Pros and Cons for possible future electricity market design solutions

Targets – challenges – options

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WORKSHOP „DESIGN OF SMART ELECTRICITY MARKETS“, ESSEN, 27 SEPTEMBER 2016

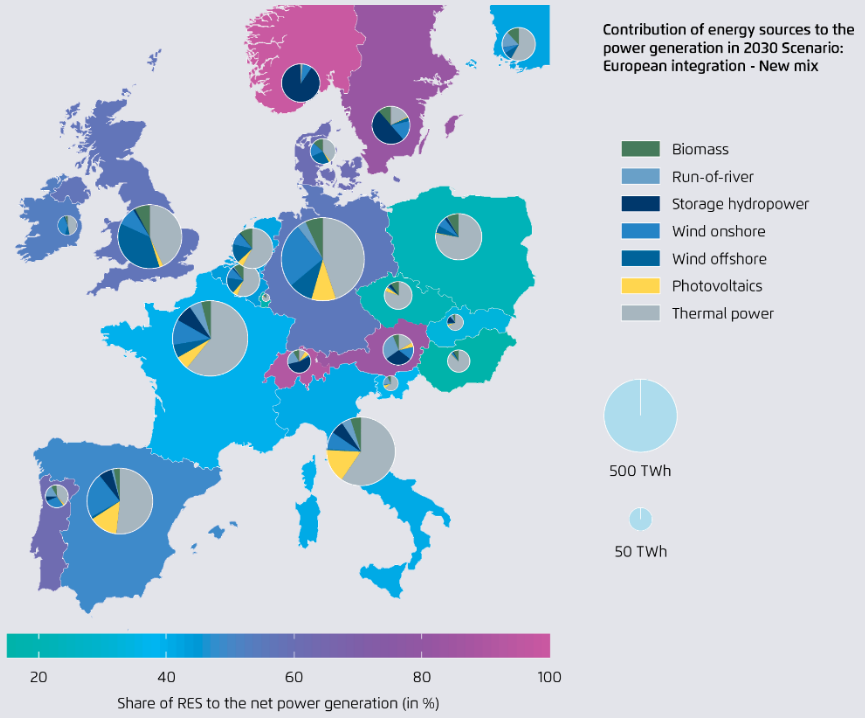
Structure

1.	The targets
2.	State of the art and underlying trends
3.	The challenges
4.	Which market design to solve this?

The targets

Europe’s 2030 climate and energy targets imply a share of some 50% RES in its power mix

RES-E share in the EU generation mix 2030



Fraunhofer IWES (2015): Assumptions based on national energy strategies and ENTSO-E scenarios in line with EU 2030 targets

RES-E are key for EU‘s 2030 strategy:

→ EU‘s 2030 climate target of -40% THG below 1990 puts power sector in centre: Emissions are to be reduced by 65% by 2030 compared to 1990*

→ EU‘s RES target of 27% by 2030 will largely be delivered by power sector, as biofuels and RES heating sources are limited

Thus, EU 2030 climate and energy targets imply

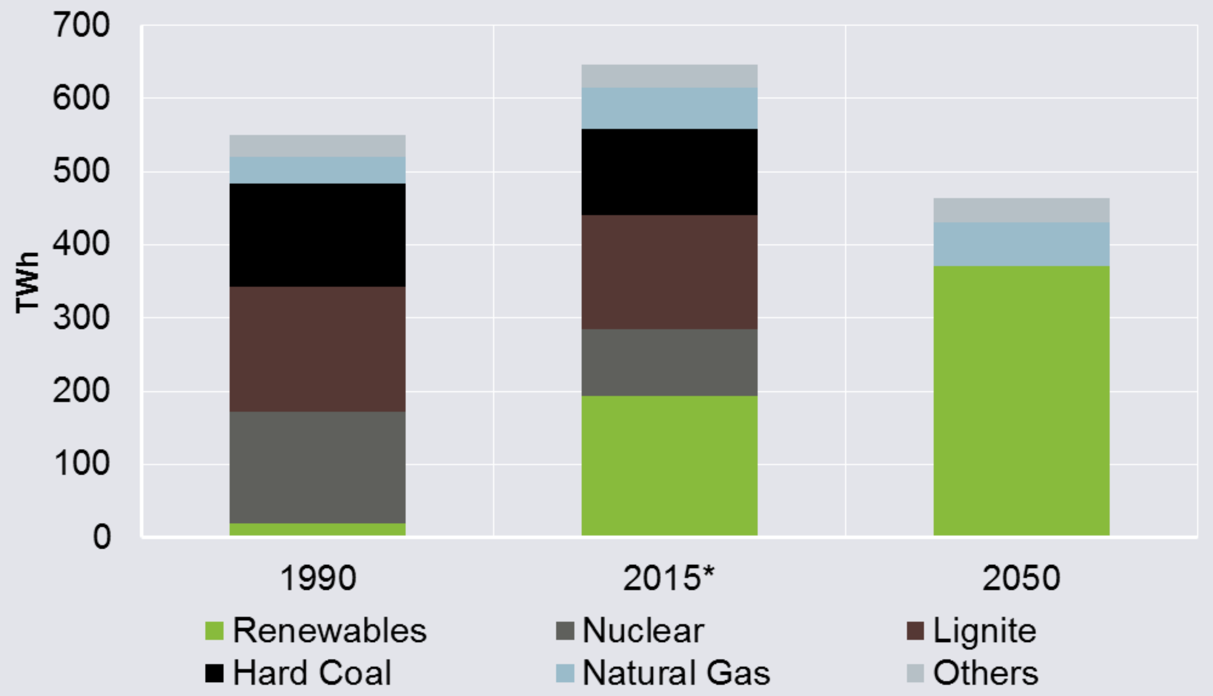
→ Some 50% RES in the power mix

→ ~30% Wind and Solar in the power mix

(* EU Commission (2011): Impact Assessment on EU 2050 Energy Roadmap, „Diversified supply technologies scenario“)

Germany has its own set of ambitious targets, implying a fundamental transformation of 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

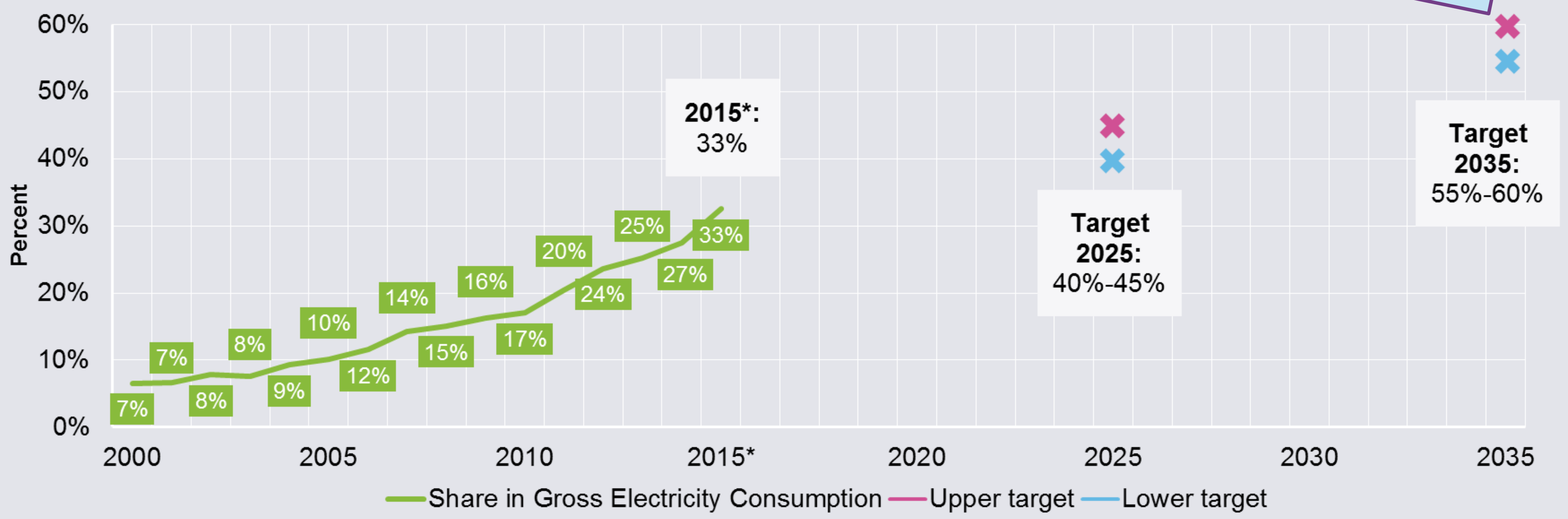
Development of renewable energies
Share in power consumption to increase to:
40 - 45% in 2025; 55 - 60% in 2035; ≥ 80% in 2050

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

Expansion corridor for RES-E deployment (since EEG 2014): RES-E share of 40 - 45% by 2025 and 55 - 60% by 2030.

