Insights from Germany's *Energiewende*

Fact and figures with a focus on the power sector transformation

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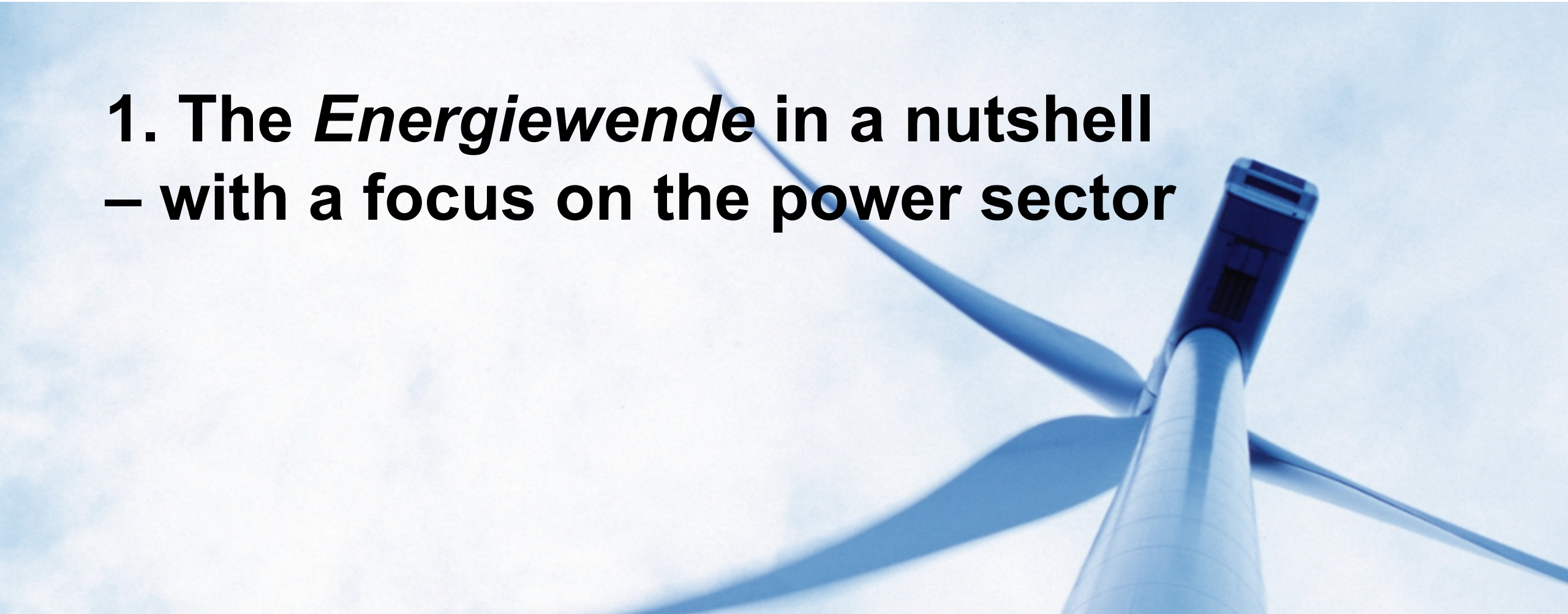
BRUXELLES, 24.06.2015

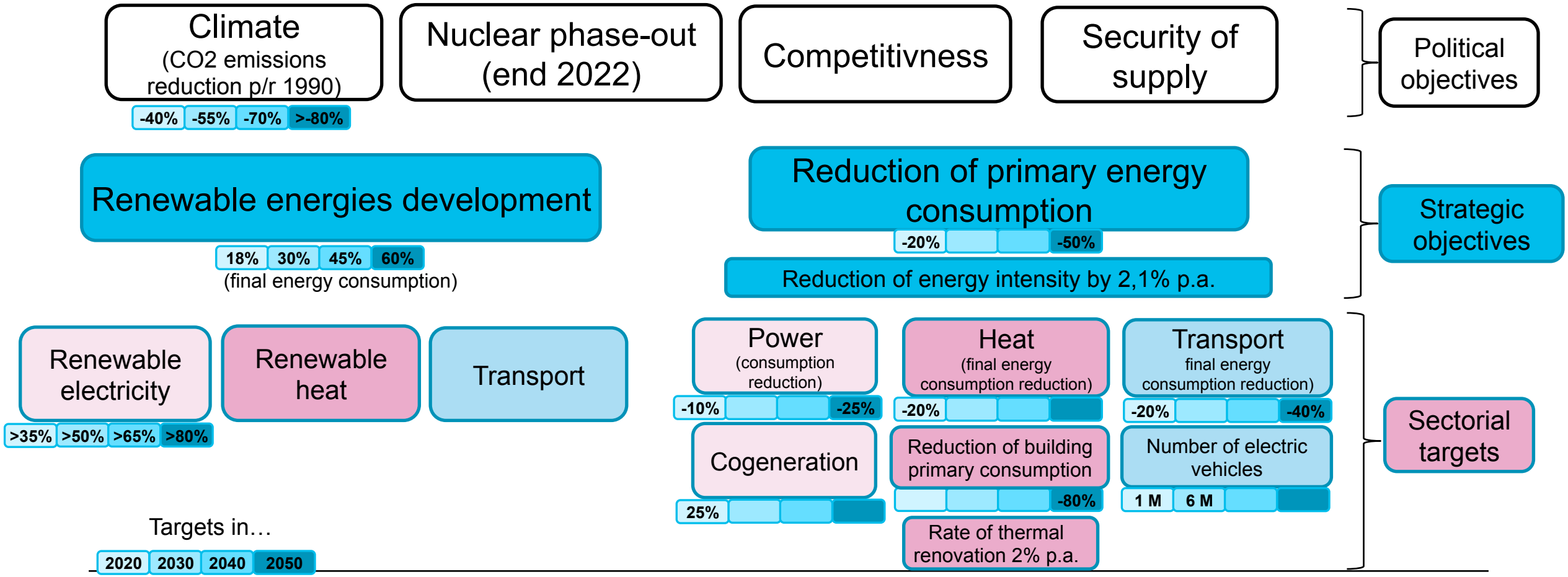
Who we are

- Independent and non-partisan think tank, 18 Experts
- Project duration: 2012-2017 | Financed with 15 million Euro by the Mercator Foundation and the European Climate Foundation
- Mission: How do we make the *Energiewende* in Germany a success story?
- Analyzing, assessing, understanding, discussing, putting forward proposals

1. The *Energiewende* in a nutshell – with a focus on the power sector

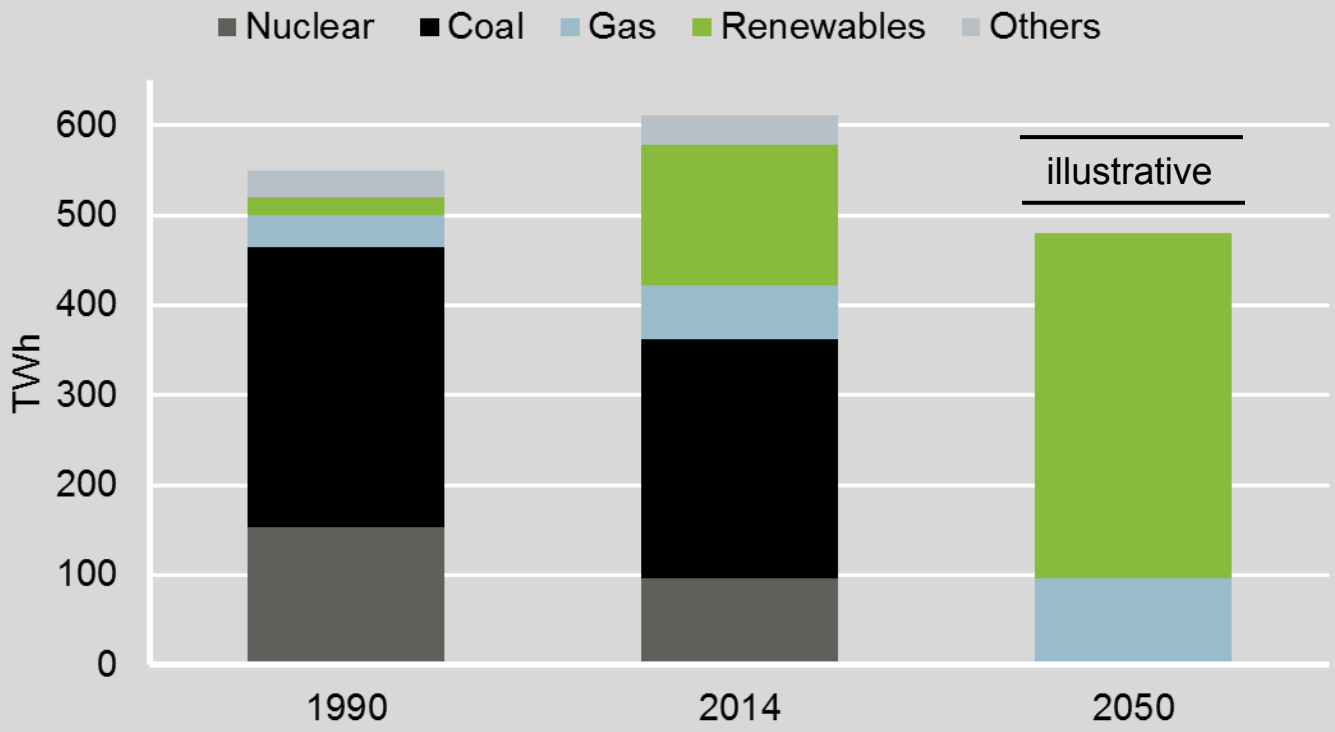


The Energiewende is a multi-sectorial transformation process, with clear mid-term and long-term objectives



The *Energiewende* implies a fundamental transformation of the power system

Gross power production in 1990, 2014 and 2050



AG Energiebilanzen (1990, 2014); illustration based on current targets (2050)

Greenhouse Gas Emissions
Reduction of 40% by 2020 and
80% to 95% by 2050 below 1990 levels

Nuclear
Stepwise shut down of all power plants until 2022

Renewables
Share in gross electricity consumption of 40-45% by 2025, 55-60% by 2035 and at least 80% by 2050

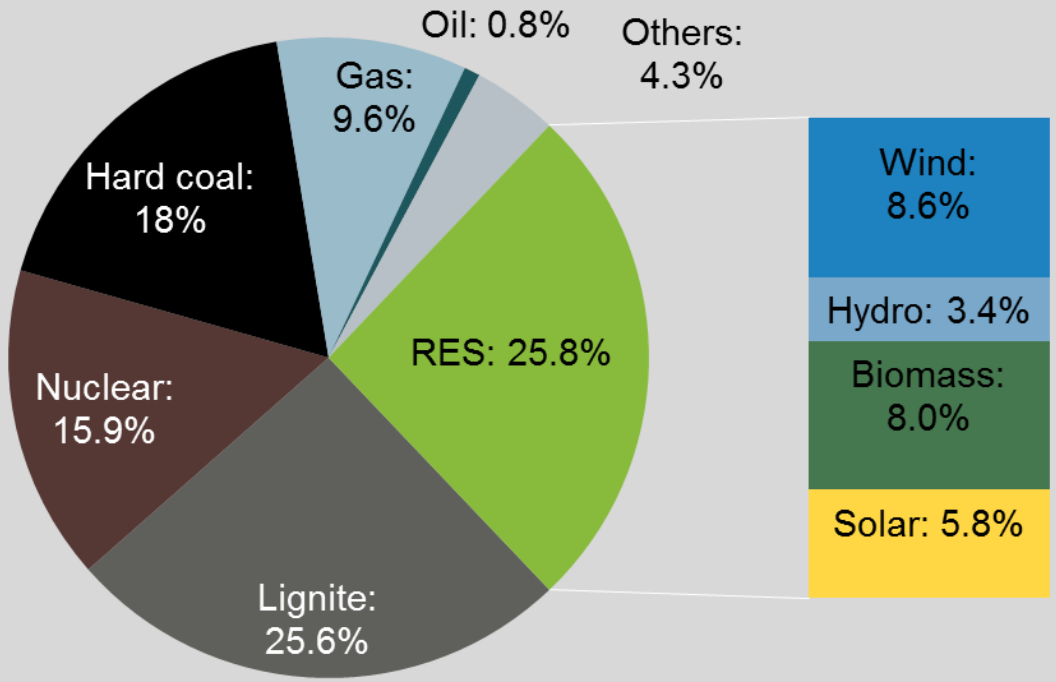
Efficiency
Reduction of electricity demand by 10% by 2020 and 25% by 2050 below 2008 levels

2. The transformation of the German power system

Where do we stand and where do we go ?

