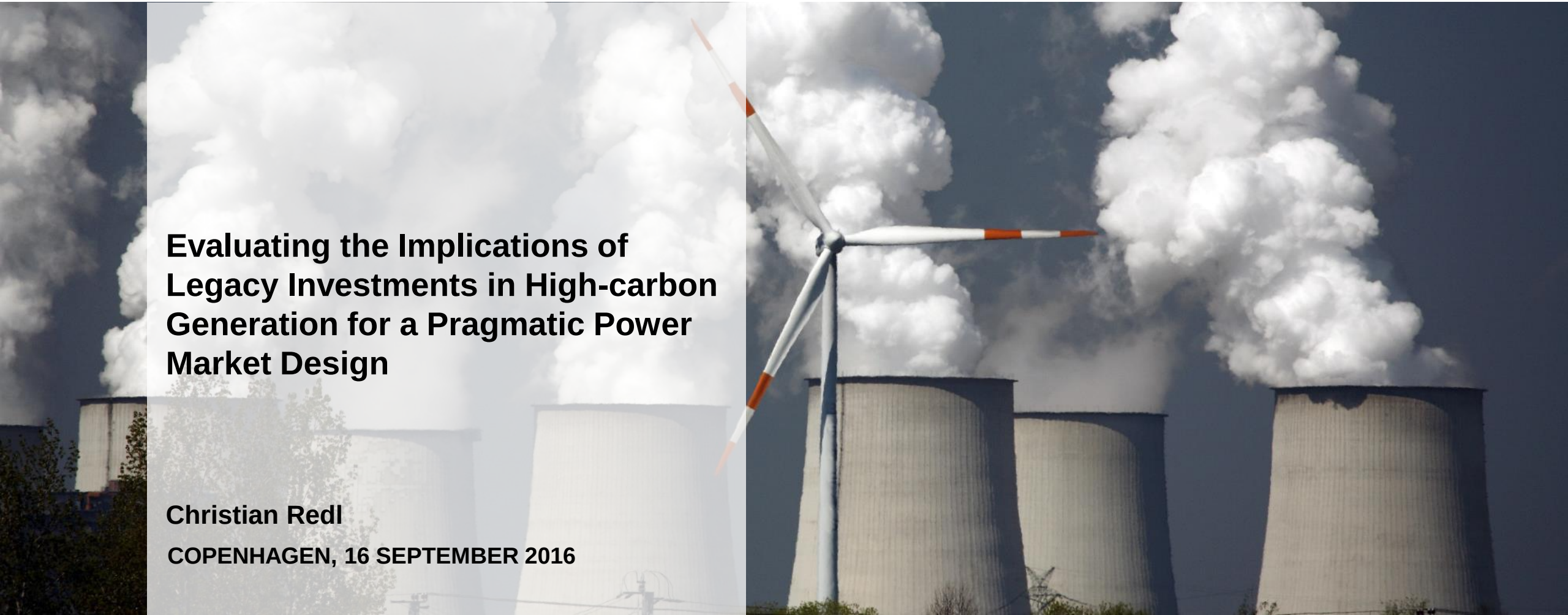


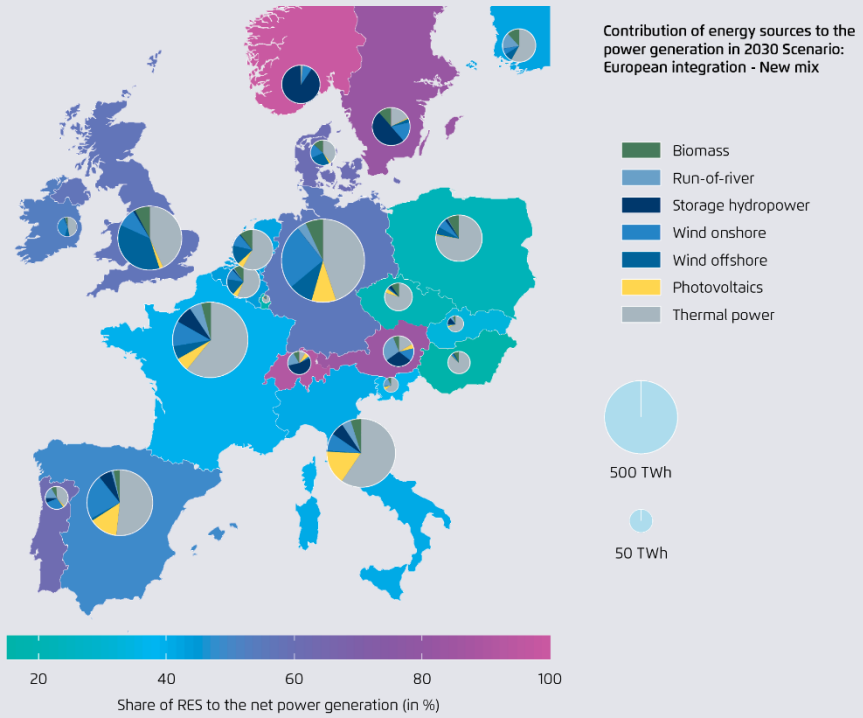
Evaluating the Implications of Legacy Investments in High-carbon Generation for a Pragmatic Power Market Design

Christian Redl

COPENHAGEN, 16 SEPTEMBER 2016

What do Europe's 2030 climate and energy targets imply for the power sector?
(1) 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 (as single largest emitting sector): Emissions are to reduce 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