Target: At least 80% RES-E by 2050

Share of renewable energies in gross electricity consumption 2000 - 2015 and targets 2025 - 2035



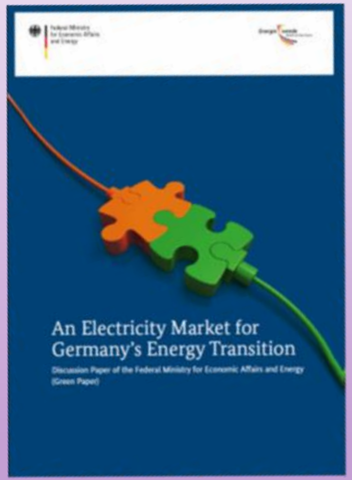
AGEB (2016), EEG (2014)

* preliminary

State of the art and underlying trends

Market design, current state I: A new Electricity Market Act (Strommarktgesetz) is under way, aiming to improve the EOM – albeit with some complements

Green Paper	White Paper	Strommarktgesetz (Electricity Market Act)
October 2014	July 2015	Fall 2015 - Summer 2016 (July)



Referentenentwurf

Entwurf eines Gesetzes zur Weiterentwicklung des Strommarktes (Strommarktgesetz)

§

Market design, current state II:
The revised German Renewable Energy Act (EEG 2017) also aims at improving economic efficiency

1. RES-E deployment based on expansion corridor (since EEG 2014)

→ In order to reach the target of at least 80% of RES-E in electricity consumption by 2050, there are intermediate targets (indicated by a ”percentage corridor”) for 2025 and 2035.

2. Keep costs for future RES-E deployment at a minimum

→ Increase of EEG surcharge until 2014. Awareness of cost debate for financing renewables is important for public acceptance of the *Energiewende*.

NEW!

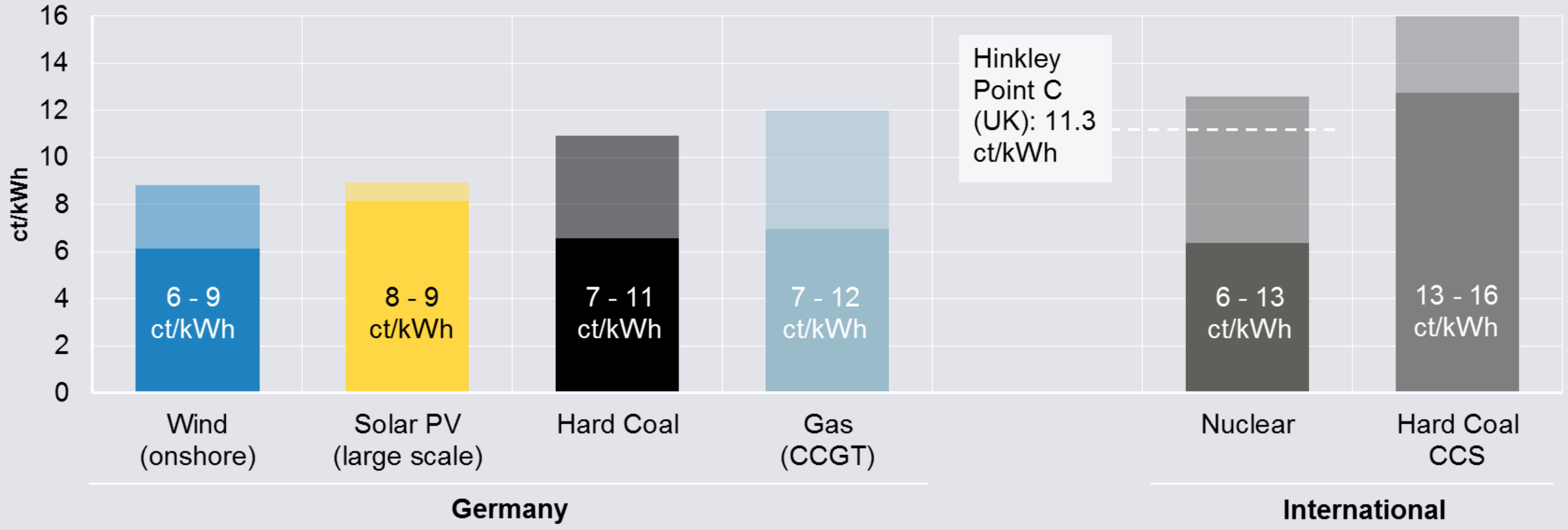
3. Introduction of auctions

→ Introduction of auctions for onshore wind energy, solar PV, offshore wind energy and biomass

Underlying trend 1: **The future is all about wind and solar.**

(Now cheapest low-carbon power source and cost competitive to newly built fossil power plants – tha's true worldwide.)