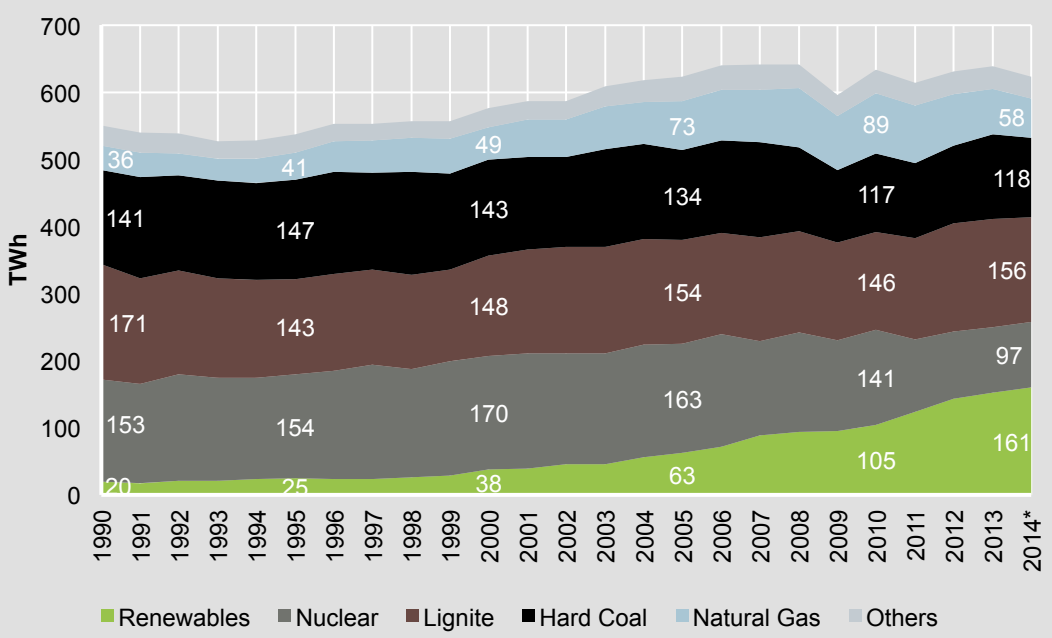
Renewables are rising, nuclear is phasing out, coal is still dominant

Share of energy sources in gross power production in 2014



AG Energiebilanzen (2014)

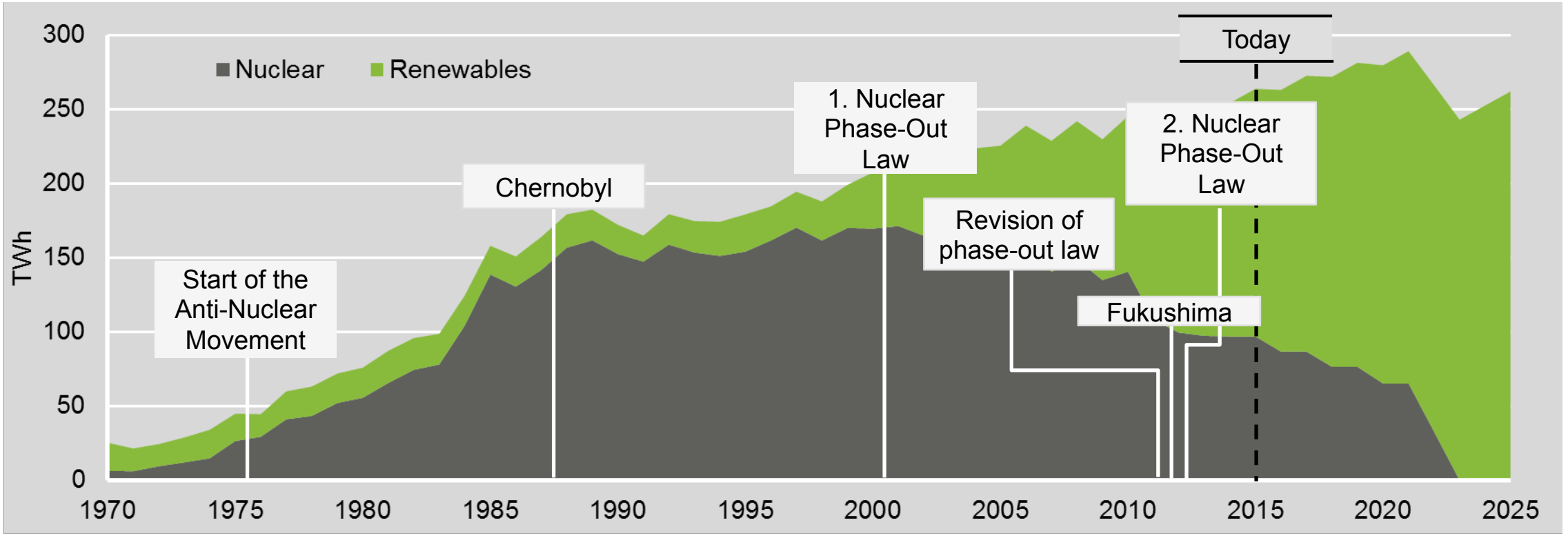
Development of gross power production 1990-2014 in TWh



AG Energiebilanzen (2014)

The nuclear energy act foresees the shut down of all nuclear power plants by 2022 with renewables more than replacing their generation

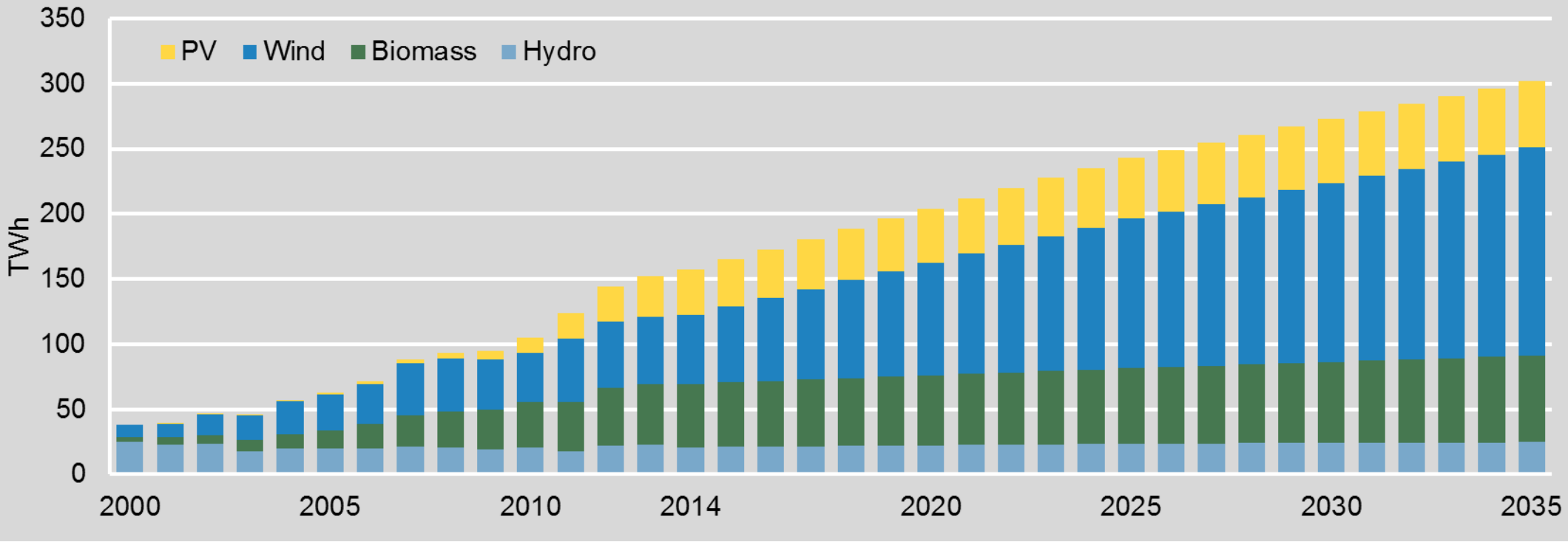
Gross electricity production by nuclear and renewable sources 1970 – 2025 in TWh



AG Energiebilanzen (1970 – 2014), BNetzA, own calculations (2015 – 2025)

The key insight of the *Energiewende*: „It's all about wind and solar!"

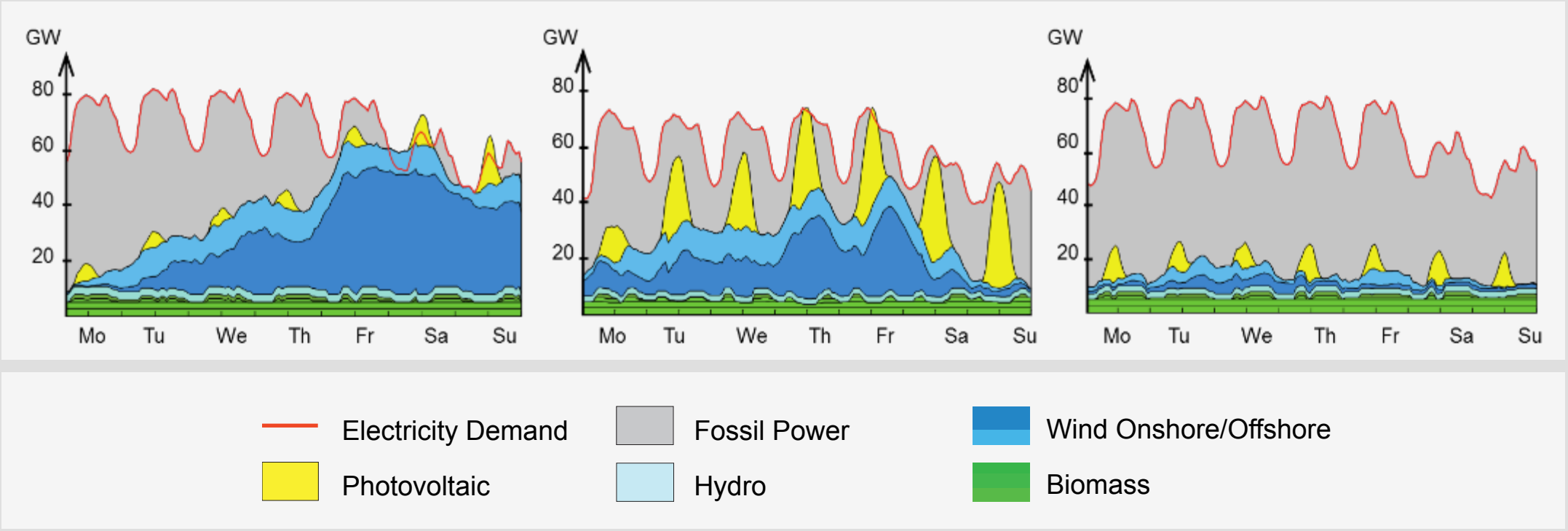
Gross electricity generation 1990 – 2035 of renewable energies



AG Energiebilanzen (2000 – 2014); BNetzA, own calculations (2015 – 2035)

Wind energy and solar PV fundamentally alter the power system and power markets

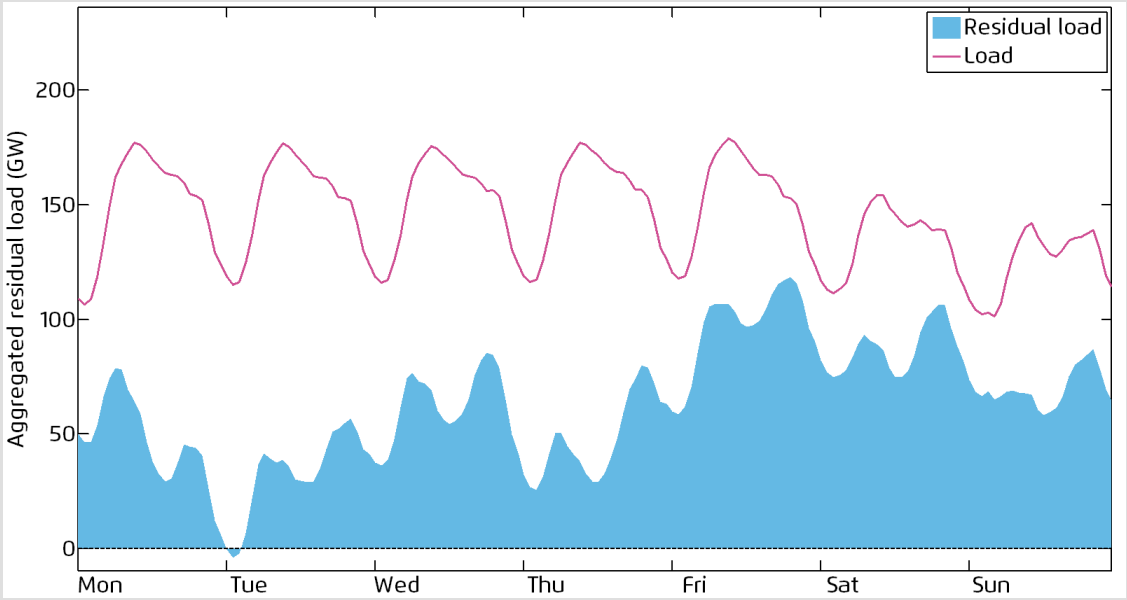
Electricity generation and demand in sample weeks of February, August and November 2023*



Agora Energiewende (2013)

The new power system is characterized by flexibility and no more baseload

(Residual) load in Central Western Europe (Week 32 - 2030)



Agora Energiewende / Fraunhofer IWES (2015)