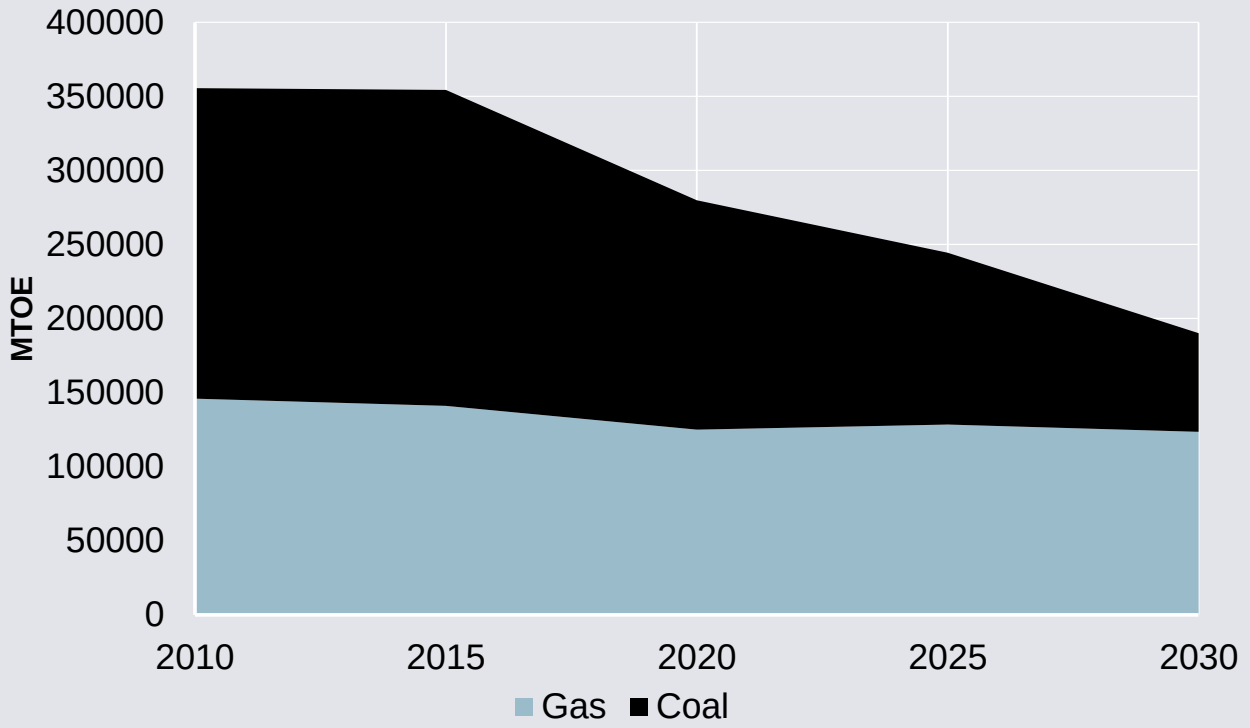
→ Some 50% RES in the power mix

→ ~30% Wind and Solar in the power mix

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

What do Europe's 2030 climate and energy targets imply for the power sector?
(2) A decline of 68% of coal use in power generation

Actual and projected coal use in EU power generation



EU Commission (2011): Impact Assessment on the 2050 Energy Roadmap

A decline of coal use in power generation is key for the EU's 2030 strategy:

→ Power sector emissions are to reduce by 65% by 2030 compared to 1990

→ In 2015, ~ 3/4 of total CO_2 emissions stem from coal- and lignite-fired power plants, although these make up only 1/4 of total EU power generation

Thus, EU 2030 climate and energy targets imply for coal power production

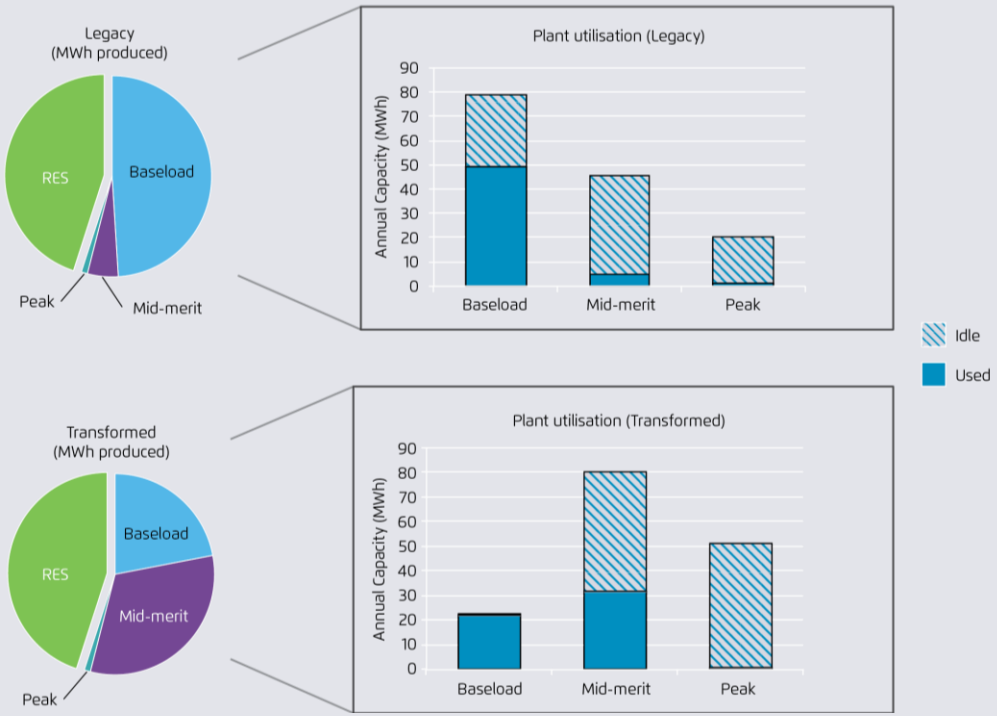
→ Minus 68% of coal use in power generation*

→ Decomissioning of roughly half of the coal fleet

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

What do Europe's 2030 climate and energy targets imply for the power sector?
(3) Transition to more flexible mix

Impact of thermal plant mix on plant utilisation rates and investments in a 45% RES-E system



RAP (2014) based on IEA (2014)

***Increasing* share of *flexible* resources and *decreasing* share of *inflexible* resources should go hand in hand with a growing share of variable renewables**

- → If mix remains essentially unchanged during transition all power plants have lower utilisation rates compared with shift to more flexible capacity mix
- → 40% <u>less investment required</u> if capacity mix is transformed towards greater flexibility
- → In transformed scenario all market participants are economically better off
- → <u>System adequacy</u> ensured <u>at lower cost</u> in a "transformed mix"

Which market design will get us efficiently to a 2030 power system with 50% RES-E, -68% coal and a flexible mix?