Range* of levelized cost of electricity (LCOE) 2015

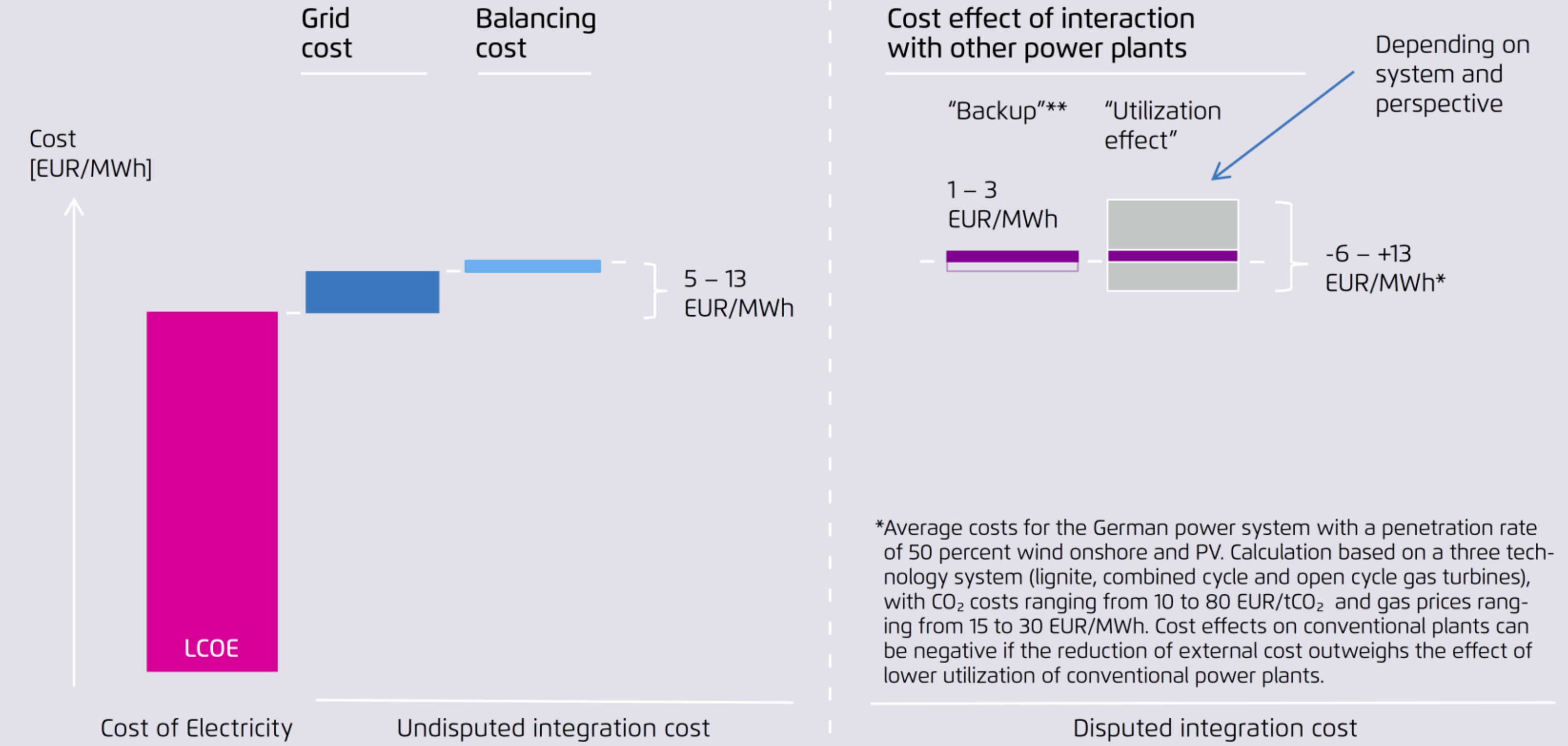


Agora Energiewende (2015e)

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

Integration cost of wind and solar do not change this picture.
(Grid and balancing costs are at 5-13 EUR/MWh, and cost effect of interaction w/ other power plants remain ambiguous.)

Overview of components discussed under „integration costs“

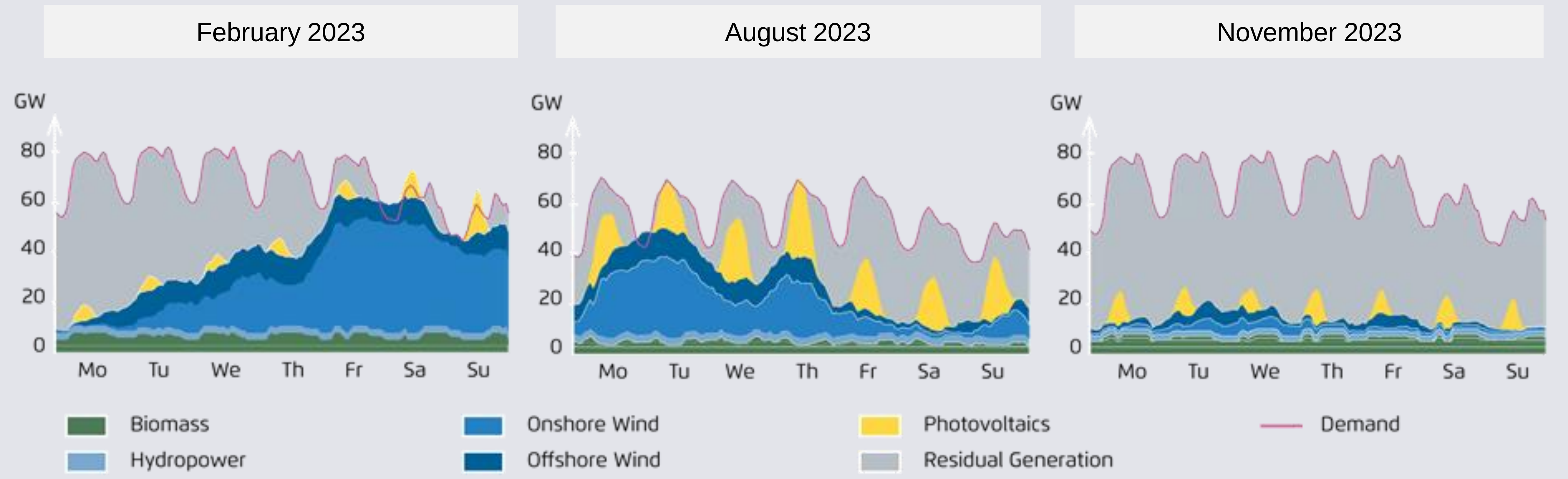


Agora Energiewende (2015)

Trend 2: Flexibility **is the new paradigm of power systems.**

(Many flexibility options available already, others upcoming)

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



Fraunhofer IWES (2013)

* Modelling based on 2011 weather and load data

Trend 3: The power system is increasingly shaped by high-fixed-low-operating-cost technologies

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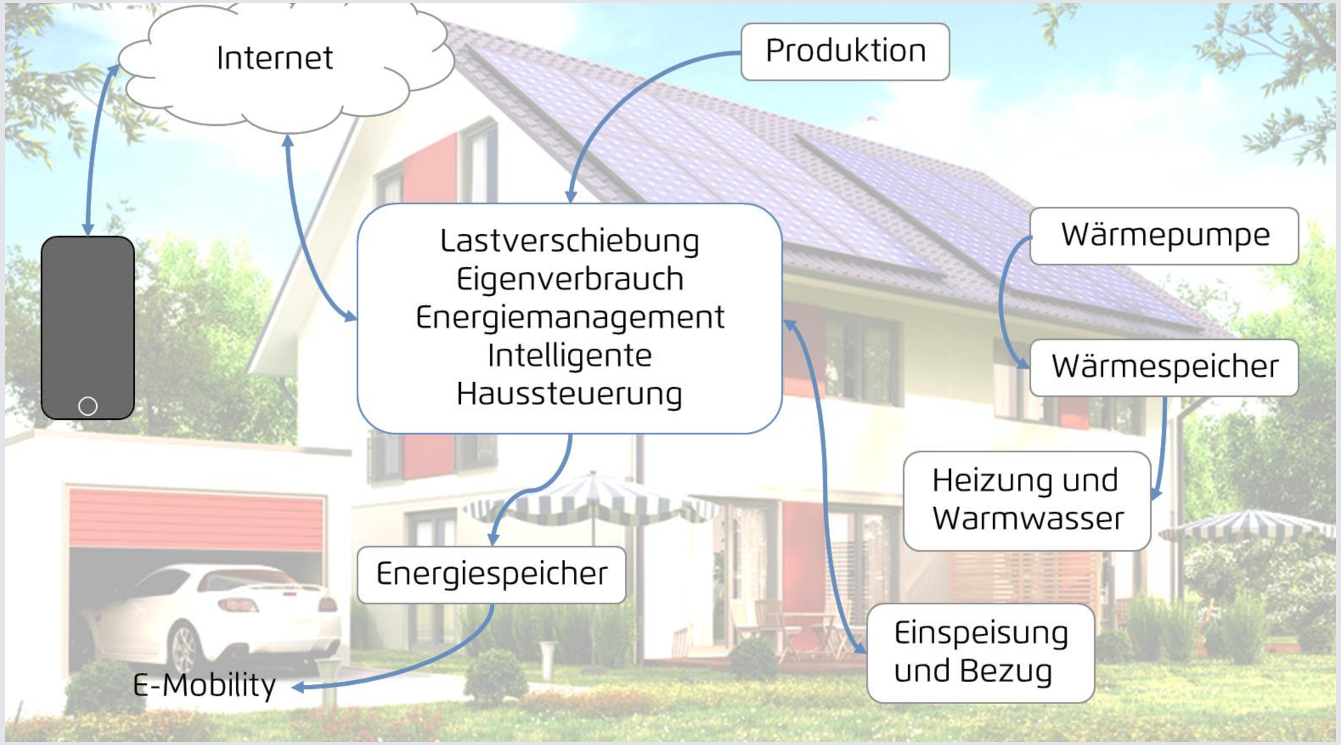
- → All key new technologies in the power market have high fixed investment costs and low operating cost
- → Applies to: Wind and Solar power installations, storage, Power-to-Heat, Backup- power plants and DSM investments
- → Capital costs are therefore key for the overall cost of the system
- → How to refinance CAPEX in a marginal cost-based energy only market?
- → Key role for (development) banks!