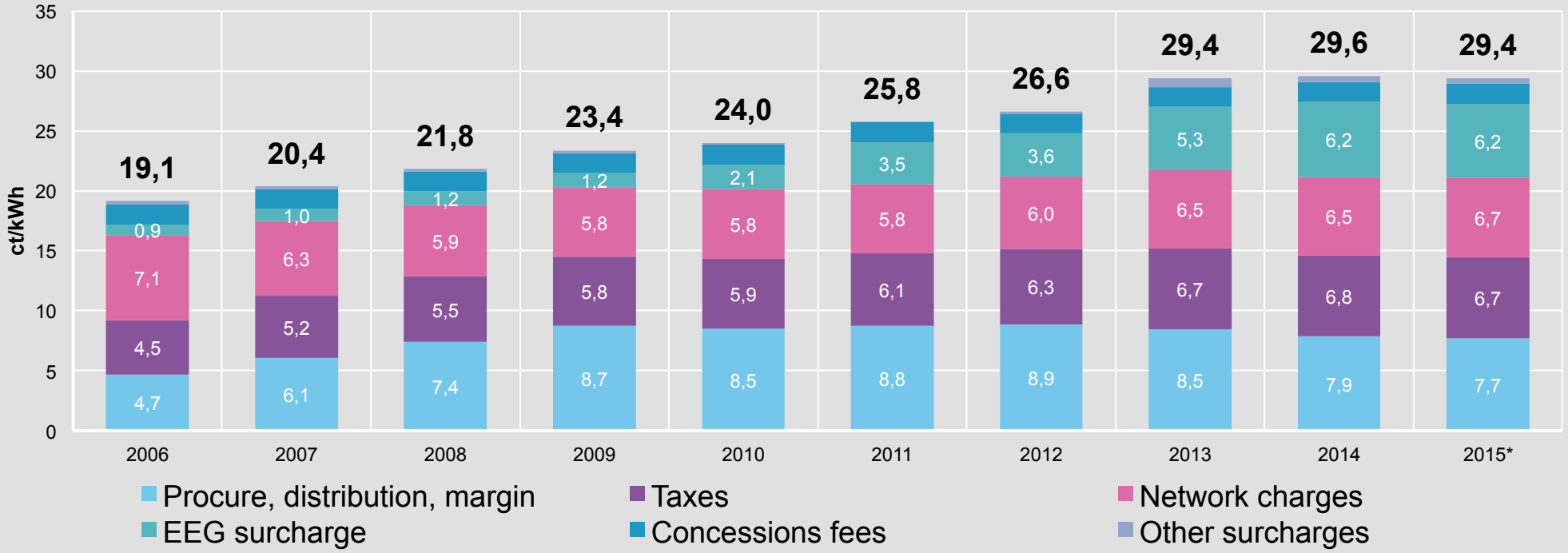
Important flexibility options

- Flexible fossil and biomass plants (incl. CHP with heat storage & Power-to-Heat)
- Grids (domestic & cross-border)
- Demand Side Management
- Partial curtailment of wind and solar power
- Storage (Hydro; Batteries, Power-to-Gas)

3. Focus on costs

The increase in households' electricity prices have been suspended

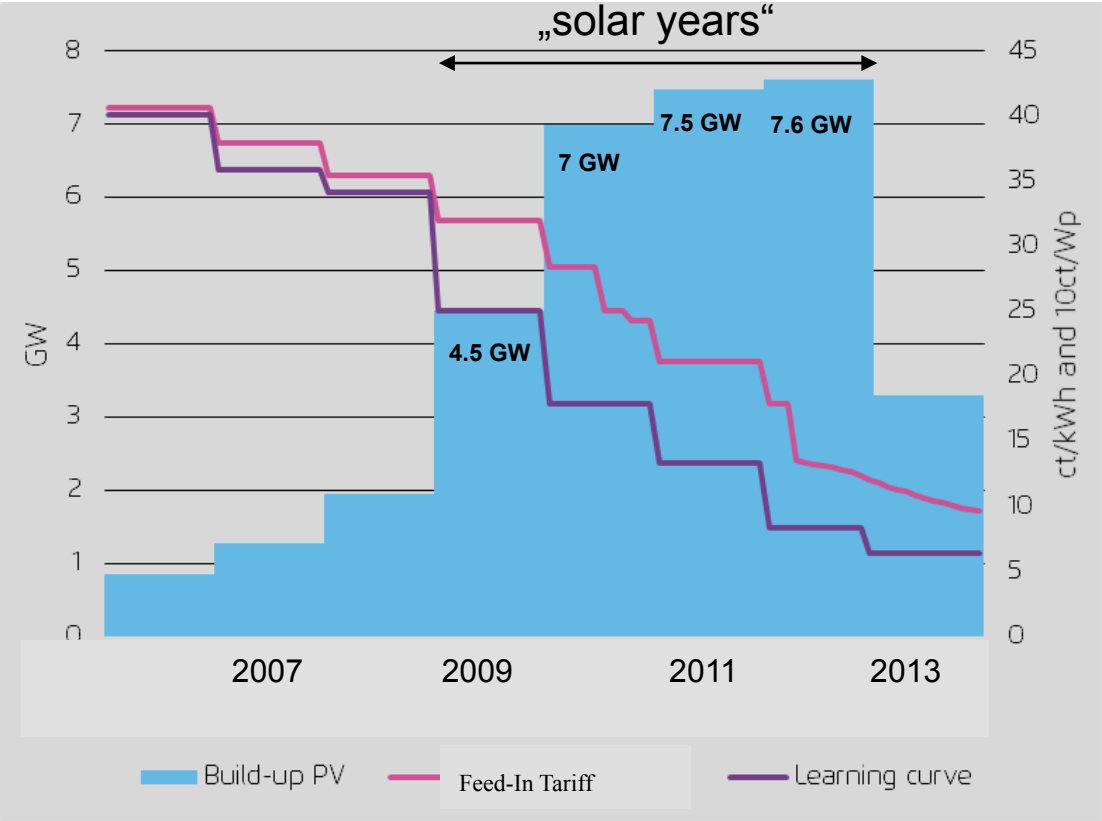
Composition of household electricity prices 2006-2015



BDEW 2014, BNetzA 2014, own calculations;

*own forecasts for 2015

The “solar years” 2009-2012 led to a substantial increase in electricity prices, while bringing pv costs down the learning curve



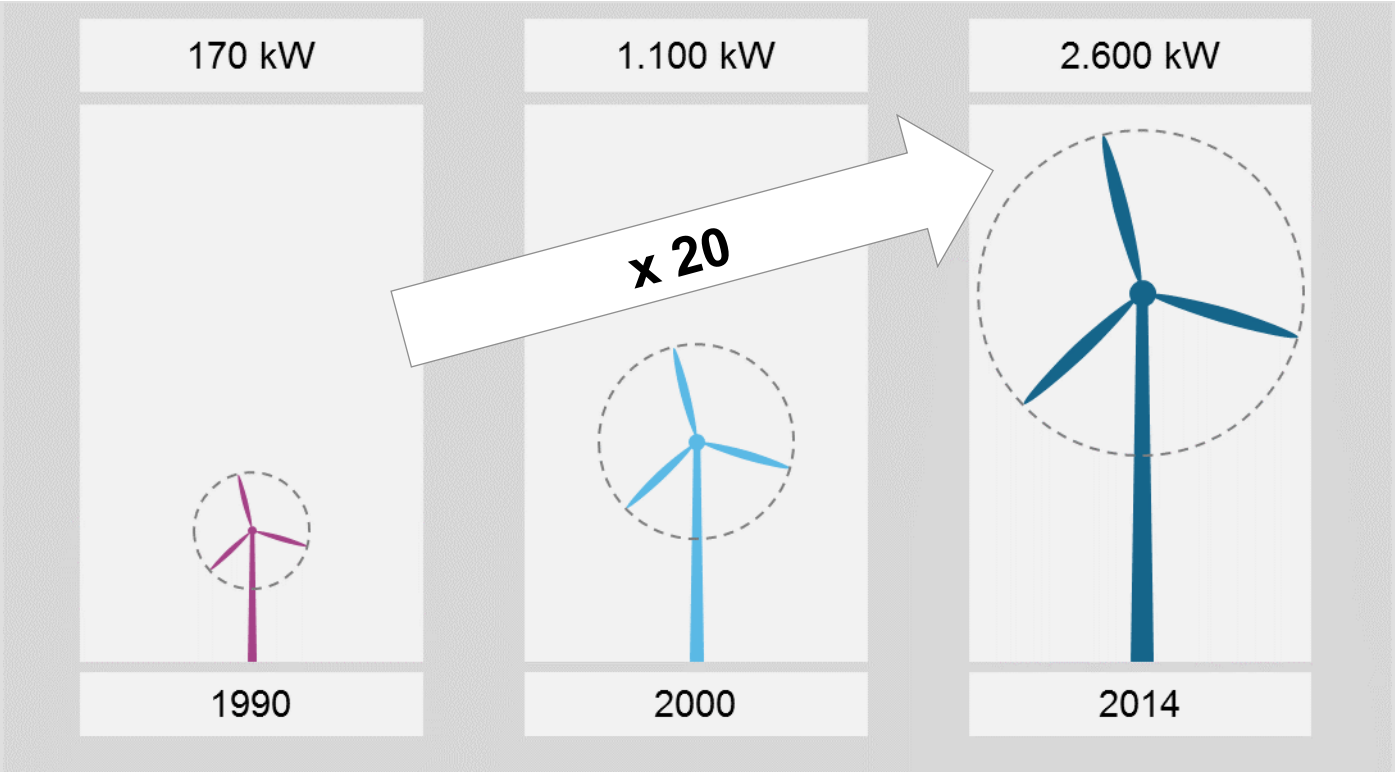
Source: SFV (2014), AGEE (2014), Fraunhofer ISE (2014)

- 25 GW photovoltaic built in 4 years (!) when feed-in tariff was very high
- „race“ between investors and policy makers. The markets moved faster
- 180 Mds € paid by German consumers 2000-2013 for pv. Under current FIT, this sum would reach only about 60 to 80 Mds € (*) overnight costs

(*) estimation to be refined

Wind Energy has become a mature technology, with windmills of 2-3 MW being standard

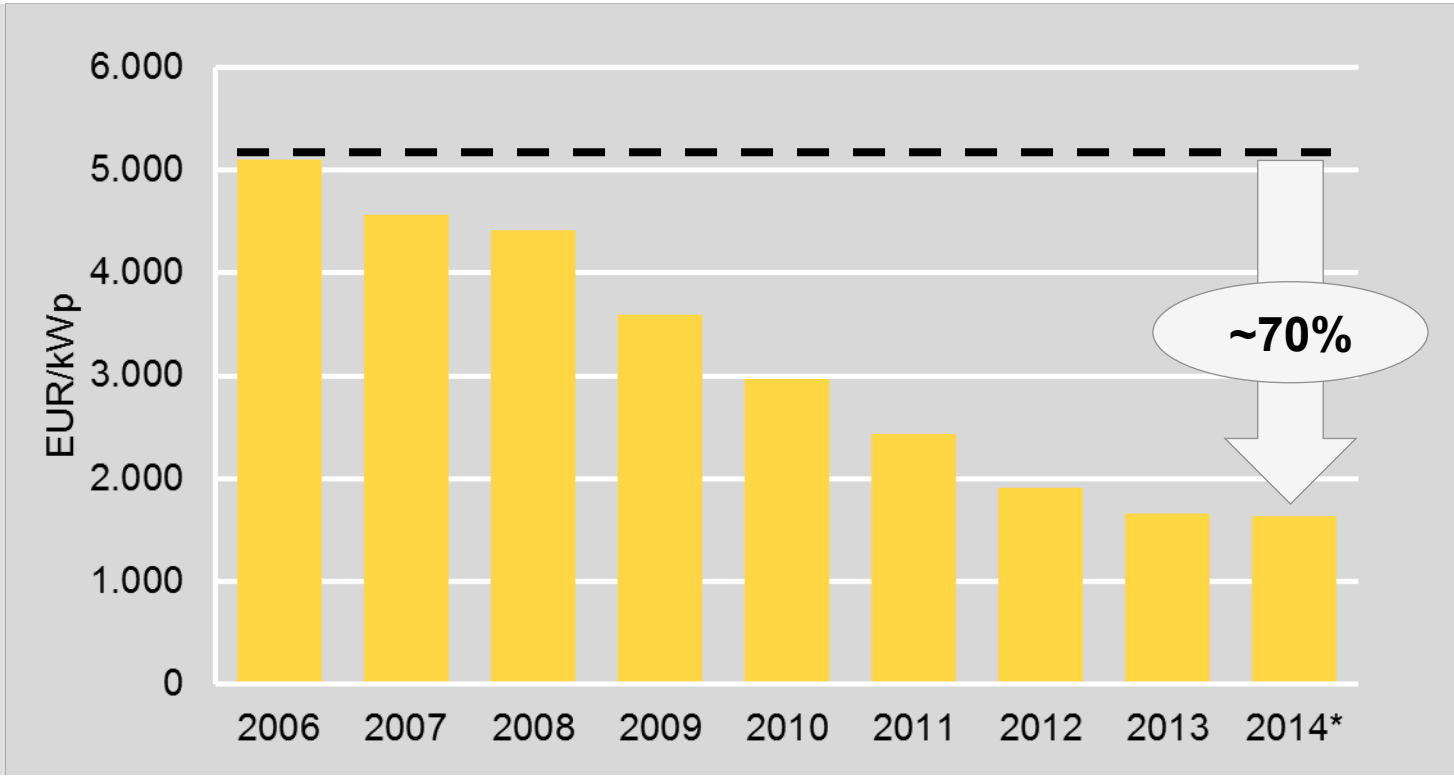
Size development of wind turbines (onshore)