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): The Power Market Pentagon

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

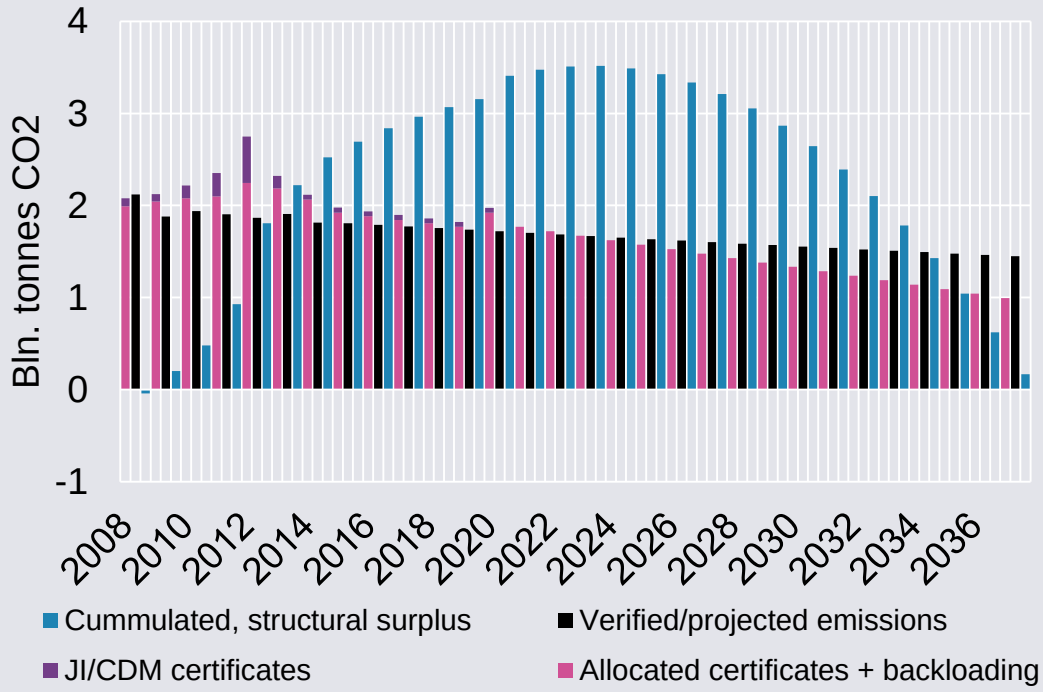
Market design based on simple textbook economics

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)

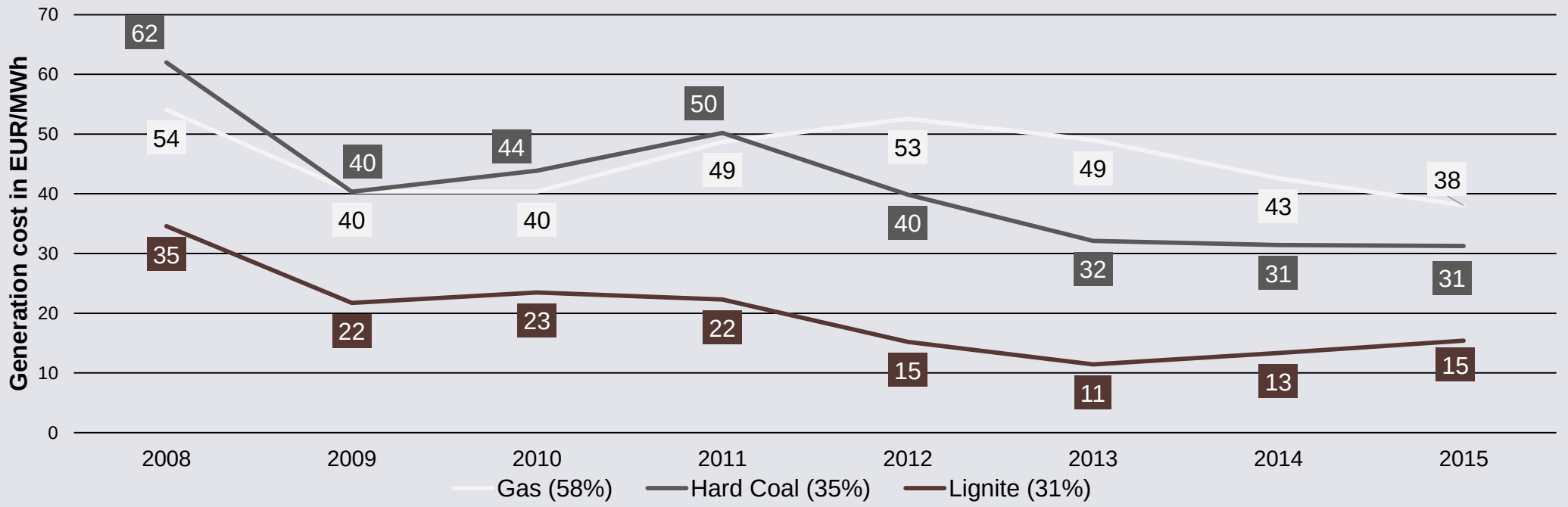
Cumulated allowance surplus in the EU Emissions Trading System



Agora Energiewende (2016)

Given low EU ETS prices, old lignite and hard coal plants are stumbling block to power system transition

Short-run marginal costs of fossil power plants (newer gas, older coal) in Germany



Own calculations based on BAFA, DEHSt, Destatis, EEA, Lazard, UBA

The bracketed numbers denote average plant efficiency

Which market design will get us cost-effectively to a 2030 power system with 50% RES-E, -68% coal and a flexible mix?