Trend 4: Digitalisation and distributed systems trigger a fundamental change of system architecture

Smart Home



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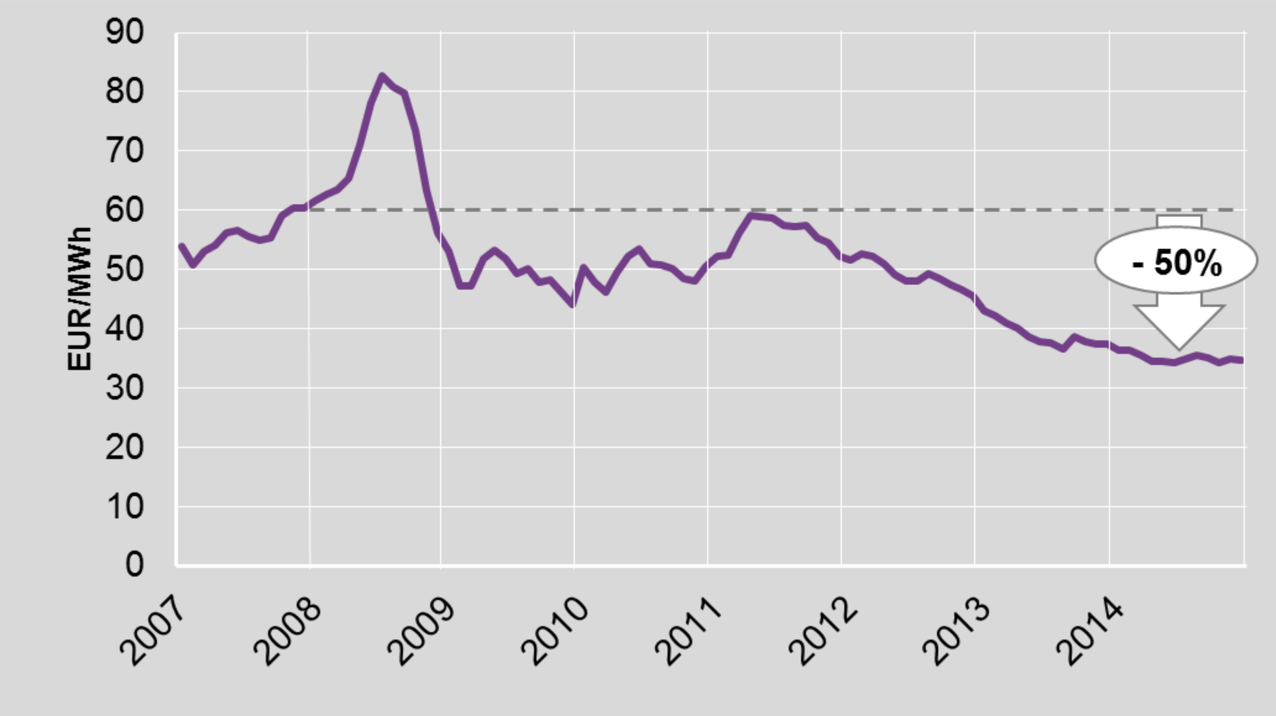
- Rooftop Solar PV-and Battery-Systems lead to increasing distributed power production and consumption („prosumers“)
- IT solutions can combine this with smart home solutions and create high share of independence from electricity from the grid
- Utilities need to become partner of prosumers, delivering energy services, back-up power and buying excess electricity
- Regulation needs to adapt as well: Adequate financing base for grids and central power plants (both RES and fossil) needs to be found

Challenges

From now on:
New power plant will not be able to write off its investment in EOM w/o substantial risk premium – be it fossil or renewable

Wholesale electricity prices* 2007 - 2014



EEX (2015)

* rolling annual futures

Reasons for the decline in power prices

→ **CO_2 price dropped:** CO_2 prices in the EU Emissions Trading system dropped since 2008 by around 70% due to high amount of excess certificates

→ **Falling resource prices:** Coal prices decreased by a third since 2008

→ **Merit-Order-effect:** Increasing power production of renewables is pushing expensive power plants out of the market

→ **Decreasing demand:** Power demand is continuously falling since 2007 (-5% by 2014)

→ **Excess capacities:** Large quantities of lignite and coal power plants are pushing gas power plants out of the market

The ETS is not performing - for the foreseeable future.

(Huge CO_2 allowance surplus in EU ETS will keep CO_2 prices well below 30 EUR/t for another 15 years)

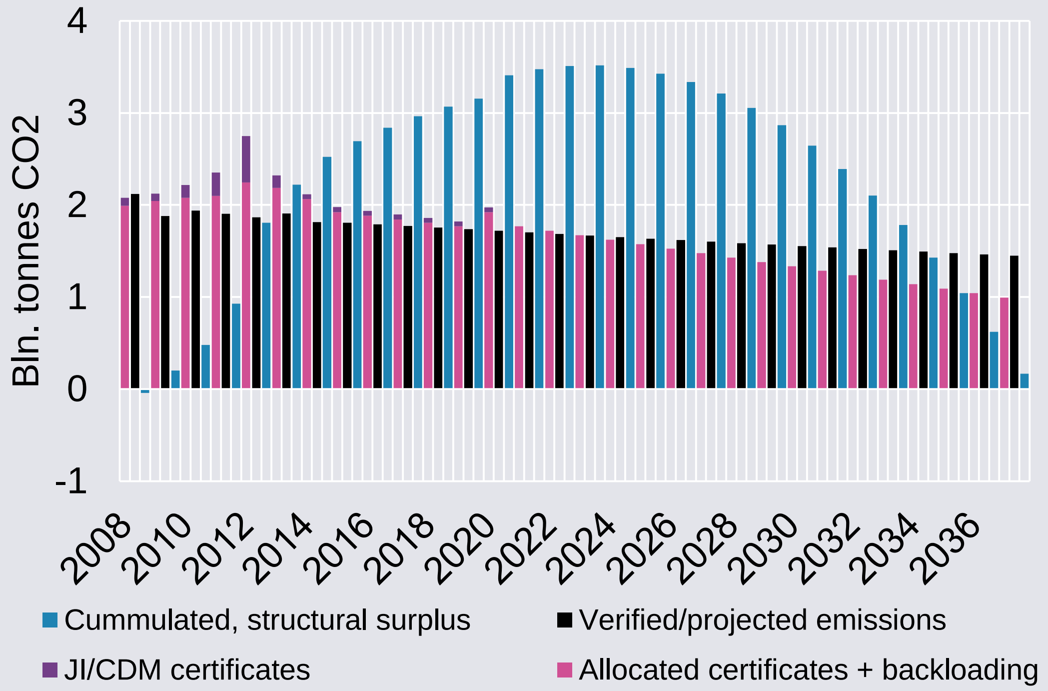
Market design based on simple textbook economics

Energy-only market, System adequacy through peak pricing

Emissions Trading (with CO_2 price reflecting social cost of carbon, i.e. > 60 EUR/t)

Agora Energiewende (2016)

Cumulated allowance surplus in the EU Emissions Trading System



Agora Energiewende (2016)

Political trust in “text-book” ETS & energy-only markets is limited.

(They are increasingly complemented by further mechanisms.)