Fraunhofer IWES

Cost breakthrough in solar PV reduced cost by ~70% since 2006

Average system price for new roof-mounted PV in EUR/kWp

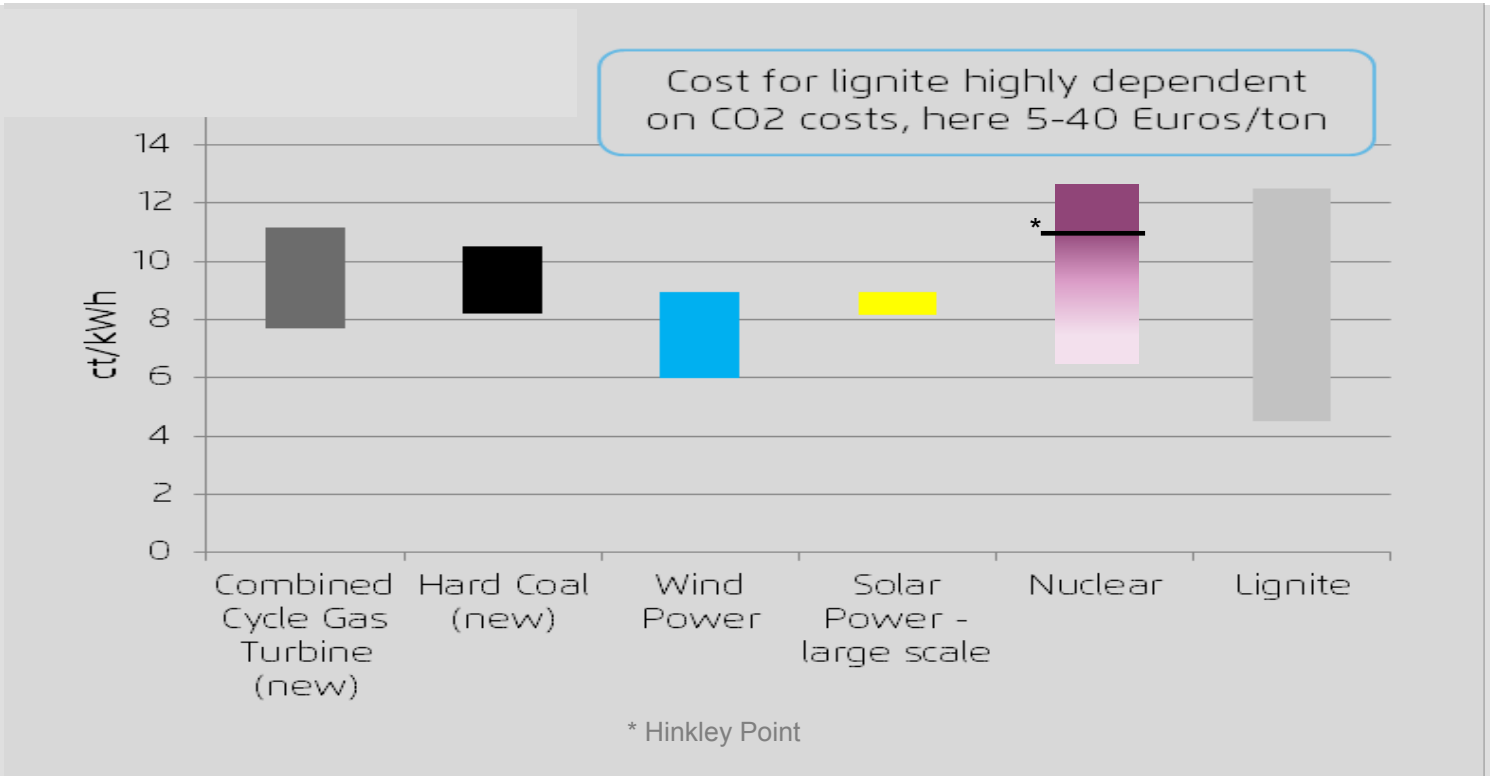


BSW Solar (2014), own calculations

* only Q1 2014

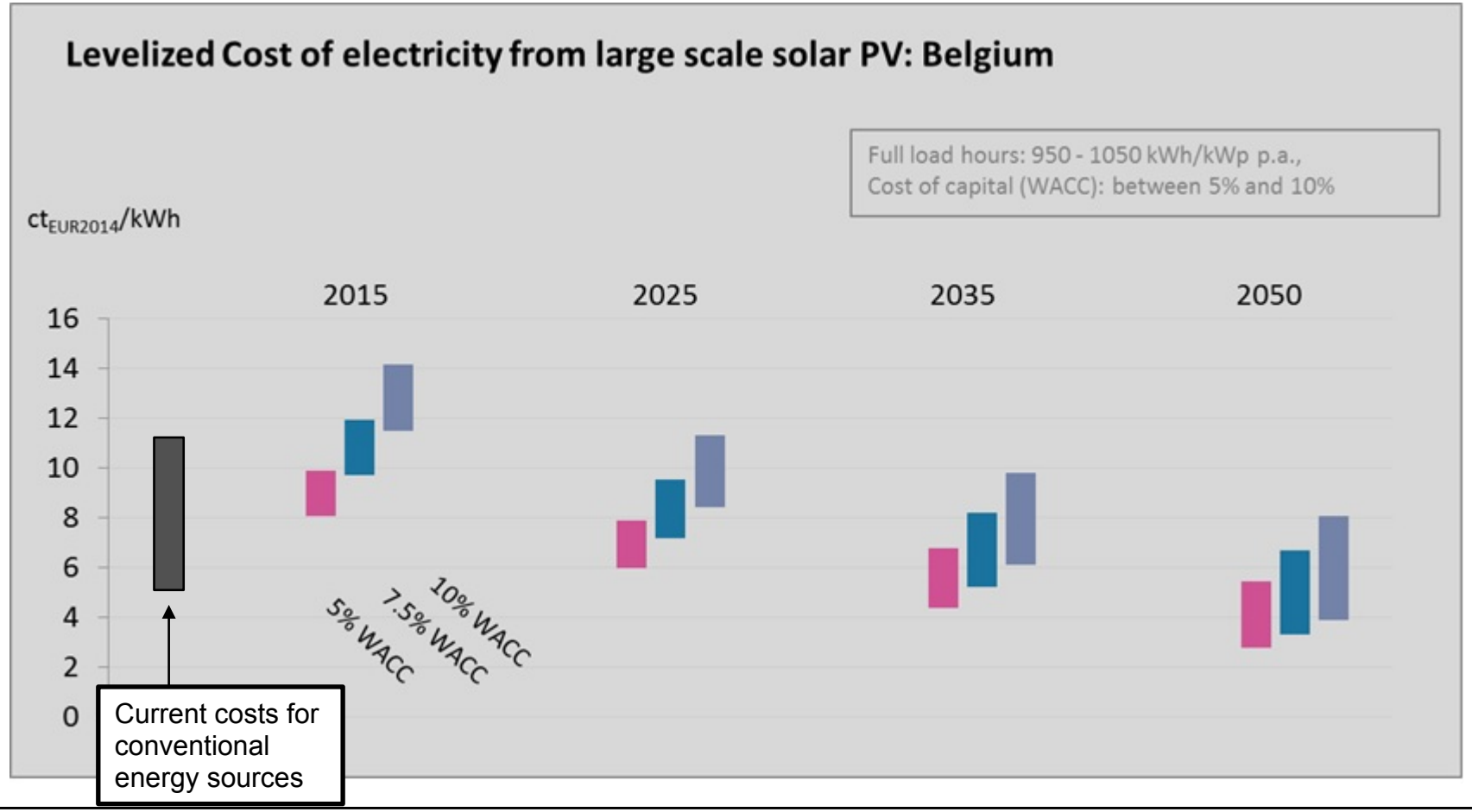
Today, wind and solar are cost competitive with newly built conventional energy sources

Range of levelized cost of electricity (LCOE) in 2015 in EUR/MWh

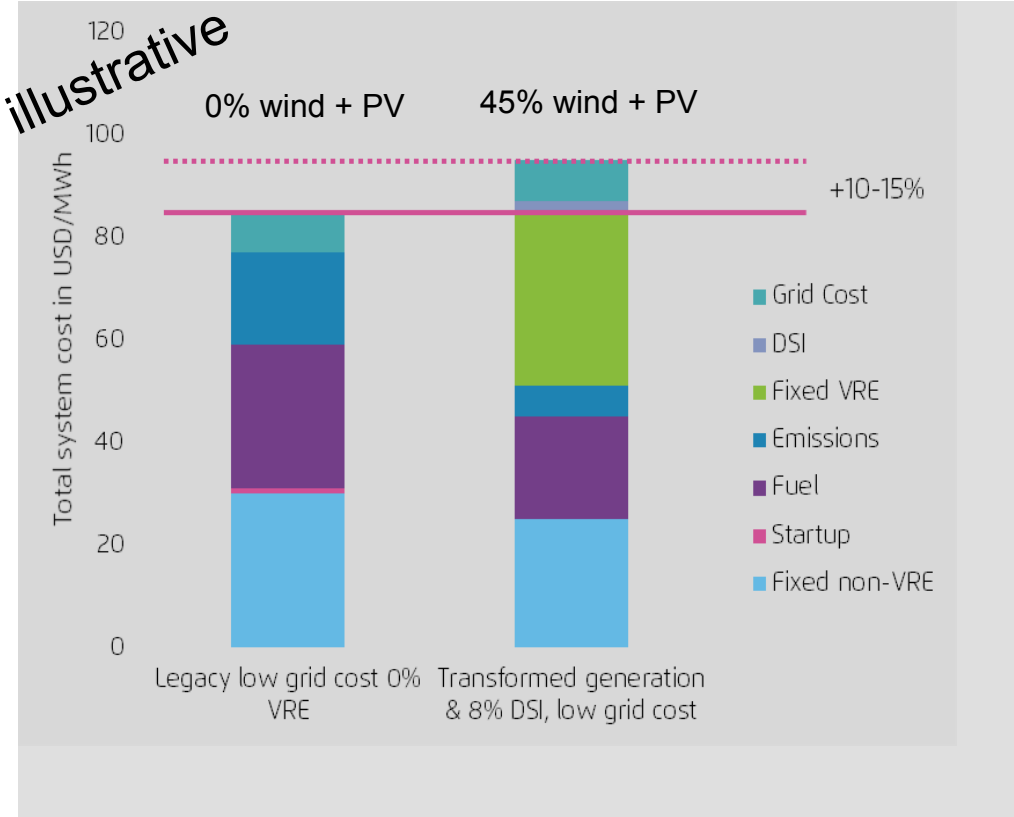


Agora Energiewende (2015)

Cost of large scale PV will continue to decrease up to 2050



Taking into account overall system costs, a wind and pv system could be only 10-15% more expensive than one based on fossil-fuels

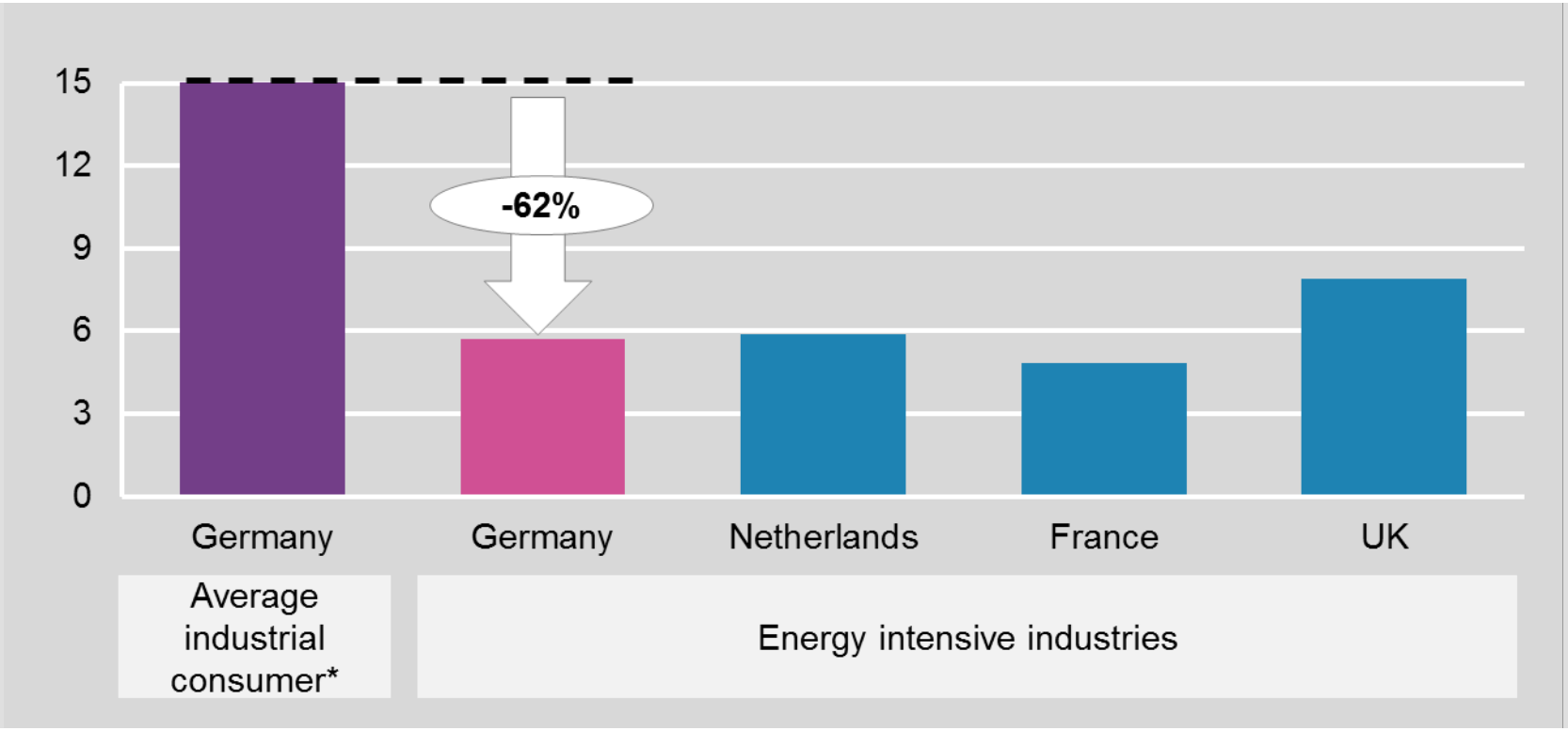


Source: own, based on IAE (2014)