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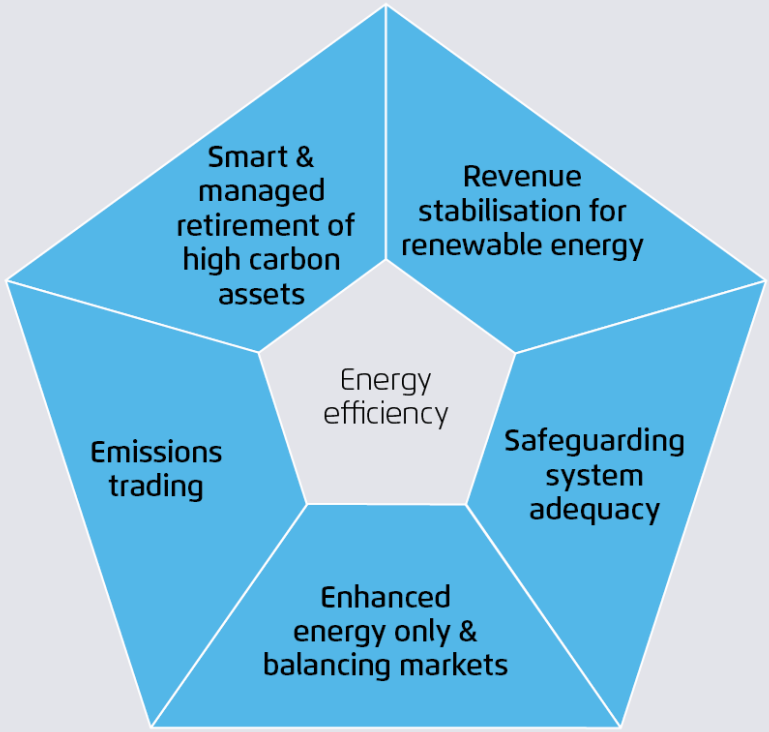
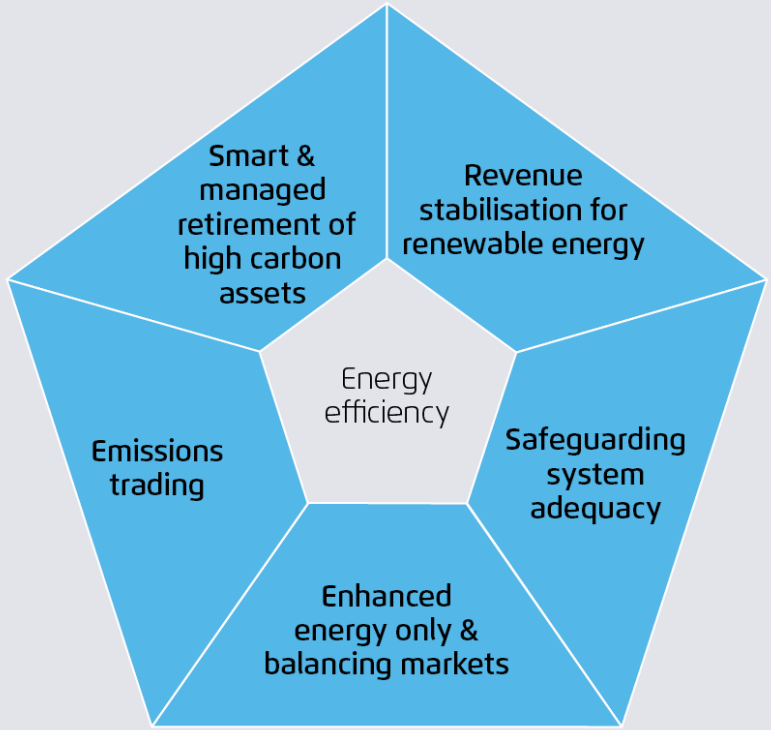
The Power Market Pentagon



Agora Energiewende (2016)

A market design that fits: EU-level provisions on EOM, ETS, Smart retirement, RES-E revenue stabilisation and System adequacy safeguards

The Power Market Pentagon



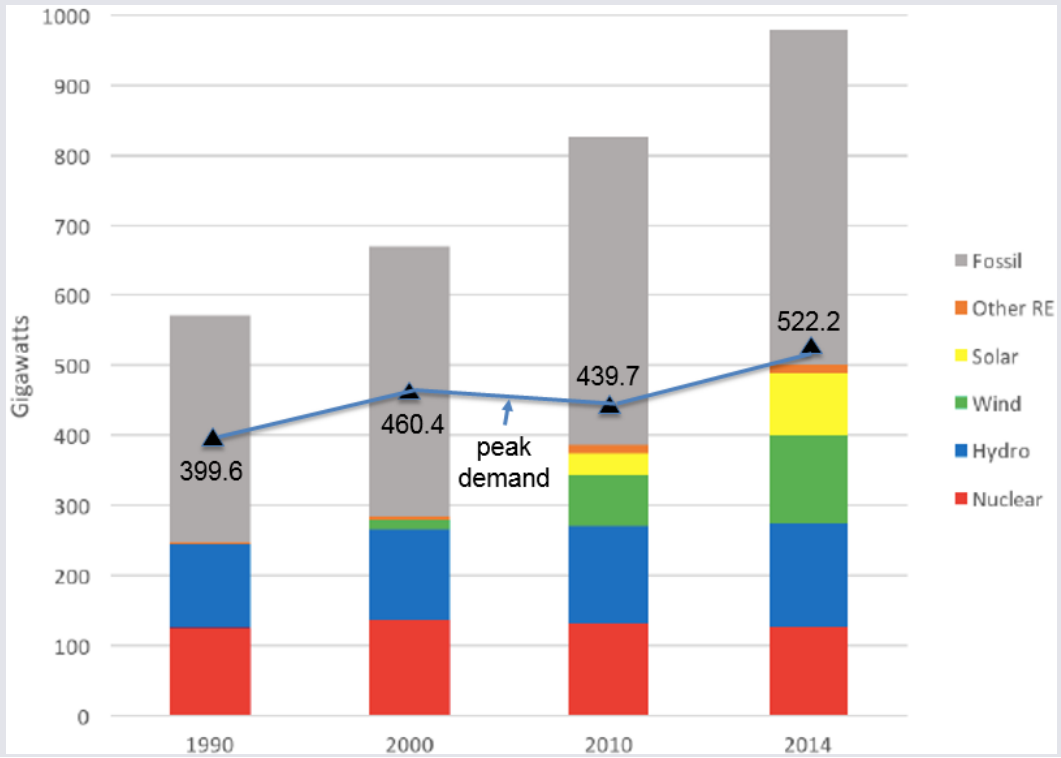
Agora Energiewende (2016)

Real-life constraints of EOM and ETS require broading of perspective and consideration of policy interactions:

- → ETS will not deliver coal retirement
- → 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