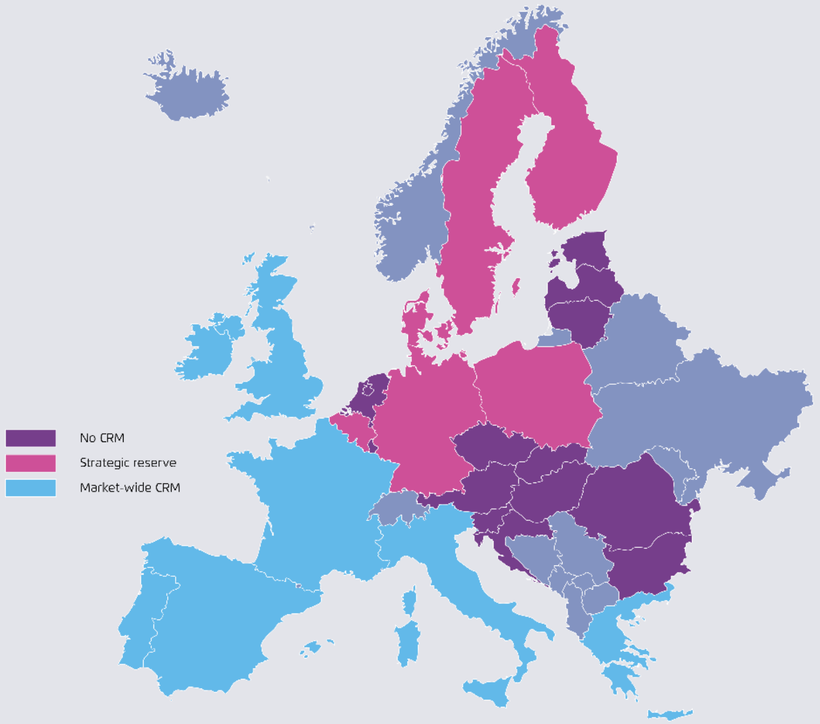
Market design based on simple textbook economics

**Energy-only market,
System adequacy through peak pricing**

**Emissions Trading
(with CO_2 price reflecting social cost of carbon, i.e. > 60 EUR/t)**

Agora Energiewende (2016)

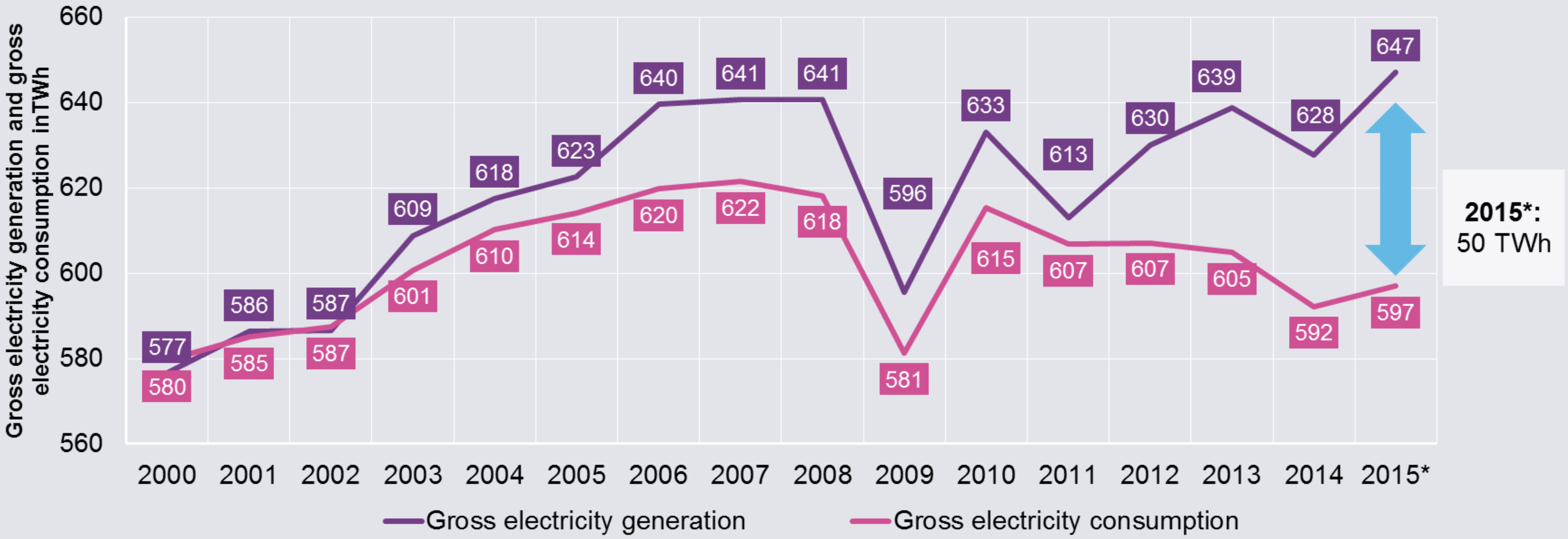
Capacity mechanisms in the EU 2015



Agora Energiewende (2016) based on ACER/CEER (2015)

Renewables account for one third of demand, and Germany's coal power fleet produces excess electricity for export markets
(Germany thus risks to miss its ambitious climate targets!)

Gross electricity generation and gross electricity consumption 2000 - 2015



AGEB (2016)

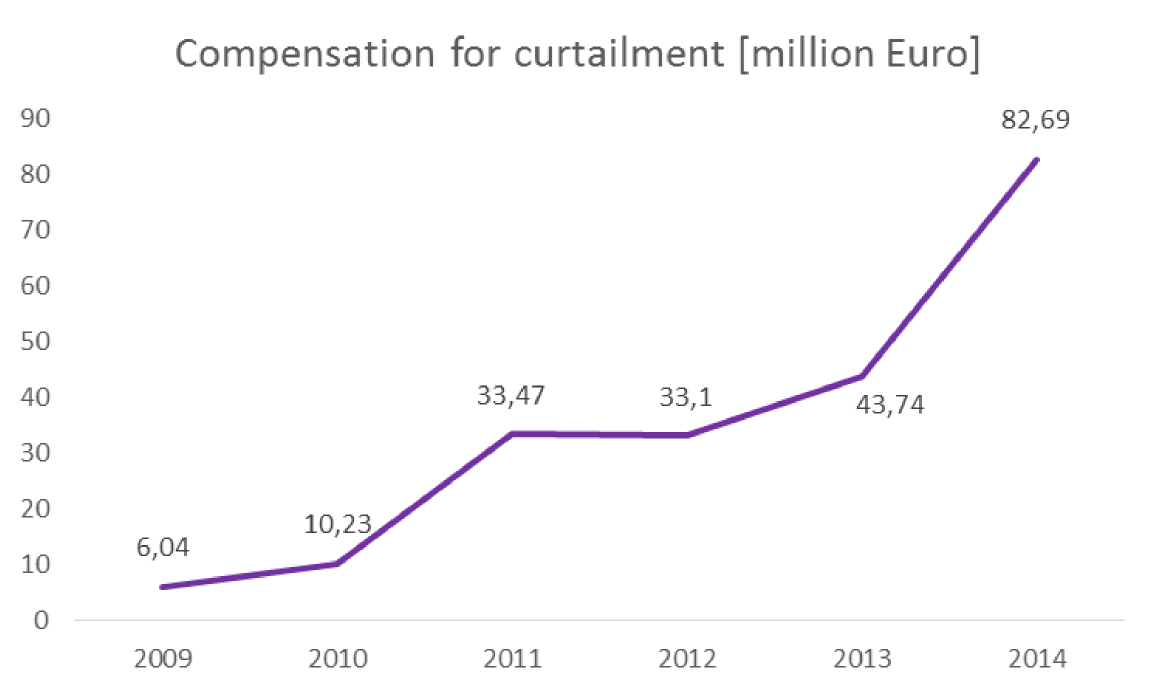
* preliminary

Last but not least: regional imbalances …

The grid as cheapest flex option is not „renewable-world-ready“.

(Grid not managed such as to cope with temporary generation hot spots.)

Compensation payments for curtailment (curtailment only, no redispatch)



BNetzA and Bundeskartellamt: Monitoringbericht 2015, p. 111

Curtailment in 2014

→ 1,581 GWh were curtailed in the year 2014 (three times as much as the year before). Neverthelss, this only amounts to 1.35% of net power production by RES-E generators.