- Future system costs depend on the flexibility of the entire system
- Integration is not simply about adding wind and pv on top of 'business as usual'. We need to transform the system as a whole to do this cost-effectively.
- In the long run, high shares of variable renewable energy (v-RES) may come at zero additional costs (IEA 2014)

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

Average electricity prices for energy intensive industrial consumers in 2013 in ct/kWh



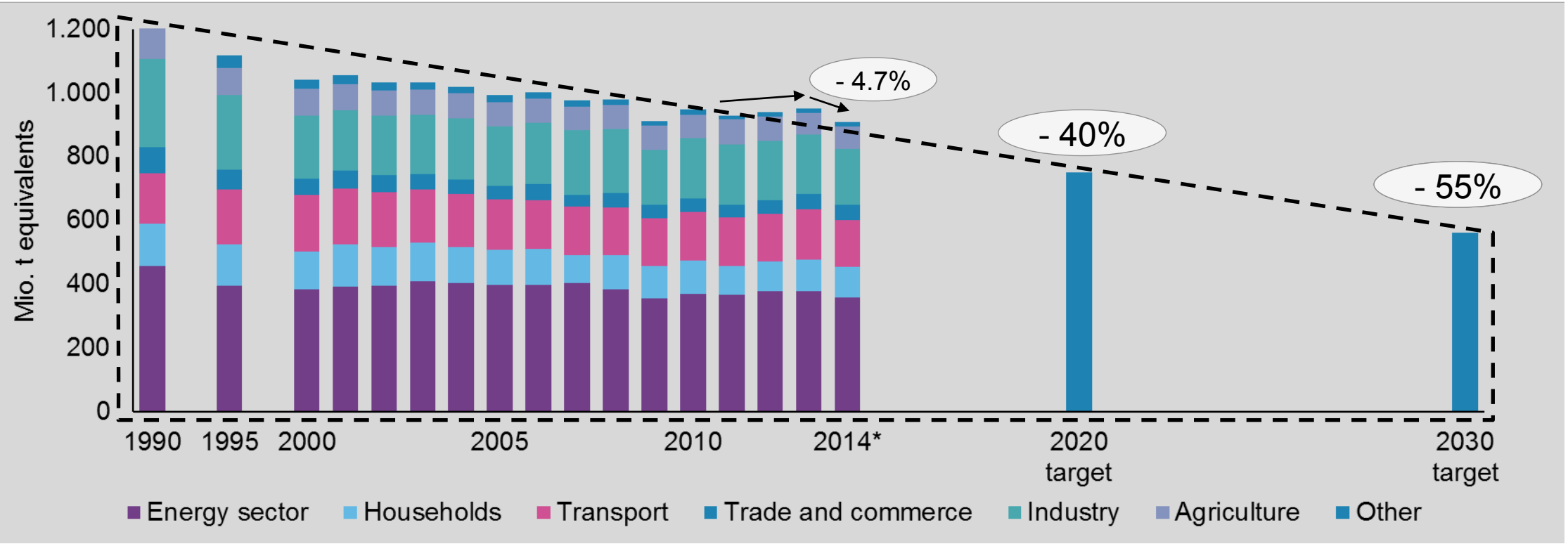
BMWi (2014)

*Assuming annual consumption of <20 MWh and partially exemptions from levies

4. Focus on decarbonization

Greenhouse gas emissions are currently at -26% compared to 1990 levels – with the power sector being the largest emitter

Greenhouse gas emissions by sector 1990 – 2014 and 2020/2030 targets

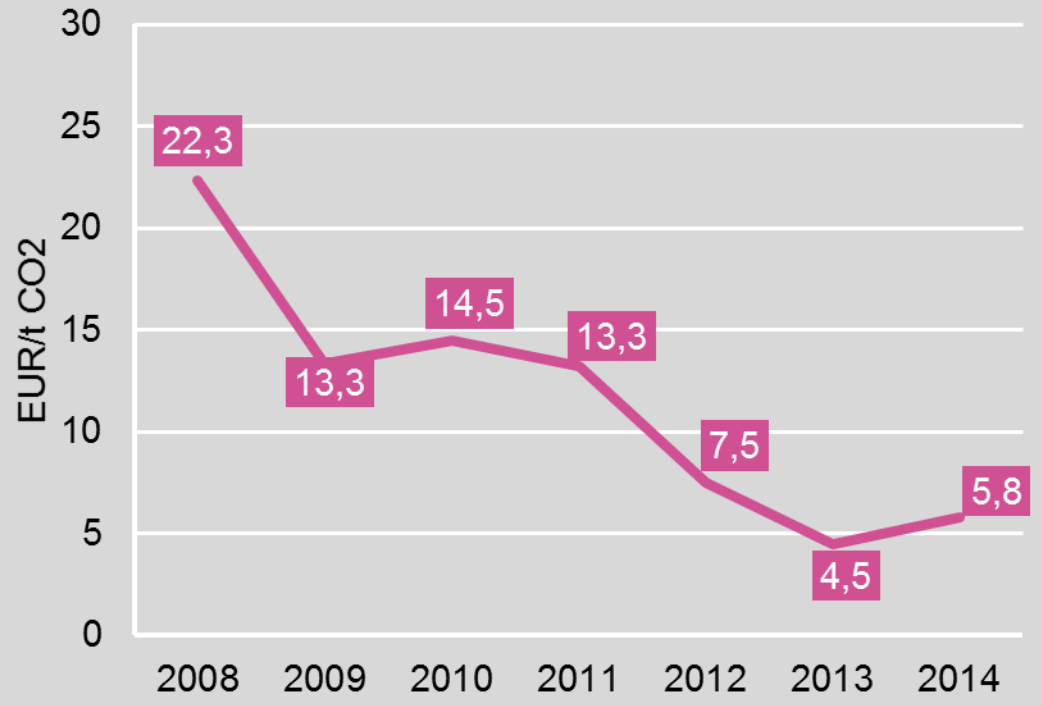


AG Energiebilanzen (2014), UBA (2014)

*own forecast

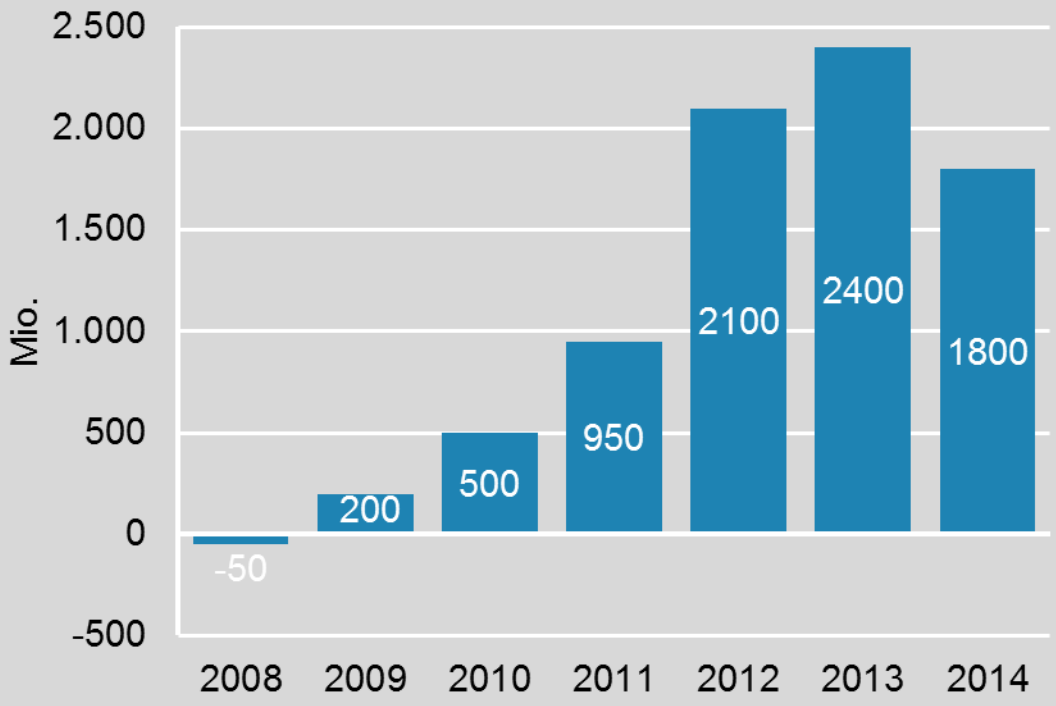
The key problem: The EU ETS faces huge overallocation, leading, unless fixed, to persistent low CO_2 prices

Price development of CO_2-certificates in EUR/t CO_2



ICE, BMWi (2014)

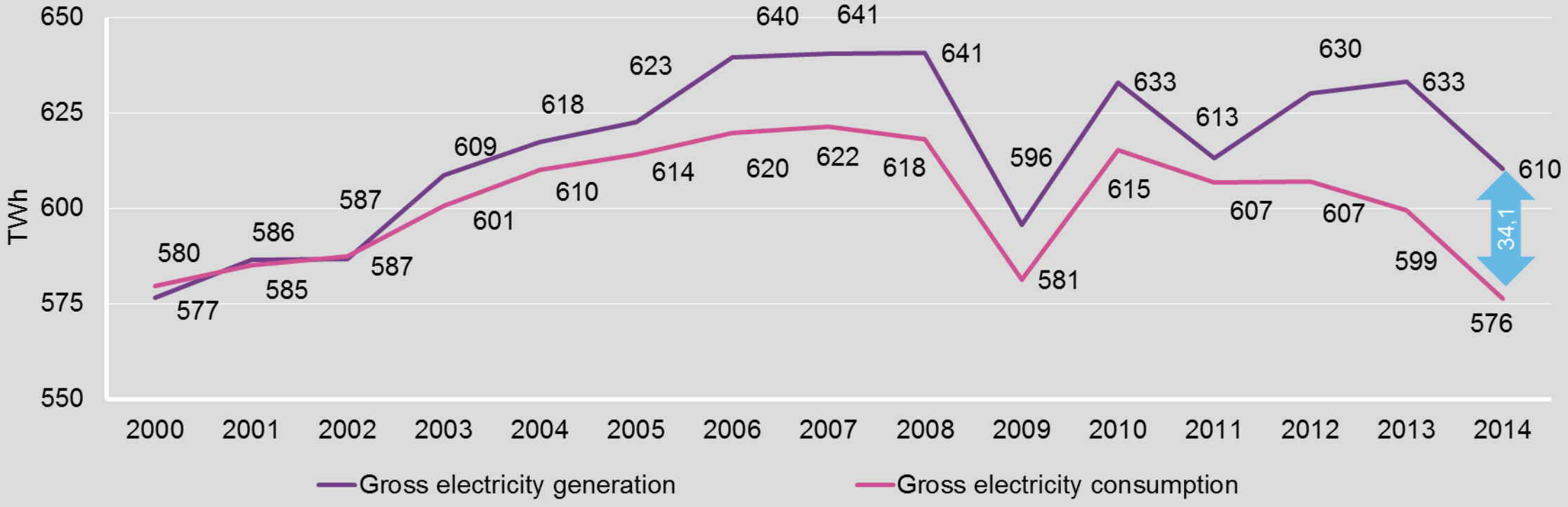
Cumulated overallocation of CO_2-certificates in Mio.



EC, DIW (2014)

Rising exports of coal-fuelled electricity threatens German climate targets

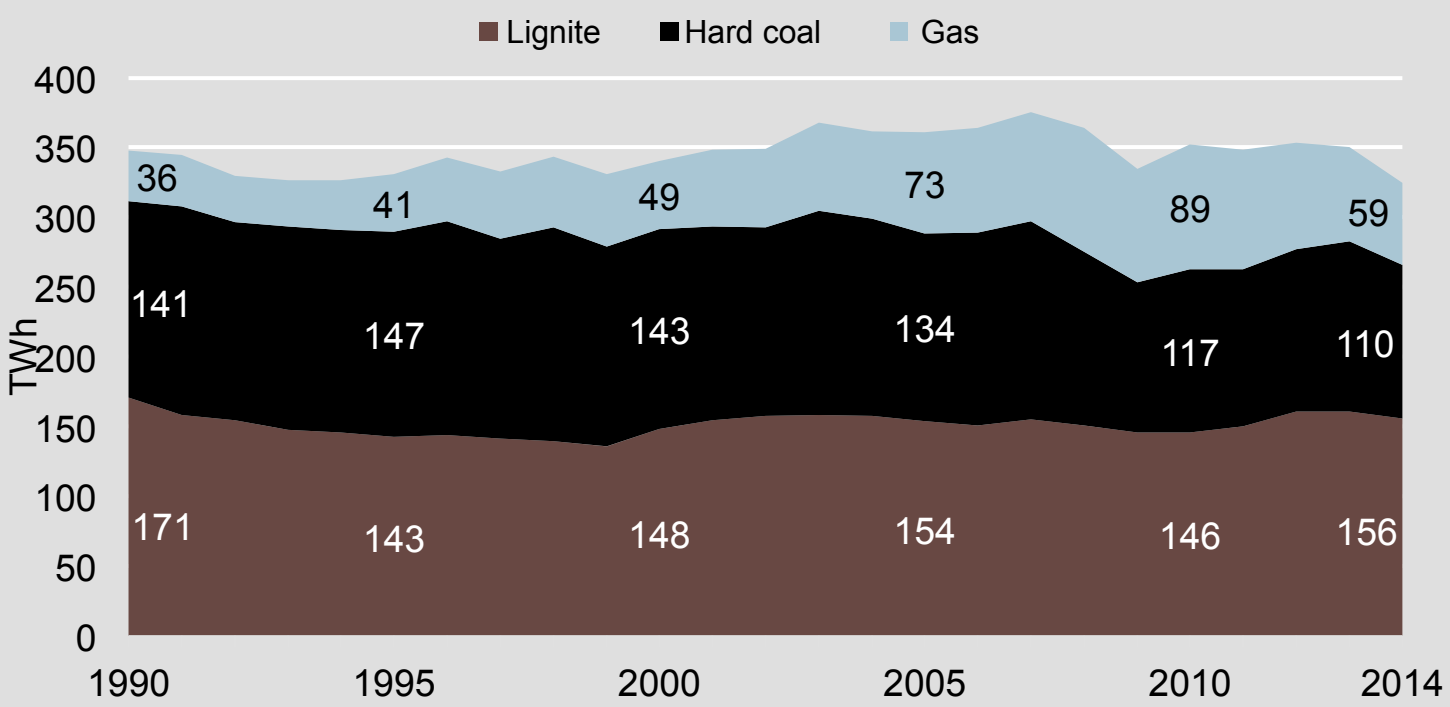
Gross electricity generation and consumption in TWh