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

Installed capacity vs. peak demand EU

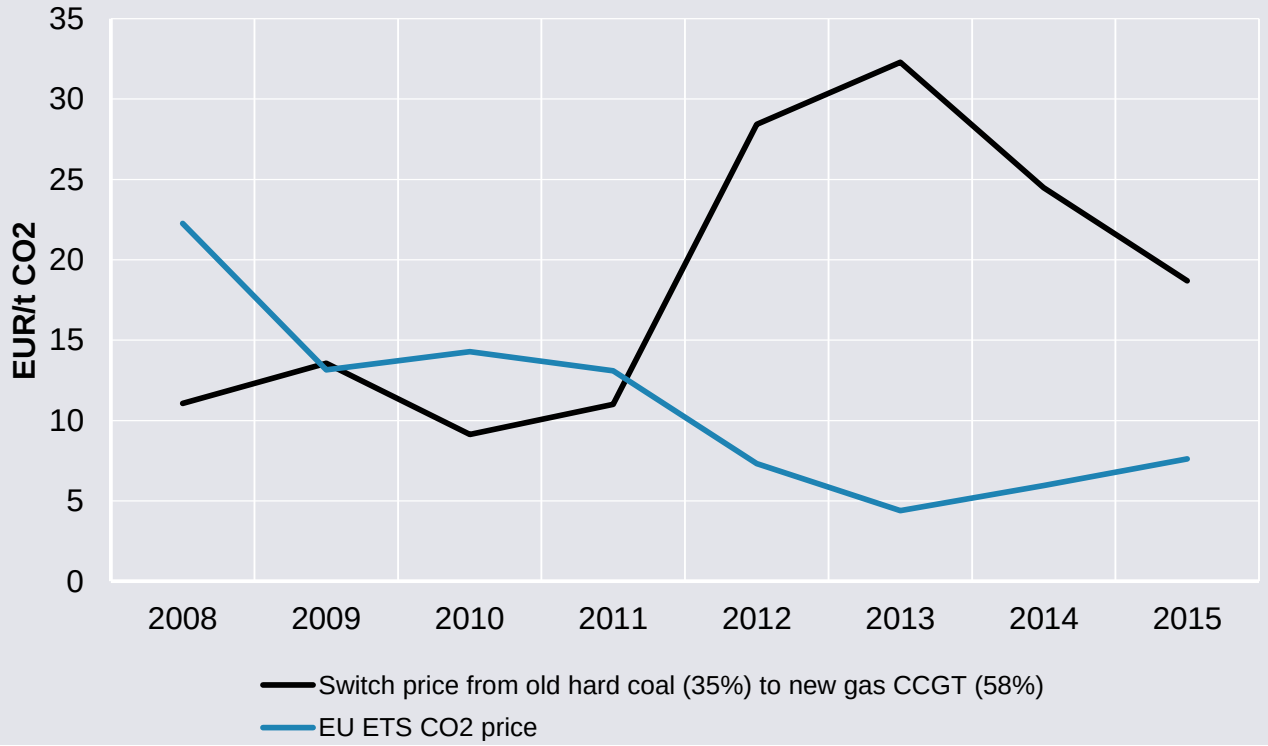


Michael Hogan, RAP (2016)

- → 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)

The *EU Emissions Trading Scheme* should provide a stable mid-level carbon price (~30 EUR/t CO_2)

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.

→ Role of ETS in power sector: Shift within fossil generation mix from high- to lower-carbon (Older lignite ➔ newer hard-coal; Older hard-coal ➔ newer gas plants) @ ~30 EUR/t CO_2

→ ETS not suitable to drive investments in renewables (esp. wind and PV)

→ Key measures for EU framework:

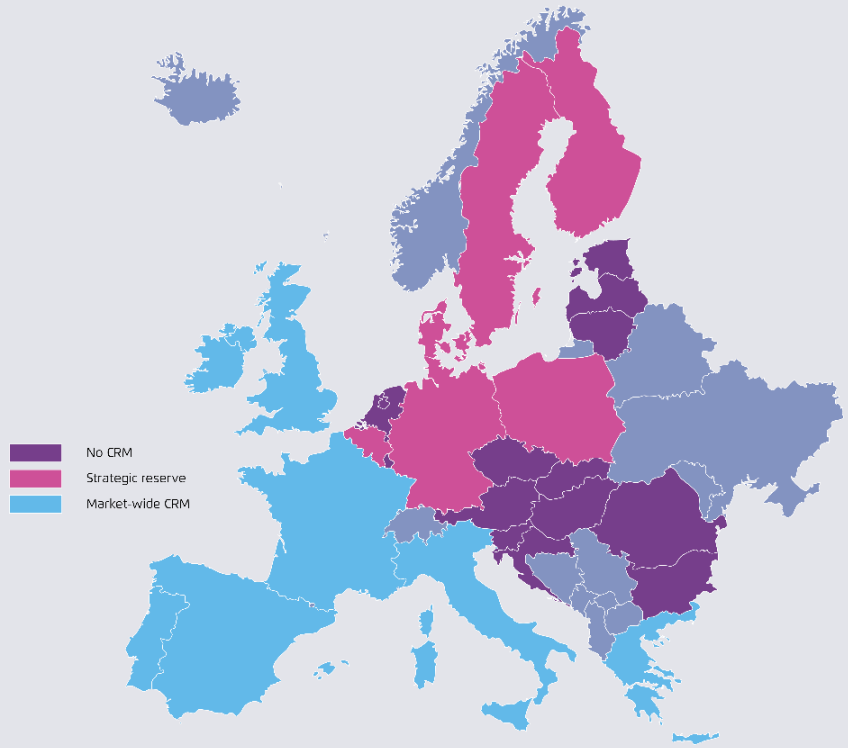
– Stabilisation of ETS price through carbon floor-price (e.g. 30 EUR/t CO_2)

– 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

System adequacy safeguards to be 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