Redispatch in 2014 (TSOs)

→ In total: 5,197 GWh, leading to redispatch costs of 186.7 mio. Euro

First quarter 2015

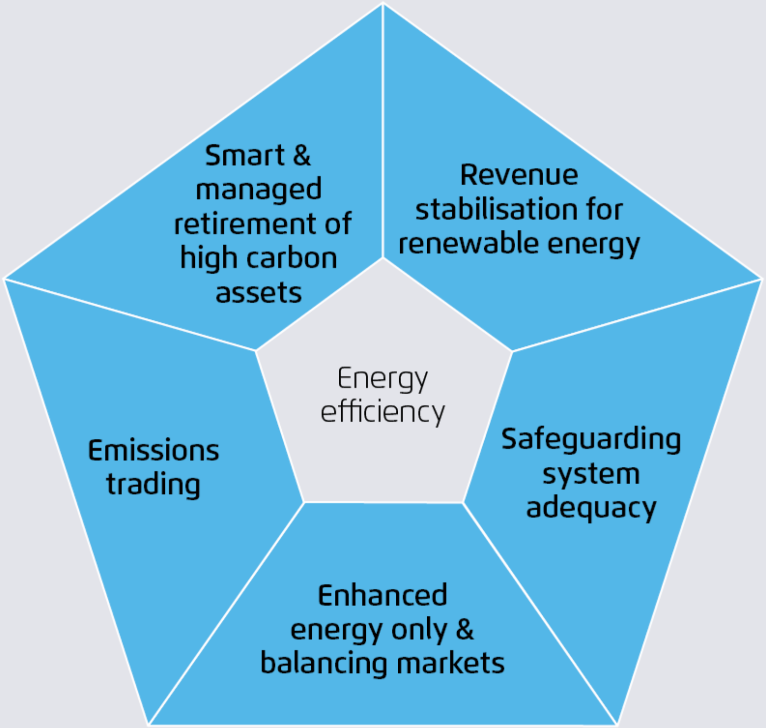
→ Redispatch amounted to 5,253 GWh (higher than total amount in 2014!), estimated cost of 266 mio. Euro.

→ Curtailment of RES-E: 1,872 GWh in the first half of 2015 (higher than in 2014). However, it is very local with one region in the North accounting for 70% (Schleswig-Holstein).

Which market design to solve this?

A market-based system that meets all targets: GHG targets and fuel switch, flexibility requirements, system adequacy, and economic efficiency

The Power Market Pentagon



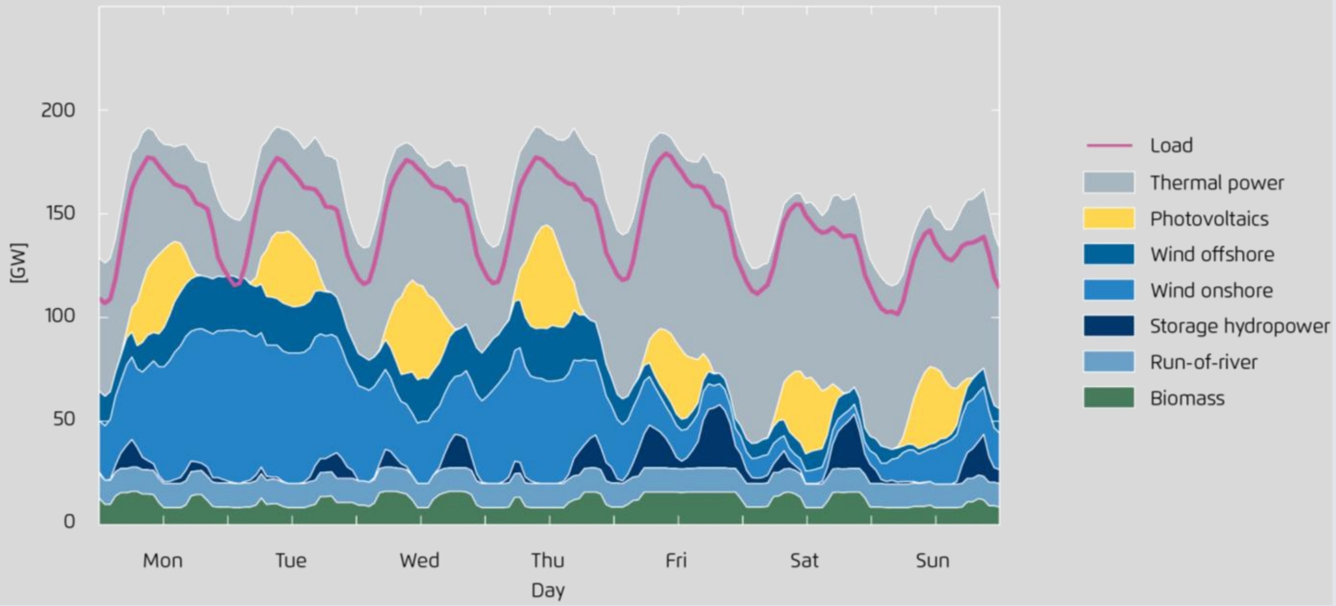
Agora Energiewende (2016)

Real-life constraints of EOM and ETS require broadening of perspective and considering policy interactions:

- → Refining EOM design is no-regret, but reaches limits due to old, high carbon, inflexible capacity in legacy mix
- → Smart retirement of old, high-carbon, inflexible capacity is prerequisite for market design reform to be fully effective
- → Reformed ETS will not deliver smart retirement, but must complement it
- → Reformed ETS will not close revenue gap for RES-E investments
- → System adequacy safeguards must be consistent with RES-E integration and retirement of high-carbon assets

Element 1: Enhanced energy and balancing markets to manage the flexibility challenge

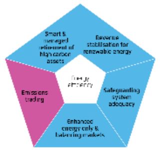
Electricity generation* and consumption* in the CWE region in a week in late summer 2030 (calendar week 32)



Fraunhofer IWES (2015)

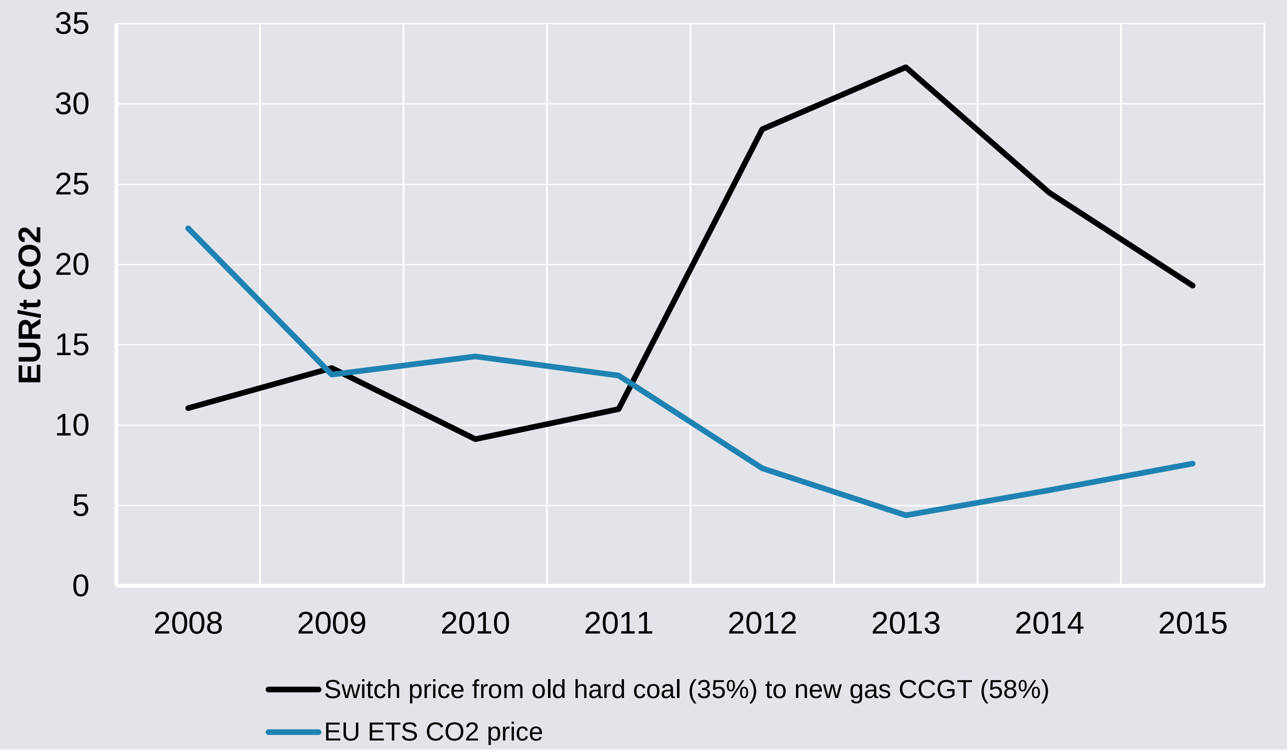
*Modelling based on 2011 weather and load data