AG Energiebilanzen (2014)

A more ambitious political intervention at national level is necessary for solving the mid-term coal issue in Germany

Gross Electricity Production from Lignite, Hard Coal and Gas Power Plants 1990-2014



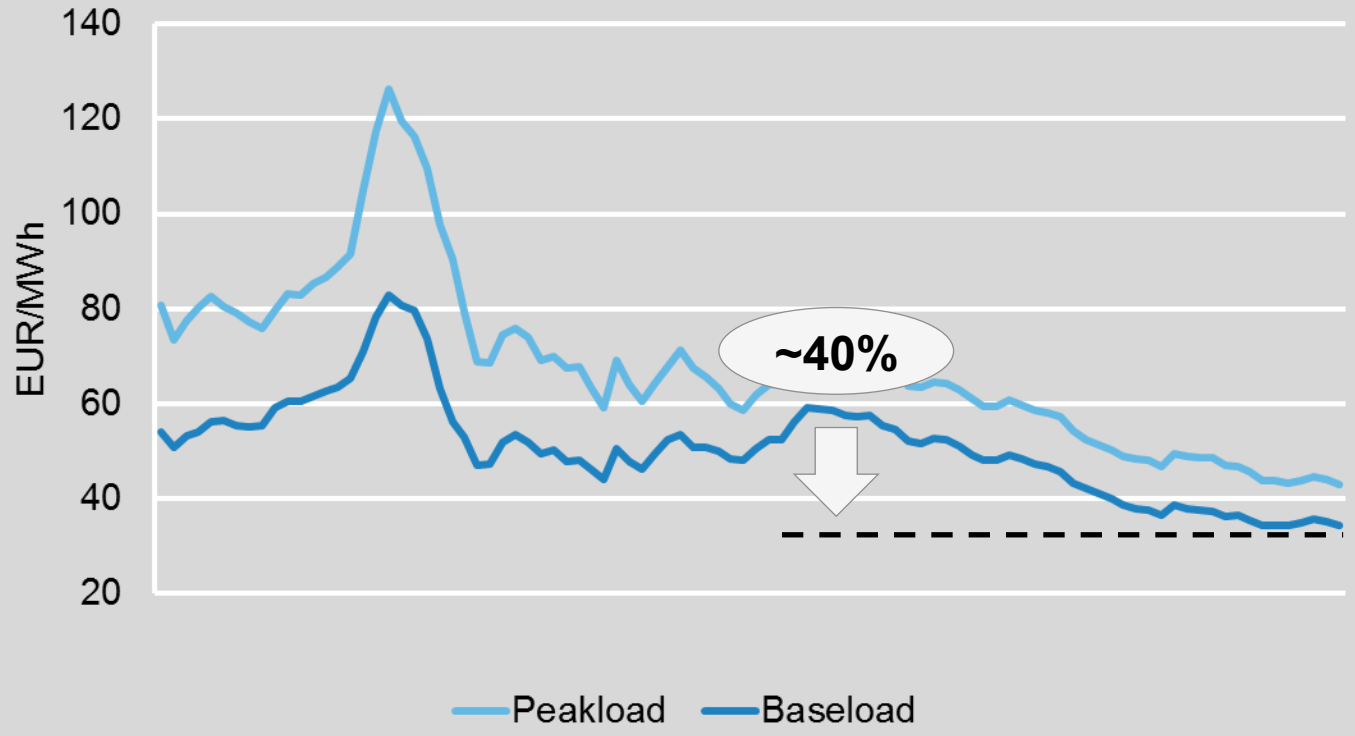
AG Energiebilanzen (2014)

- New fossil generation capacities, planned in 2007, went online in 2013/14.
- Current economic conditions are favorable for existing coal power plants but are unfavorable for any new investment decisions.
- A more ambitious political intervention must be undertaken to solve the coal problematic. Without such measures, Germany will miss its 2020 climate target (22 MtC02 too much would be emitted)
- A structural change is nessecary on the basis of a « coal consens »

5. Energy security and new market design

A refined market design is needed to enhance flexibility, finance renewables and fossil-fuel backup power plants

Wholesale electricity prices in EUR/MWh (1-year future)



EEX (2014)

Power market is currently characterized by overcapacities

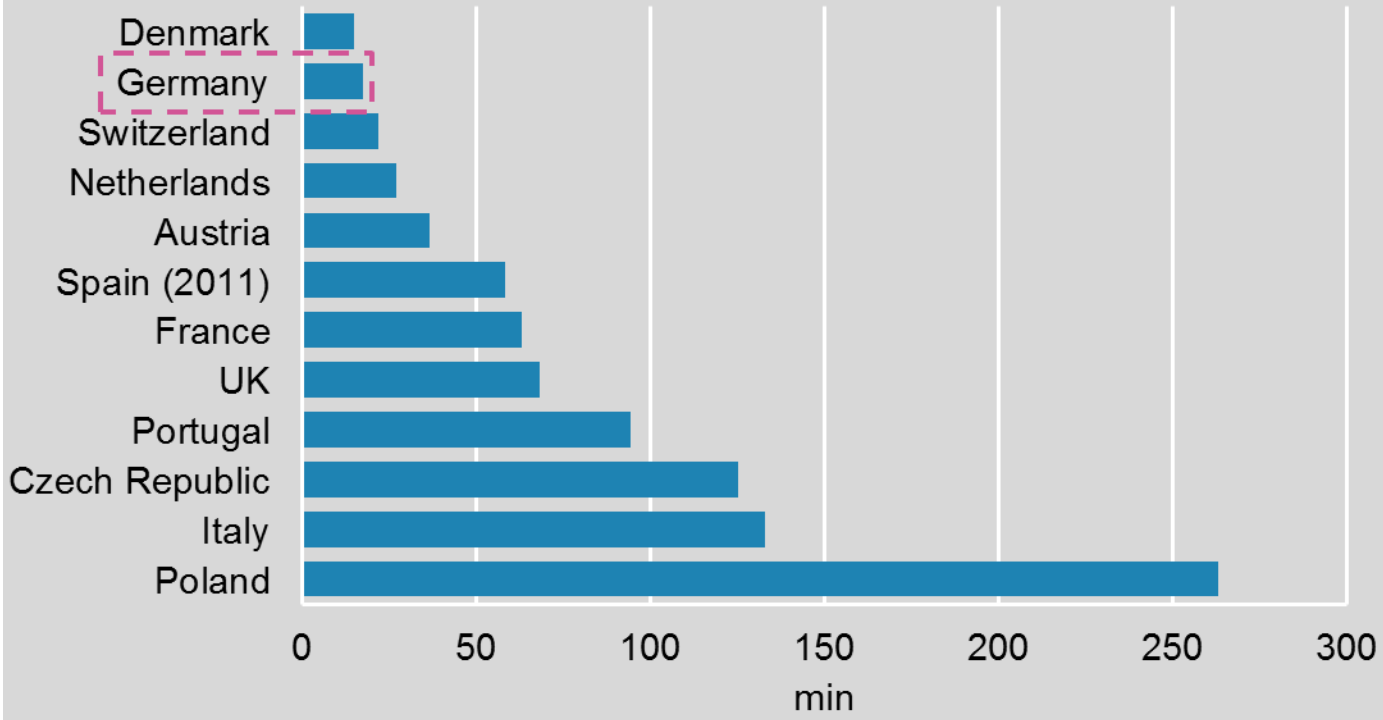
Long term objectives : integrating RES in the power market and guaranteeing security of supply

How to secure long-term investments ?

Political debate (Green book) : Energy only market (EOM) 2.0 vs capacity market

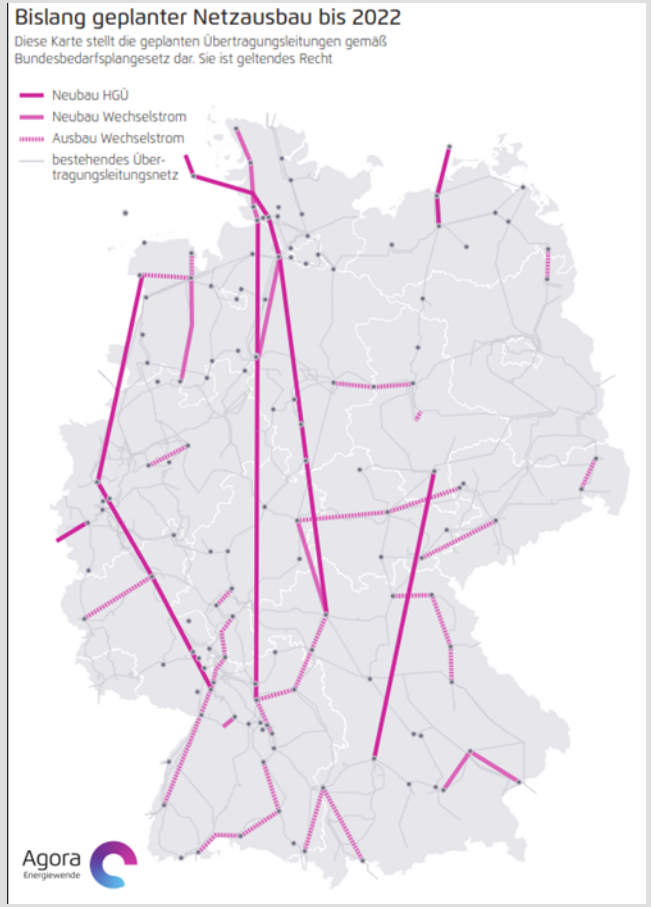
The current power system is reliable but Germany is facing slow developments on its North-South Grid

System Average Interruption Duration Index (SAIDI)* in 2012



CEER (2013)

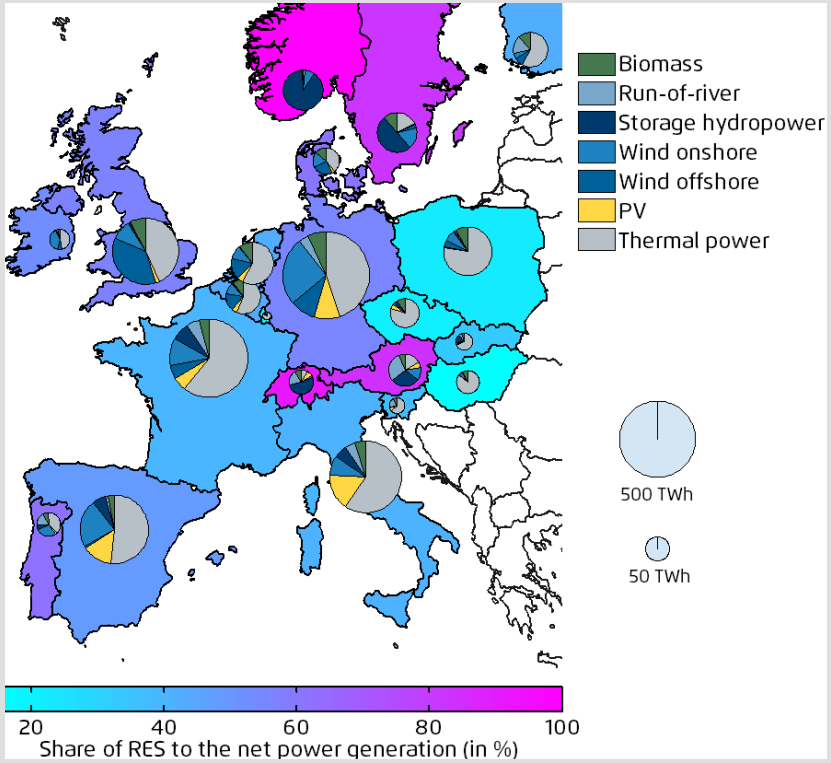
* including exceptional events



5. Is Germany a special case?

Wind power and solar PV become key pillars of the European power system

RES-E share in the “EU” generation mix 2030



Fraunhofer IWES (2015) on behalf of Agora Energiewende; Assumptions are based on national energy strategies and ENTSO-E scenarios in line with EU 2030 targets