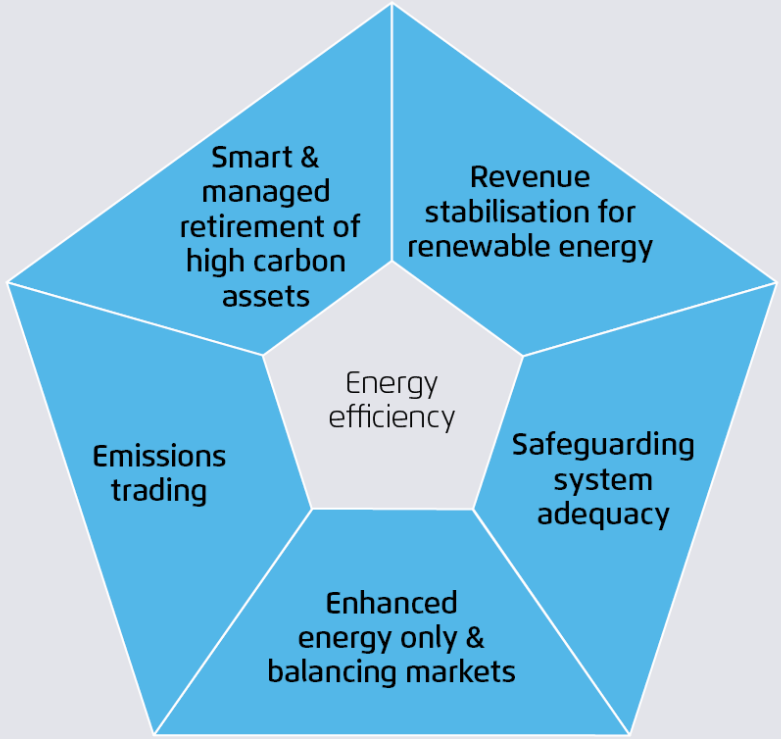
→ EU regulatory framework (4th Energy Package and new EEAGs):

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

– Emission standards in EEAGs and 4th Energy Package and "minimal invasiveness" principle

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

The Power Market Pentagon



Agora Energiewende (2016)

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

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Thank you for your attention!

Questions or Comments? Feel free to contact me:

christian.redl@agora-energiewende.de

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.

Backup

Energy-only markets increasingly complemented by out-of-market mechanisms

Market design based on simple textbook economics

Energy-only market, System adequacy through peak pricing

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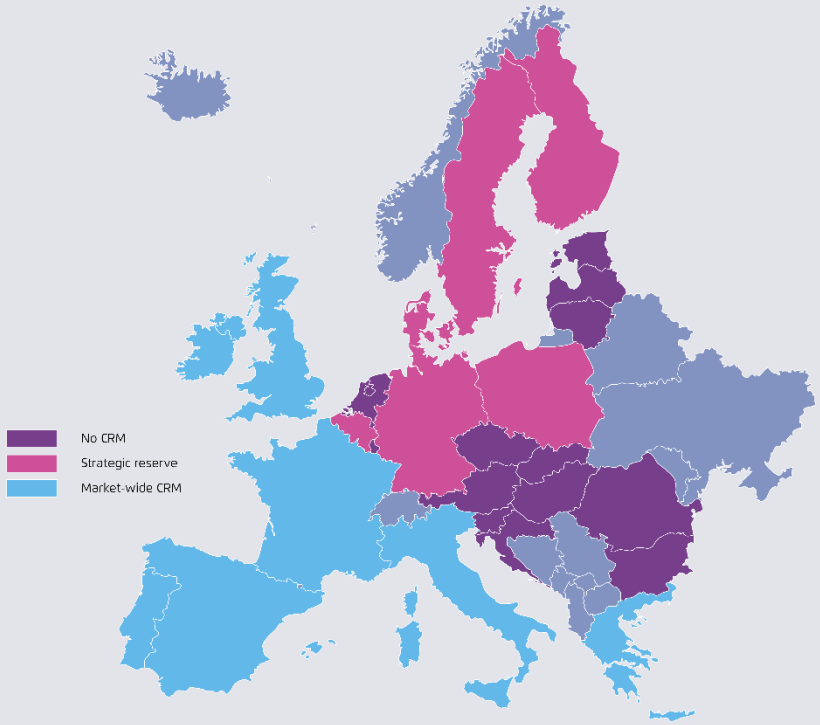
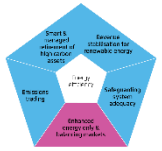
Agora Energiewende (2016)

Capacity mechanisms in the EU 2015

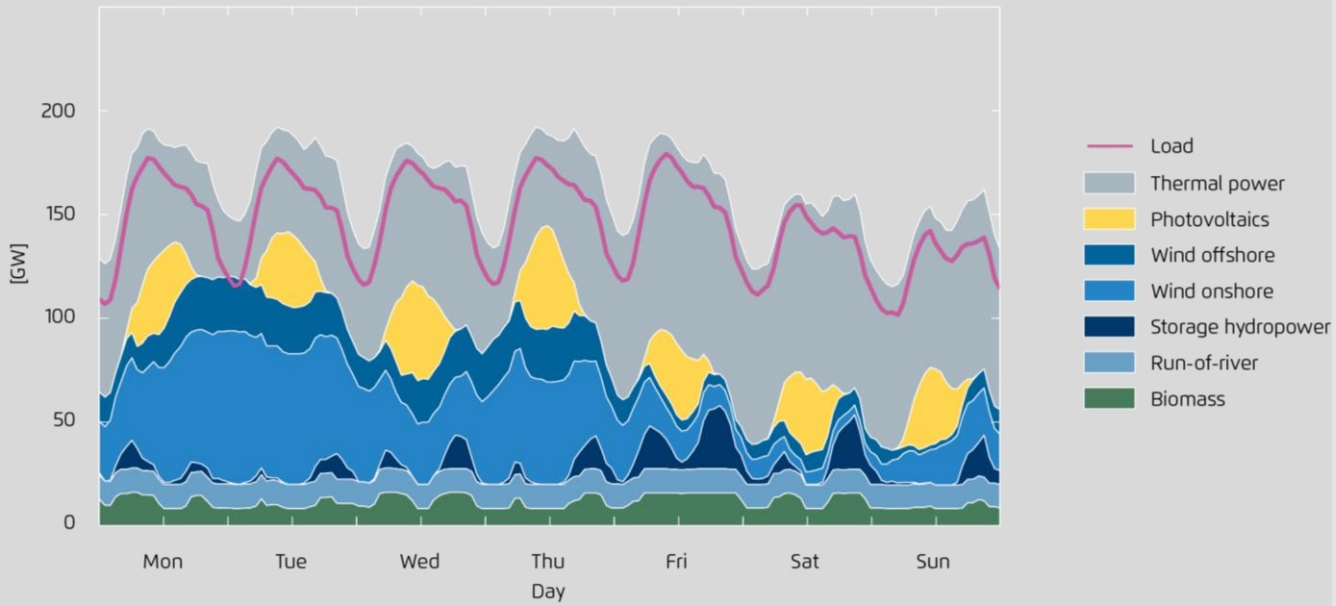


Agora Energiewende (2016) based on ACER/CEER (2015)