- → To ensure efficient scheduling, enabling flexibility
- → Efficient dispatch rests on power prices reflecting real-time value of electricity. Key features of market design:
  - – Coupling energy markets and “making them faster” (e.g. 15 minute products with 30 minute gate closure and progressive improvements)
  - – Level-playing field for demand and supply side flexibility
  - – Balancing market design (products, contracting, pricing) must not distort incentives for energy market operations
- → “Price propagation” from real-time (balancing) prices to intraday & day-ahead
  - – Improving predictability of scarcity prices supports price propagation in addition, reduces risks & supports efficient investments



Element 2: An appropriate and clear signal for power generation to switch to cleaner fuels

Comparison of the hard coal-to-gas CO_2 switching price* and the actual CO_2 price in the EU-ETS



BAFA, DEHSt, EEA, Lazard, Federal Statistical Office Germany, UBA, own calculations. *Assuming an electrical efficiency of 35% for (old) hard coal plants and 58% for (new) gas-fired plants.

Current incentives for fuel switch

→ Role of ETS in power sector is to trigger a fuel switch from high to low carbon generation

→ Equally, current ETS price levels not able to drive investments in renewables

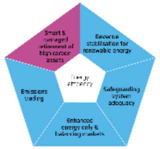
→ This requires a minimum price of around 30 EUR/t CO_2

Key measures for EU framework:

– Stabilisation of ETS price through carbon floor-price (e.g. 30 EUR/t CO_2)

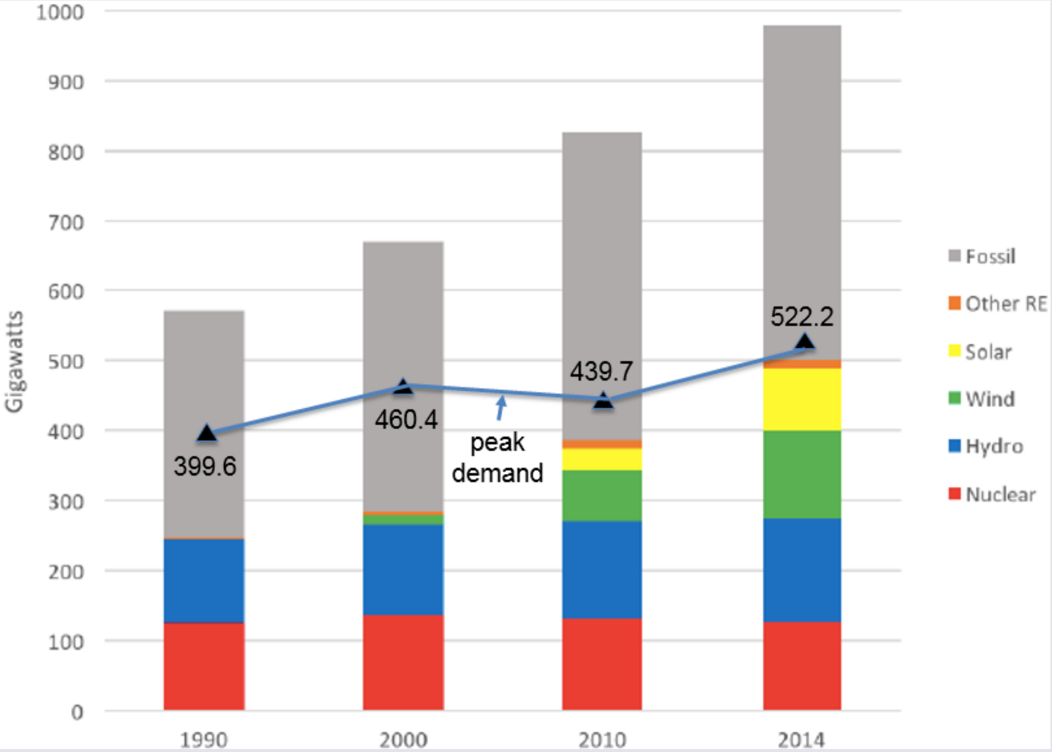
– Cancellation mechanism for additional domestic or EU climate policy measures to enable national action

– Then, ETS interacts with CO2 reductions from RES, EE and smart retirement policies



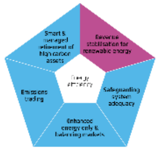
Element 3: Smart & managed retirement - The active removal of old, high carbon, inflexible capacity

Installed capacity vs. peak demand EU



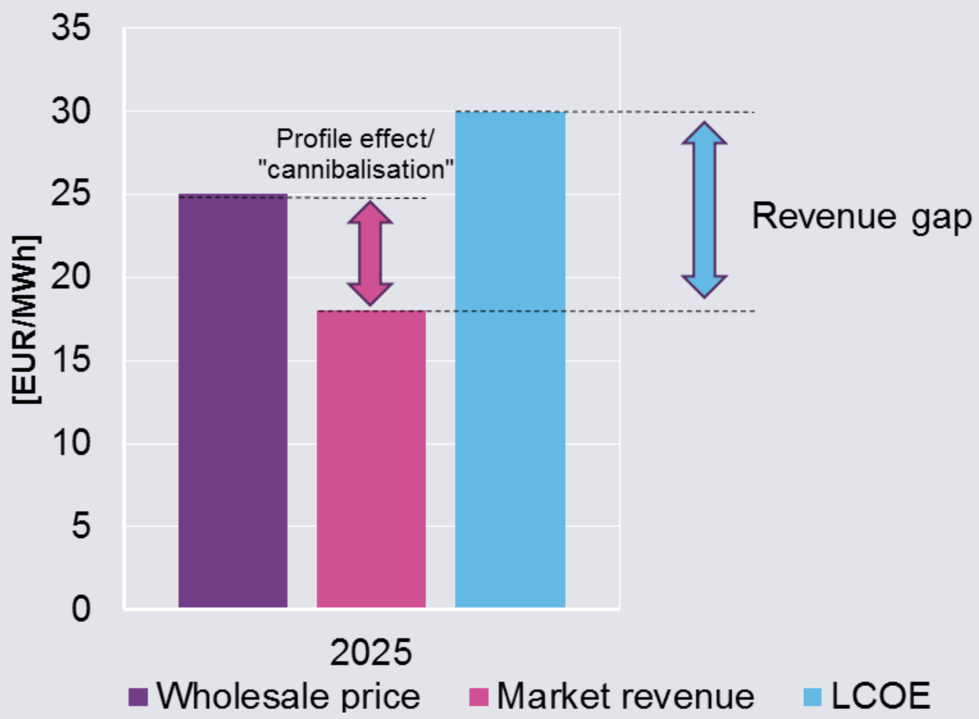
Michael Hogan, RAP (2016)

- Most urgent challenge of EU power markets are implications of legacy investments; Energy market design alone reaches limits
- (National) managed retirement of old, high-carbon, inflexible capacity prerequisite for successful market design & to support shift to a more flexible mix of conventional generation
- Enabling EU framework:
  - Spotlight on system adequacy, flexibility challenge and required reduction of carbon intensity in *national energy and climate plans* and IEM and RE Directive revisions
  - EU budget to offer opportunities to assist lower-than-average GDP member states
  - Efforts to close gaps in Industrial Emissions Directive
  - Appropriate emission performance standards (EEAGs)