EU 2030

- 50% RES-E in the generation mix
- 30% Wind and PV in the generation mix

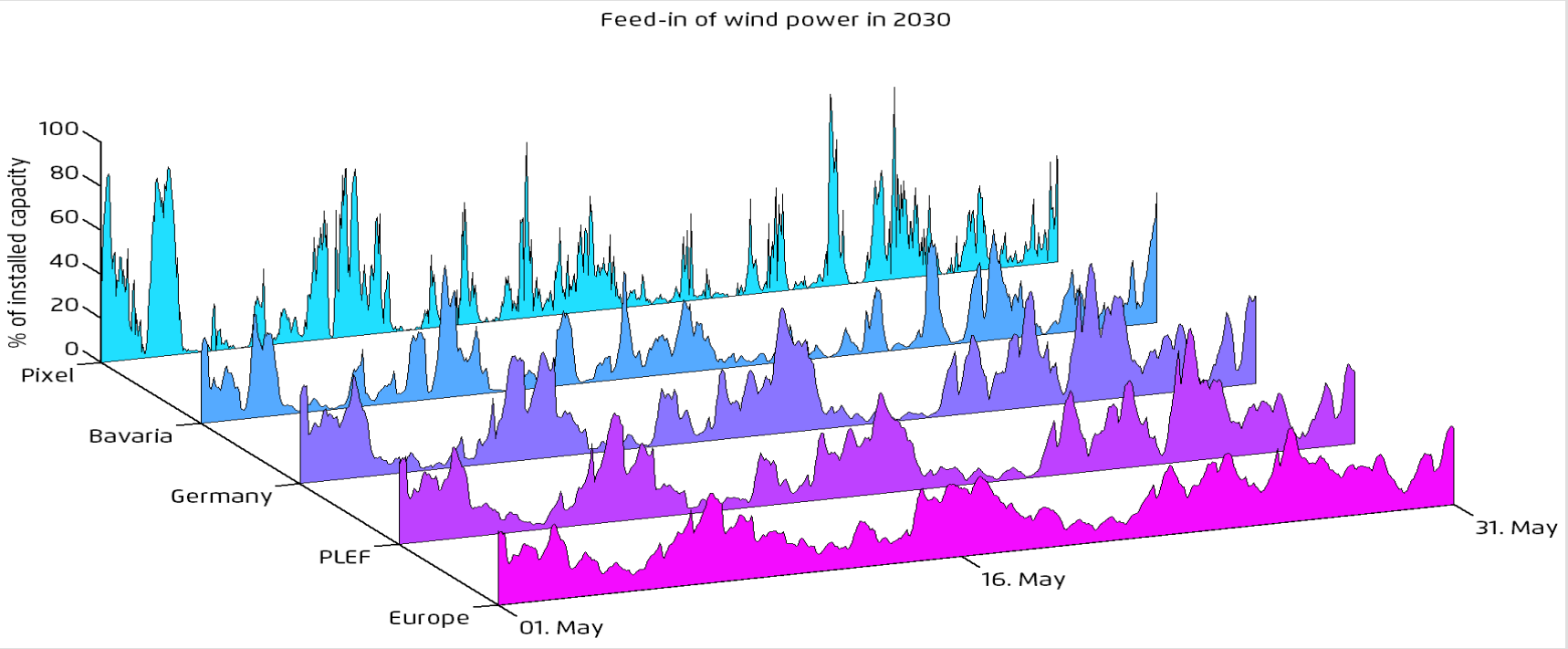
Region Pentalateral Energy Forum* 2030

- 54% RES-E in the generation mix
- 34% Wind and PV in the generation mix

* AT, BE, CH, DE, FR, LU, NL

Regional European power system integration mitigates flexibility needs, through smoothing effects

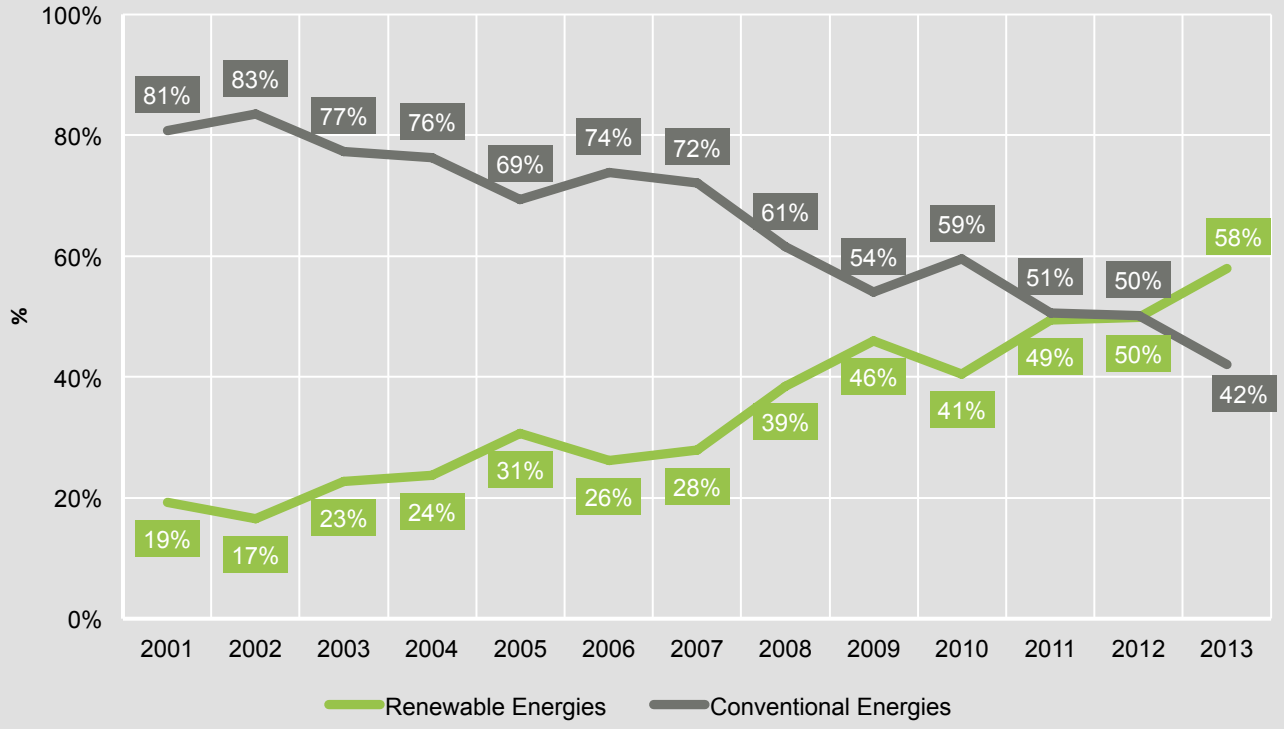
Wind feed-in in 2030 at different aggretated levels



Agora Energiewende / Fraunhofer IWES (2015)

Global investments in renewables have overtaken fossil investments

Share in global capacity investments 2001 - 2013



IRENA (2014)

5. Conclusions

Conclusion - Key insights (I)

- The German energy transition is a complex, long-term, industrial and societal transformation process, with clear mid-term and long-term objectives.
- Photovoltaic and wind are the backbones of this transformation. This implies a paradigm shift towards system flexibility.
- Inclusion of heating and transportation sectors will enhance the flexibility of the overall energy transformation.
- Challenges of the transformation are numerous, but some of them, like the “cost of RES-generation” are about to be solved.
- A reform of the energy market is necessary to trigger efficient dispatch and investment decision in flexible and low-carbon assets.

Conclusion - Key insights (II)

- Reaching mid- and long-term decarbonization objectives may only be met through a new consensus on the question of coal.
- The German energy transition is not an exception within the EU, but the tempo and magnitude of the transformation is unique.
- The pace of the German transition can lead to spill-over effects in neighboring countries. These effects are nevertheless being solved bilaterally (e.g. phase-shifter DE-PL)
- Stronger EU and regional cooperation, especially on RES support scheme and SoS, would bring overall benefits.
- The Energy transition benefits from a strong support within the German society. But given the nature of the transformation, there will necessarily be “winners and losers”.

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Thank you for your attention!

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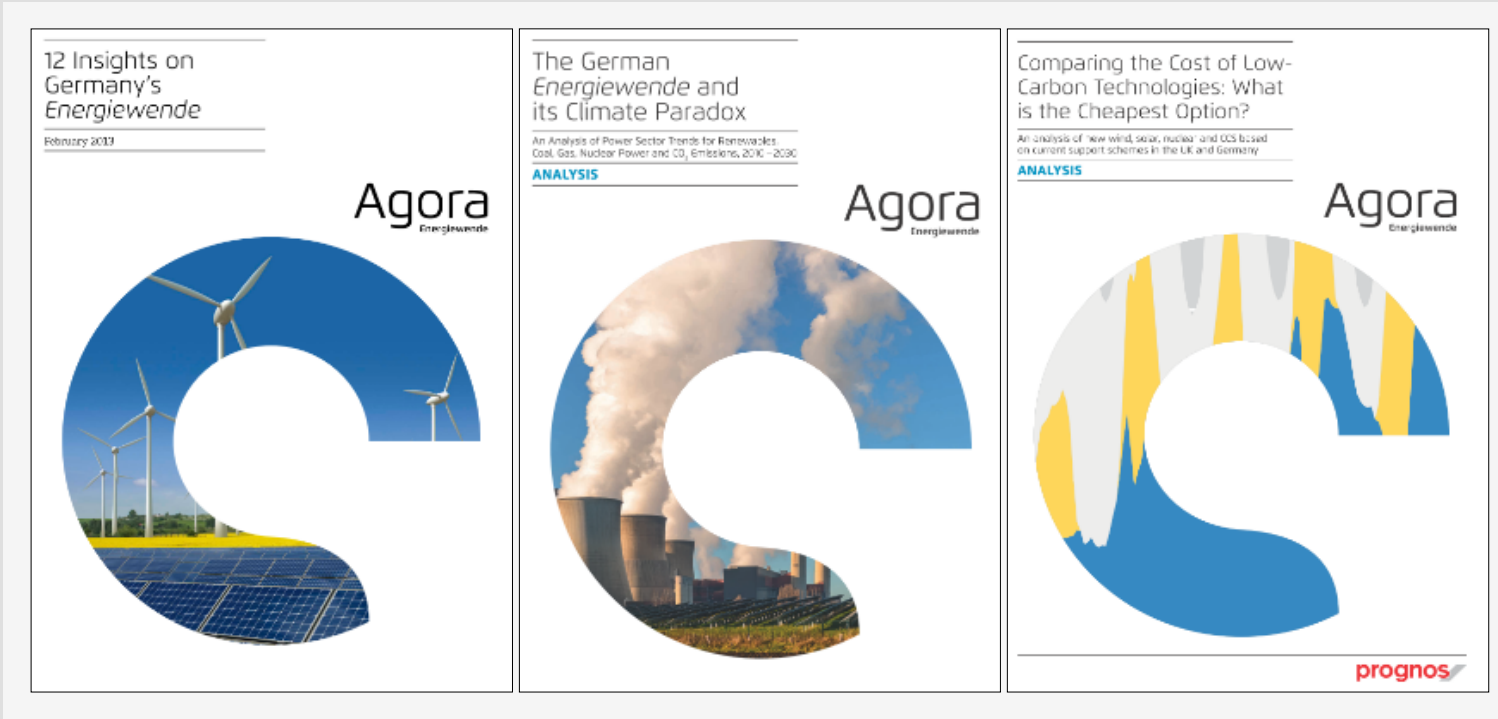
Agora Energiewende is a joint initiative
of the Mercator Foundation and
the European Climate Foundation.

More information and studies available at our website

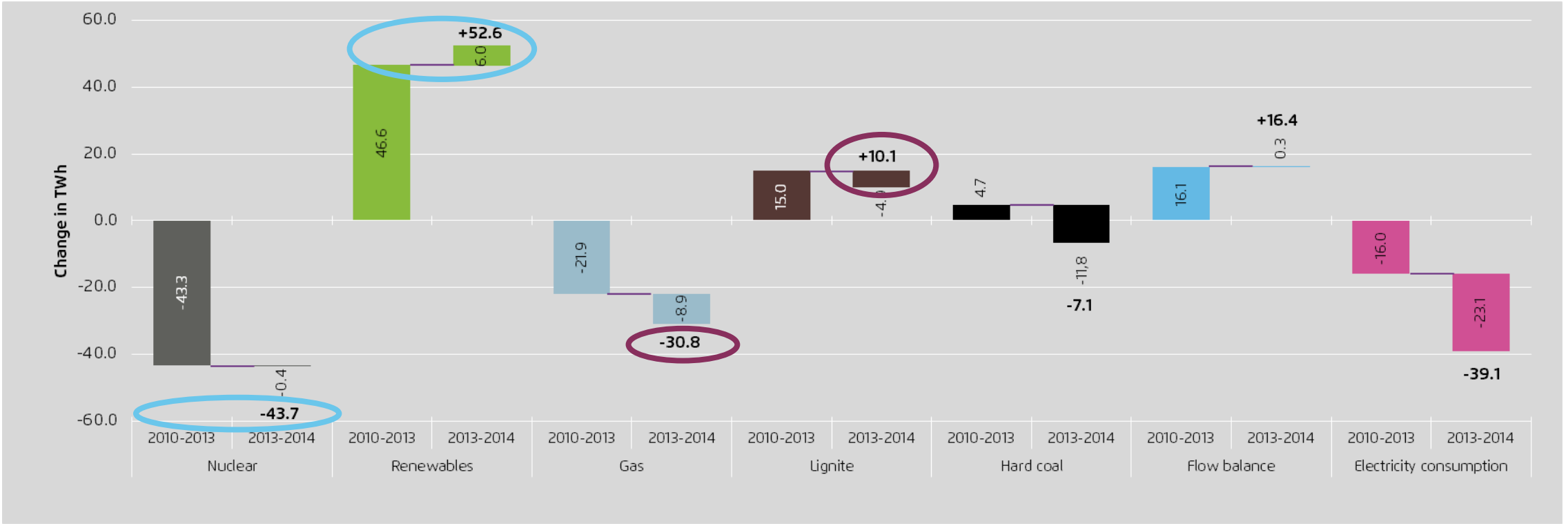
www.agora-energiewende.org



Back-up

2010-2014: Renewables offset nuclear decrease, switch from gas to coal (weak EU Emissions Trading Scheme!), consumption reduction and net export increase