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:

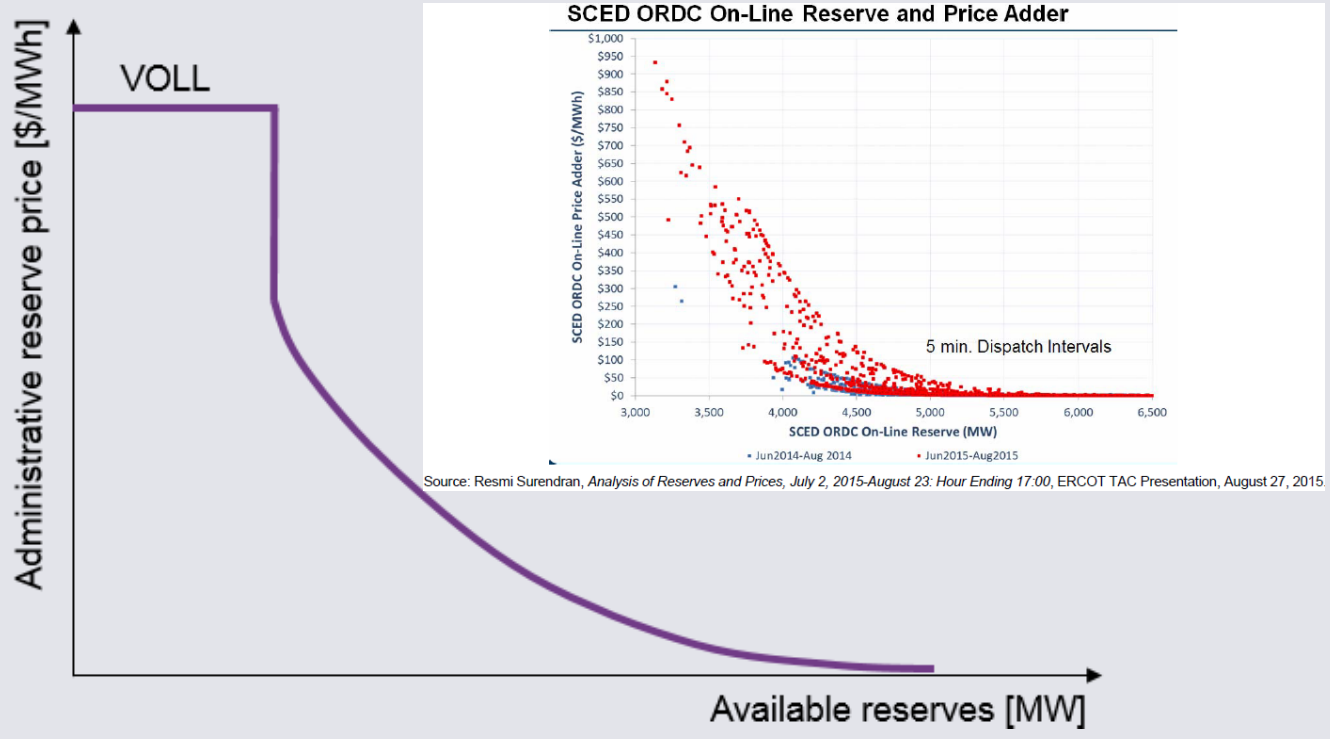
- Coupling energy markets and "making them faster" (e.g. 15 minute products with 30 minute gate closure and progressive improvements)
- Level-playing field for demand and supply side flexibility
- Balancing market design (products, contracting, pricing) must not distort incentives for energy market operations

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

Administrative adjustment of prices for reserves in the Texas electricity market



Source: Resmi Surendran, *Analysis of Reserves and Prices, July 2, 2015-August 23: Hour Ending 17:00*, ERCOT TAC Presentation, August 27, 2015

Potomac Economics (2015); William Hogan (2016)

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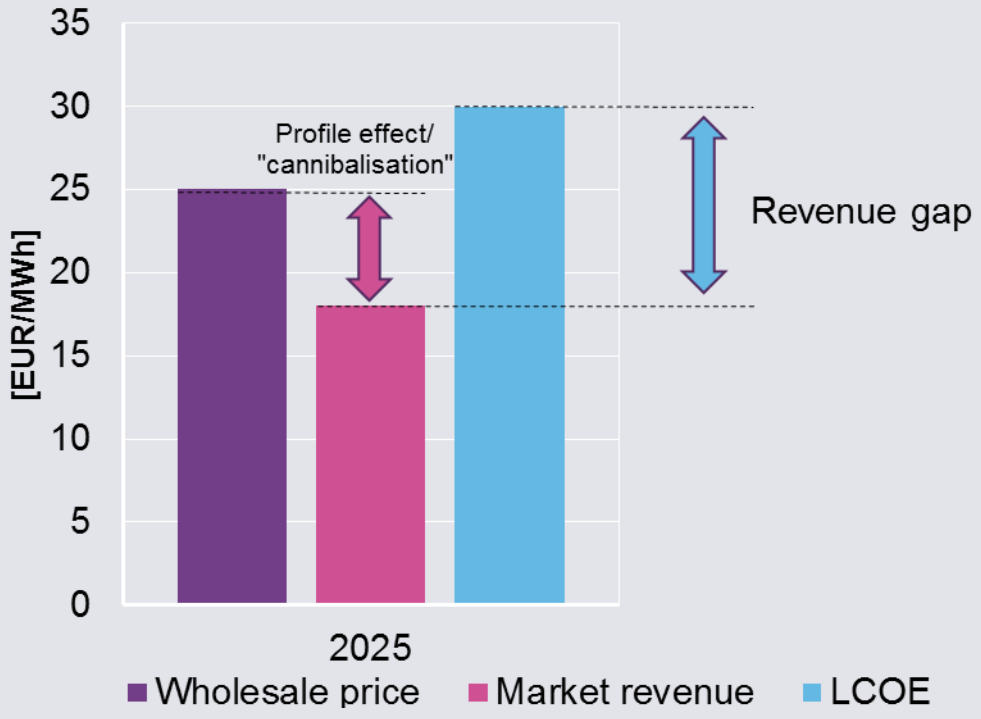
  - Improving <u>predictability of scarcity prices</u> supports price propagation in addition, reduces risks & supports efficient investments

