Best Sites“) 2033



Fraunhofer IWES (2013)

German network development plan 2025



BNetzA (2014)

Renewables are deployed in a highly decentralized and asymetric patchwork of small-scale facilities.

An **enhanced grid infrastructure** (national and supranational) is necessary to transport electricity and benefit from “smoothening effects” between different consumption and production patterns.

Decentralization is a new and lasting structural trend of the Energiewende:

- congestion in the grids are likely to persist
- active and connected „prosumers“ with a preference for regional electricity products
- citizen and politic attach great importance to decentralized solutions.

-> **Regional power markets** will deliver a new framework to decentralization.

To do #4 : manage well the fossil decline
Coal phase-out is very likely to be an important focus of German politics after the federal election (fall 2017)

Open lignite mine in Nochten, Germany

www.markowski.de

Legacy investments in coal plants are stumbling block to energy transition. The managed retirement of old, high-carbon, inflexible capacity is prerequisite for successful shift to a more renewables

In Germany, coal-fired power generation and **CO2 emissions in the power sector have been slightly declining** since 2014. However, a gradual coal phase-out is needed to meet the national climate targets.

The **Germany's Climate Action Plan 2050**, adopted in 11.2016 after month of disputes, defines mid-term CO2 reduction targets in all sectors, including a CO2 reduction in the energy sector of about -60% by 2030 (against 1990's levels).

Coal phase-out is likely to be an **important focus of German politics after the federal election** (Fall 2017). The level of ambition and the pace of the transformation will depend on the ruling coalitions.

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