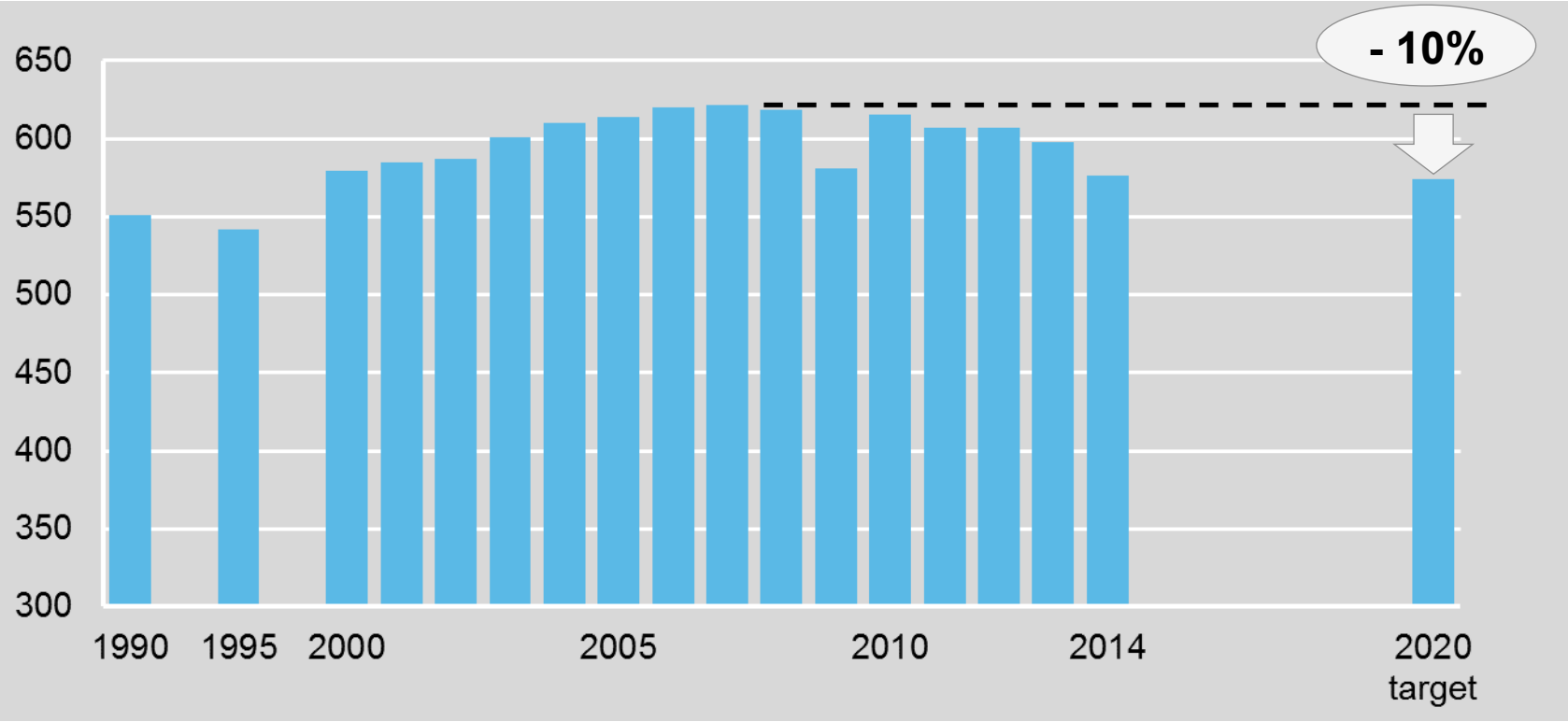
Production and consumption changes in TWh



AG Energiebilanzen 2014, own calculations

Implementing a coherent efficiency strategy to consolidate declining trend in power demand

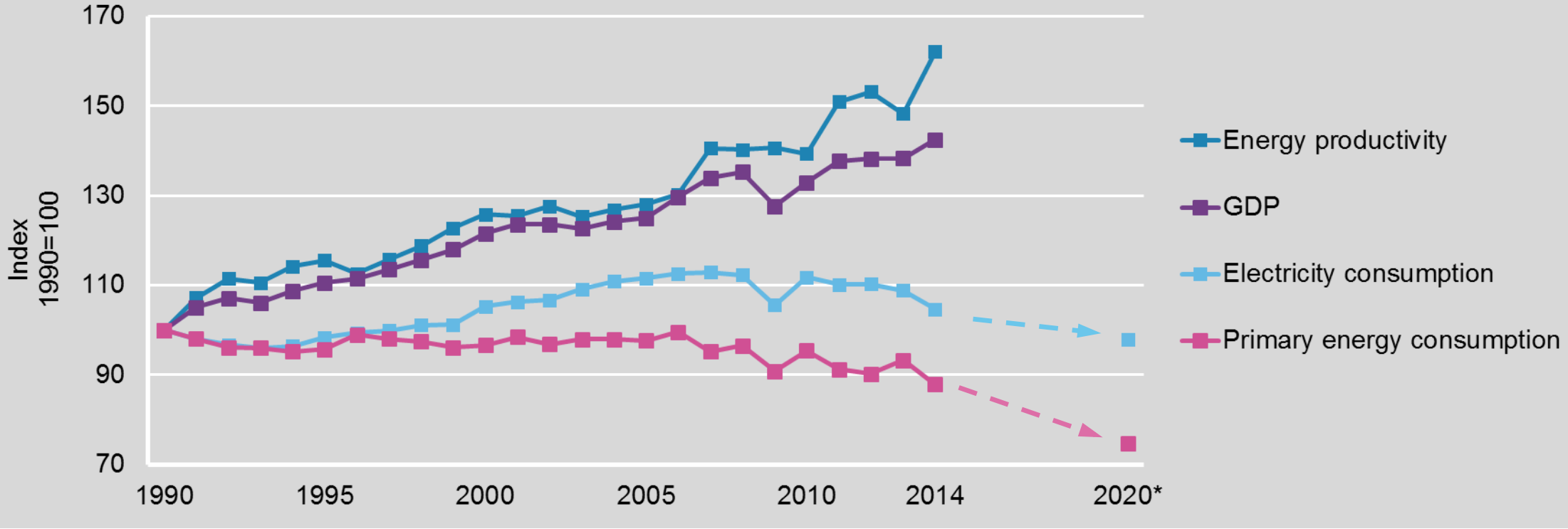
Gross electricity consumption in TWh



AG Energiebilanzen (2014)

Germany decoupled economic growth from energy consumption – but there is still work to do to reach the 2020 efficiency targets

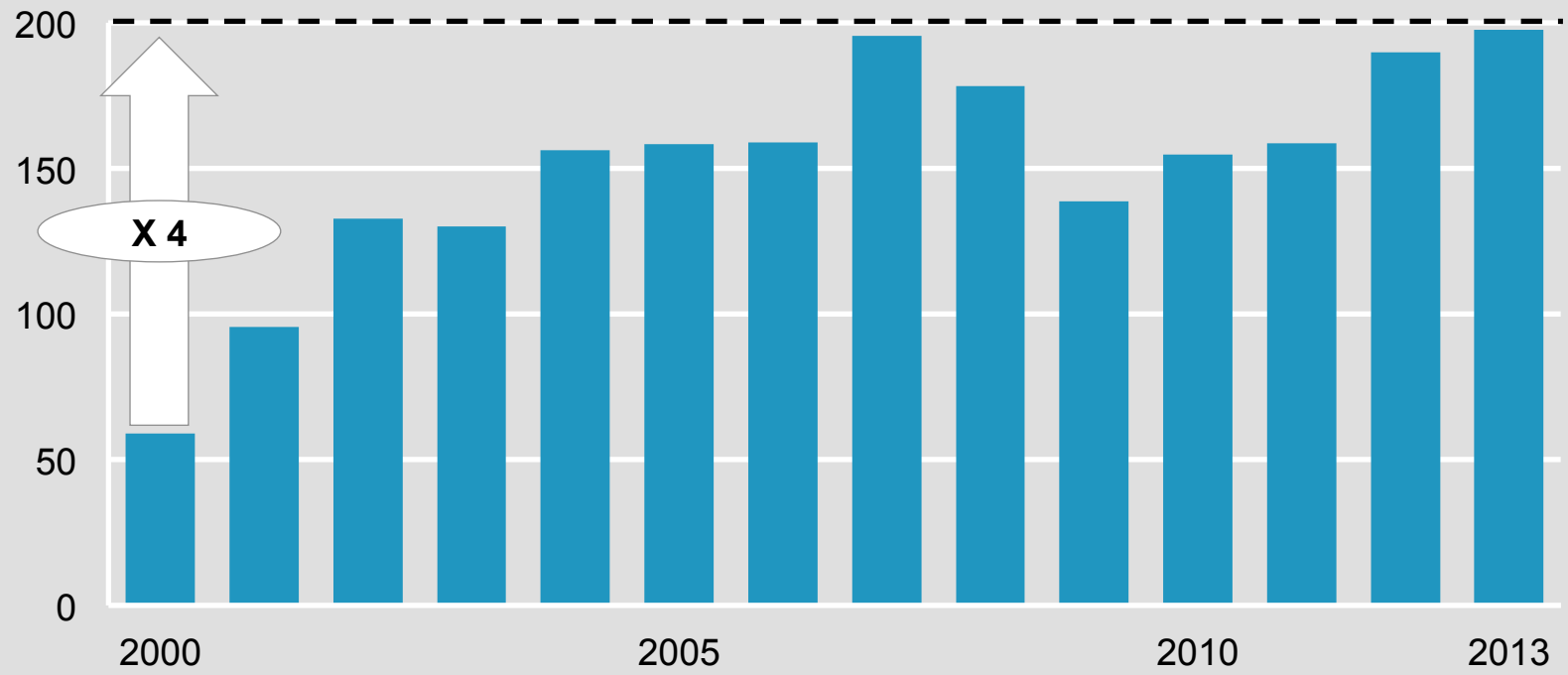
Energy productivity and consumption and economic growth 1990 – 2014 (Index, 1990=100)



AG Energiebilanzen (2014), BMWi (2014)

The *Energiewende* does not seem to harm Germany's economic competitiveness

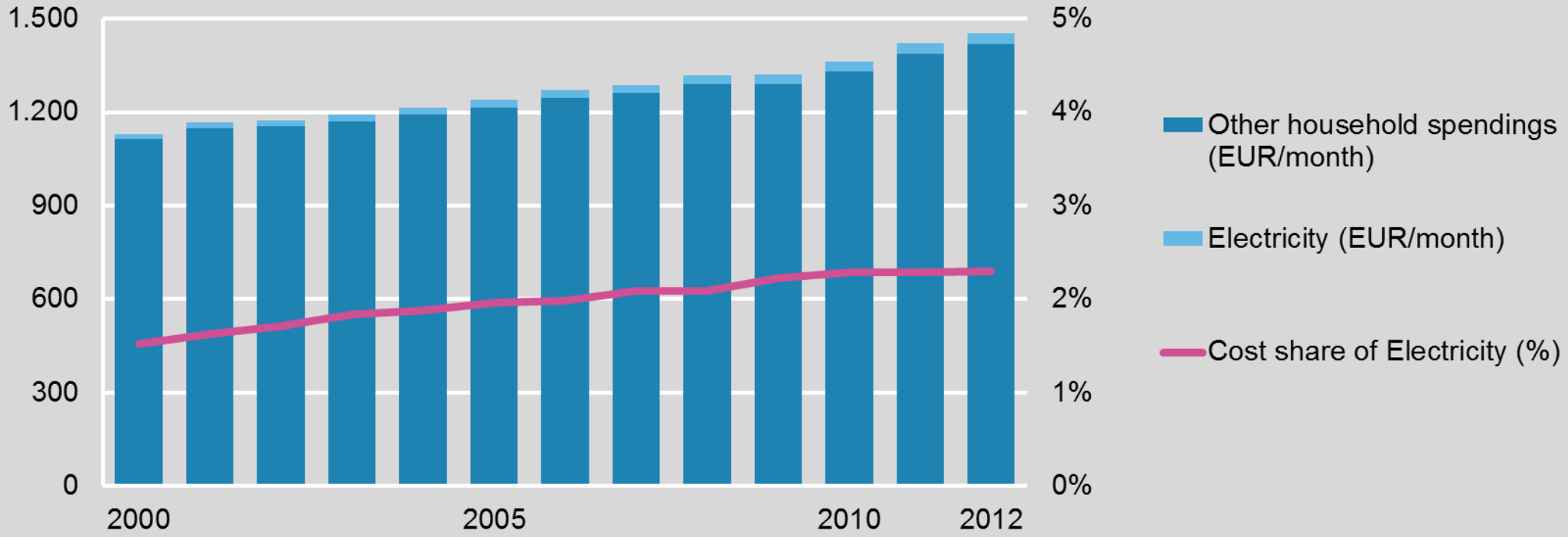
Export surplus in Bln. EUR



Destatis

…with average household expenditures on electricity having varied between 1.6% and 2.4% in the past 20 years.

Share of electricity in average household spending



Destatis (2014)

Because of lower consumption, annual power bills of households in Germany are still in the same region as in other OECD countries.

Average household electricity bills in EUR/year

	Consumption (kWh)	Price (Ct/kWh)	Bill (EUR)
Denmark	4,000	30	1,200
US	11,800	9	1,060
Germany	3,500	30	1,050
Japan	5,600	18	1,010
Spain	4,400	23	1,010
Canada	10,800	8	850
UK	4,200	19	800
France	5,000	16	800
Italy	2,700	25	680

World Energy Council, EIA, Eurostat, Energy Intenlligence, New Energy, own calculations