Revenue stabilisation 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 CO2 cost scenario in 2025



Öko-Institut (2014), IRENA (2015)

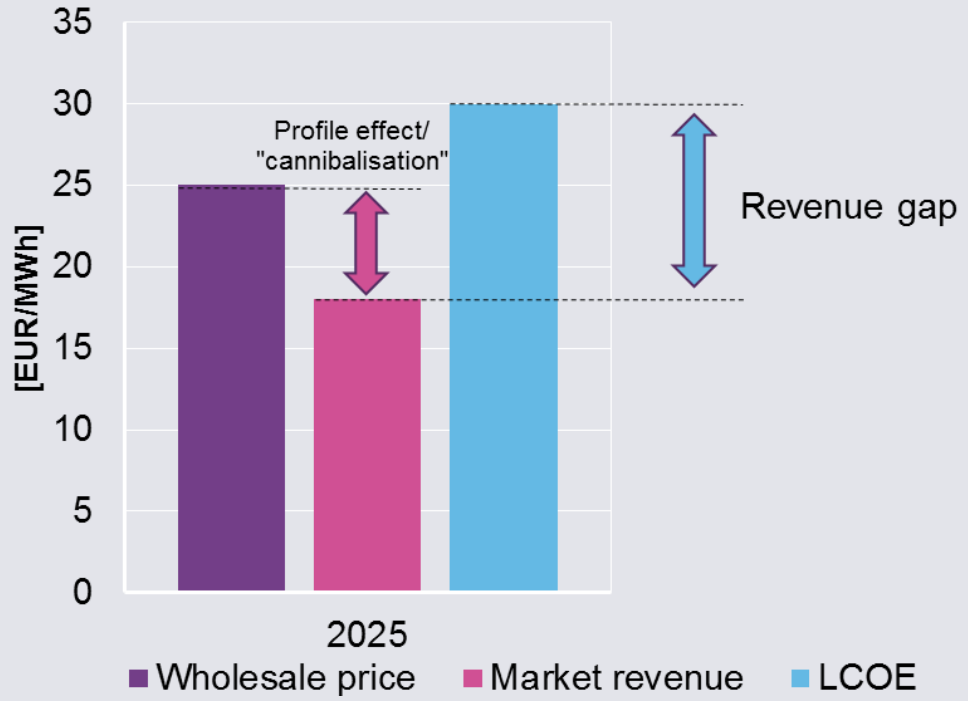
- Energy-market based RES investments lead to higher risks for investors, higher cost of capital, higher costs for society
- "Cannibalisation" effect of wind & PV: Typically, they do not generate in times of high prices: Market revenues below average baseload price
- Weak 2030 outlook for ETS prices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

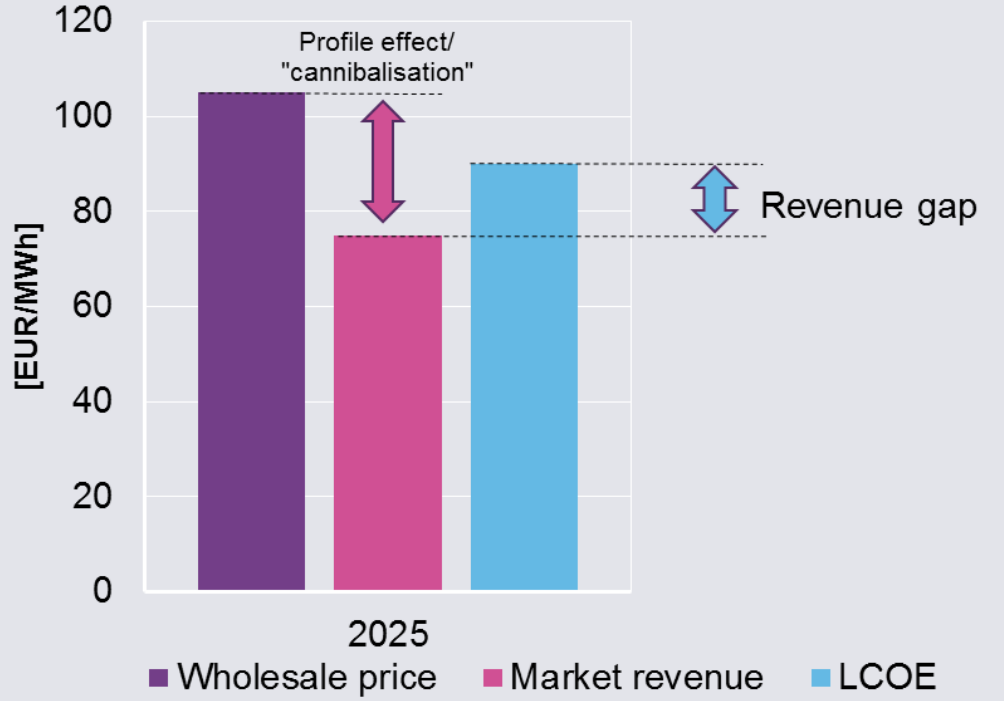
Element 4: Providing stable revenues for new RES-E investments to achieve EU target at least cost

Best case LCOE wind onshore, market revenue & wholesale price in a low fuel & low CO2 cost scenario in 2025



Öko-Institut (2014), IRENA (2015)

Worst case LCOE wind onshore, market revenue & wholesale price in a high fuel & high CO2 cost scenario in 2025



Öko-Institut (2014), IRENA (2015)