Element 4: Providing stable revenues for new RES-E investments to achieve EU target at least cost

Best case LCOE wind onshore, market revenue & wholesale price in a low fuel & low CO_2 cost scenario in 2025

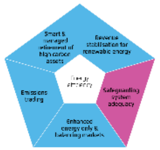


Öko-Institut (2014), IRENA (2015)

- Energy-market based RES investments lead to higher risks for investors, higher cost of capital, higher costs for society
- “Cannibalisation” effect of wind & PV: Typically, they do not generate in times of high prices: Market revenues below average baseload price
- Weak 2030 outlook for ETS prices yields market revenues below LCOE of wind & PV

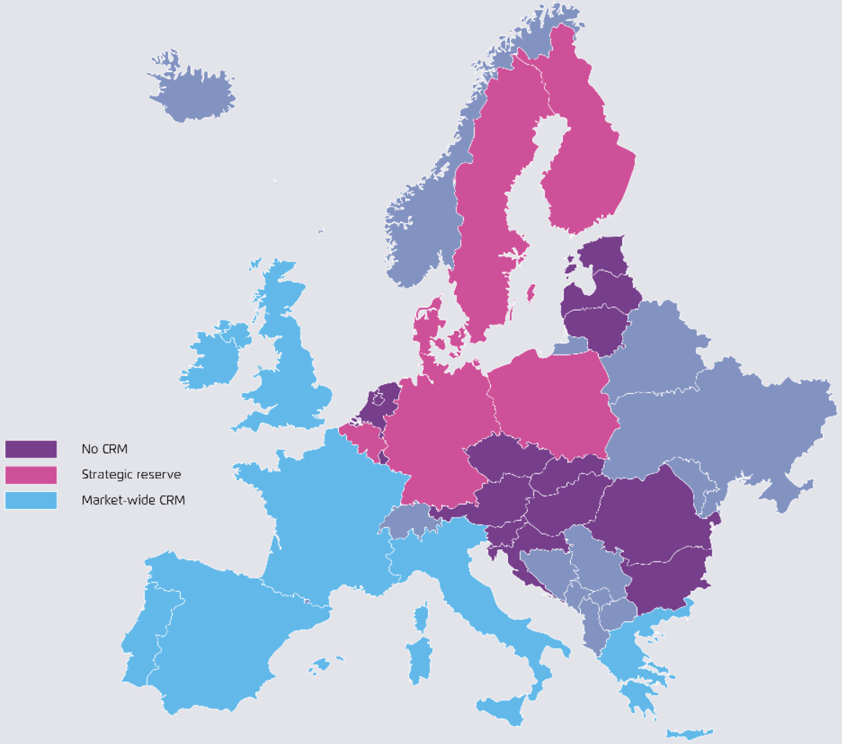
→ Future EU RES framework & cost of capital

- National assessments of RES barriers
- EU mechanism for de-risking RES investments in member states
- Curtailment rules (priority access / dispatch) impact cost of capital and total support costs
- Competitive tendering will show where and when energy market conditions are sufficient



Element 5: System adequacy safeguards consistent with long-term decarbonisation and flexibility needs

Capacity mechanisms in the EU 2015



Agora Energiewende (2016) based on ACER/CEER (2015)

→ System adequacy is not only about *“how much”* but *“what kind”* of capacities

– *Strategic reserves* operating fully outside energy and balancing markets

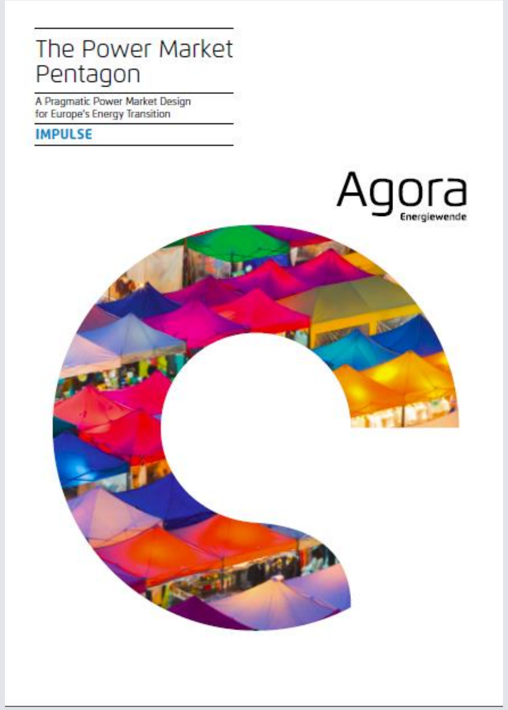
– *Energy-based payments* by stabilising scarcity prices

– *Capability remuneration mechanisms* Resource capability rather than capacity has to be primary focus

→ Regional adequacy assessment requirement for domestic CRMs ➔ reduces overall investment needs

The resulting real-life challenge: how to design the Power Market Pentagon elements such that they are mutually supportive and do not contradict each other

Publication



For more details: Agora Impulse paper on „the power market pentagon“ on our website

Download unter: https://www.agora-energiewende.de/fr/themen/-agothem-/Produkt/produkt/281/The+Power+Market+Pentagon/

Things *not to do* include:

→ Introduce a capacity market without managed retirement of old high-carbon assets; Restrains meeting CO_2 targets and flexibility

→ Reform the ETS under the assumption it would enable full refinancing of RES-E

→ Enhance energy markets without letting demand side and RES-E fully participate in the balancing markets and managed retirement policies

→ Redesign renewables remuneration mechanisms without taking their effects on the energy-only market into account, **…**

Think of market design in a holistic way, combining all five elements sensibly

As mentionned, an additional challenge in Germany:

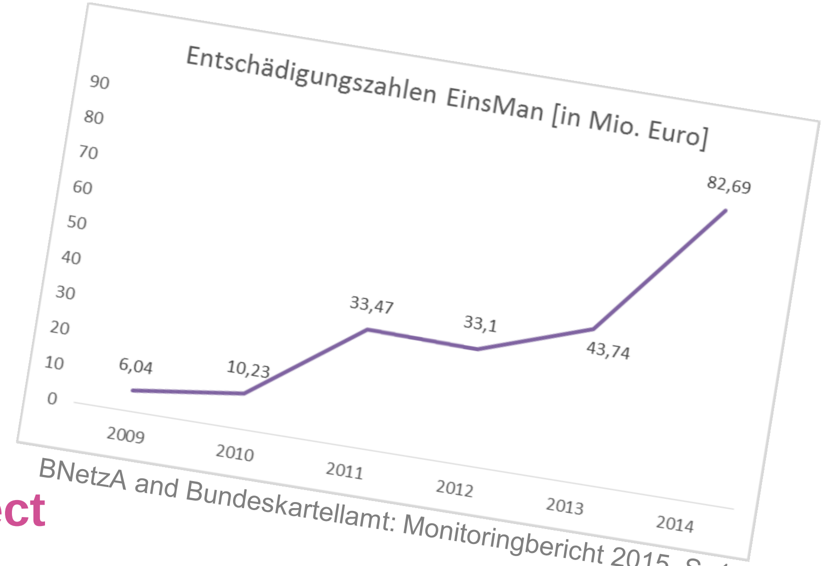
Regional disparities and ”smart markets”

Trends (very briefly)

- → Regional concentration of new renewables (wind in the North, PV in the South), increase in cross-border flows, decreasing full load hours of conventional power stations, distributed generation & actors
- → Divergence of generation and demand, new demand (from heat and transportation sectors) coming up
- → Increasing cost of curtailment and redispatch (largely in the North)

Implications and questions for grid planning and operation

- → 3% curtailment rule indicates abandonment of ”copper plate” ideal
- → Is there a trade-off btw grid extension vs ”smarter” operation ...?
- → What is an ”efficient” balance btw managing grid bottlenecks locally and total system balance?



BNetzA and Bundeskartellamt: Monitoringbericht 2015, S. 111

➔ These and related issues are in the focus of a new Agora project on ”smart markets” (work in progress)

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