Governing Flexibility in a Reliable Low-Carbon Electricity System

Salzburg REFORM Meeting Session on
“Governing the Transition to Low-carbon Futures”

DR. BARBARA PRAETORIUS | SALZBURG, 03.09.2014

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?
- *Methods:* Analysing, understanding, discussing, assessing, putting forward proposals

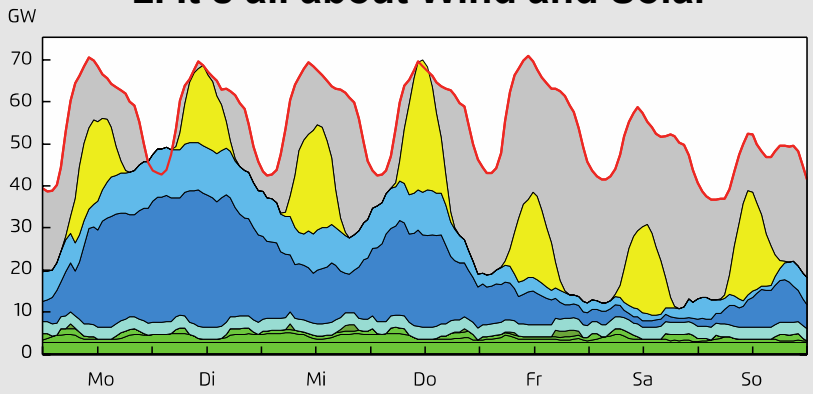
12 Key Insights of Agora Energiewende

Agora Energiewende

1. It‘s all about Wind and Solar“

Wind and PV are the cheapest renewable energy sources

The potential of other renewable energy sources is limited



> weather dependent
> variable
> only capital expenditure

How to balance demand and supply?
How to minimise costs?
How to realise the *Energiewende* in the European context?

TECHNICAL SYSTEM

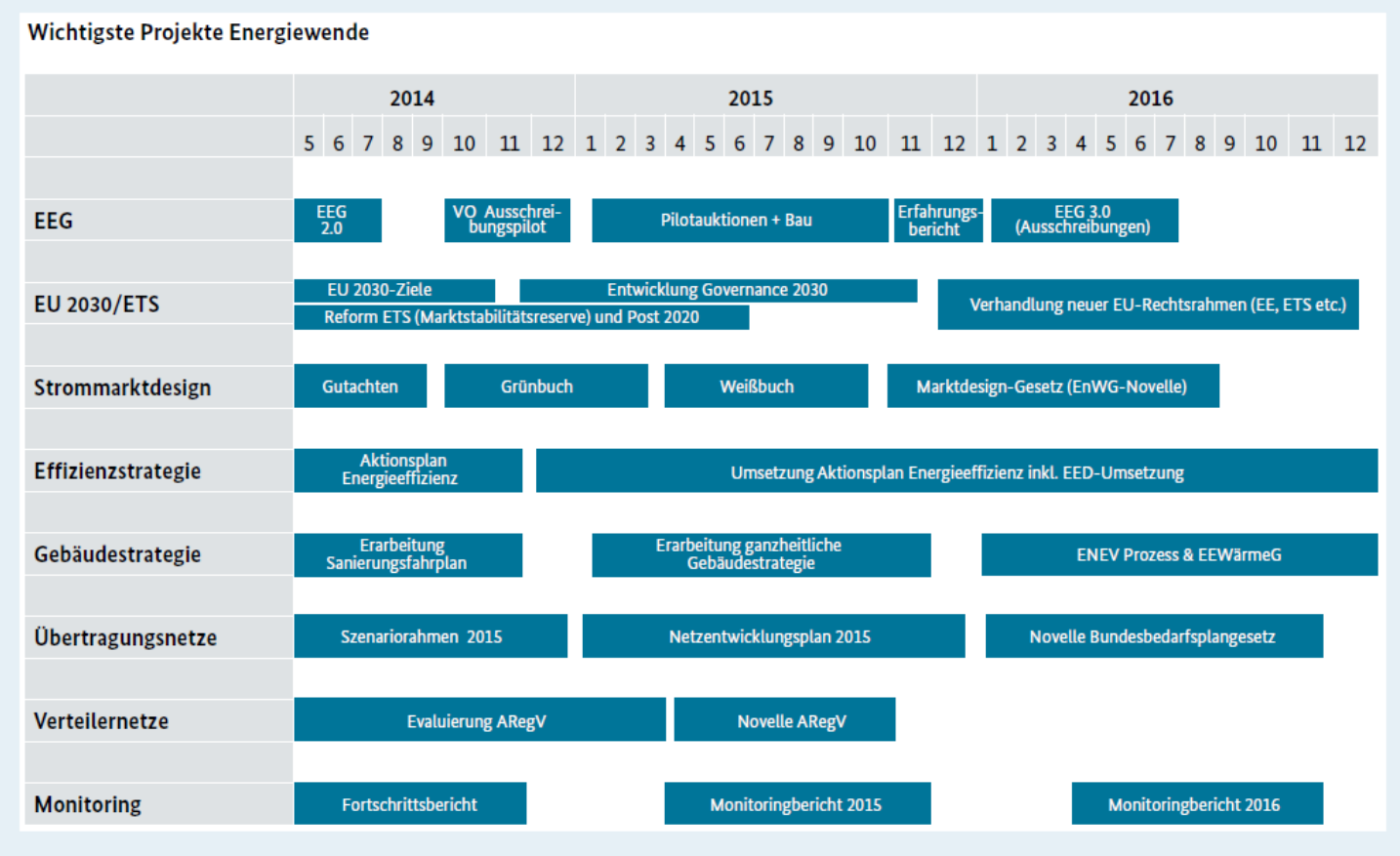
2. “Base-Load” power plants disappear altogether, and natural gas and coal operate only part-time
3. There is plenty of flexibility – but so far it has no value
4. Grids are cheaper than storage facilities
5. Securing supply in times of peak load does not cost much
6. Integration of the heat sector makes sense

MARKET DESIGN AND REGULATION

7. Today’s electricity market is about trading kilowatt hours – it does not guarantee system reliability
8. Wind and PV cannot be principally refinanced via marginal-cost based markets
9. A new Energiewende Market t is required
10. The Energiewende Market must actively engage the demand-side
11. It must be considered in the European context

12. A saved kilowatt is the most cost-effective kilowatt

Governance:
The Government has anounced ambitious plans for reforms in the legislative period 2013-2017



Source: Federal Ministry of Economic Affairs (BMWi), 2014

Outline

1. Status quo and trends in electricity generation
2. Challenges ahead: flexibility and reliability needs
3. Activating flexibility
4. Conclusions

Status quo and trends in electricity generation in Germany

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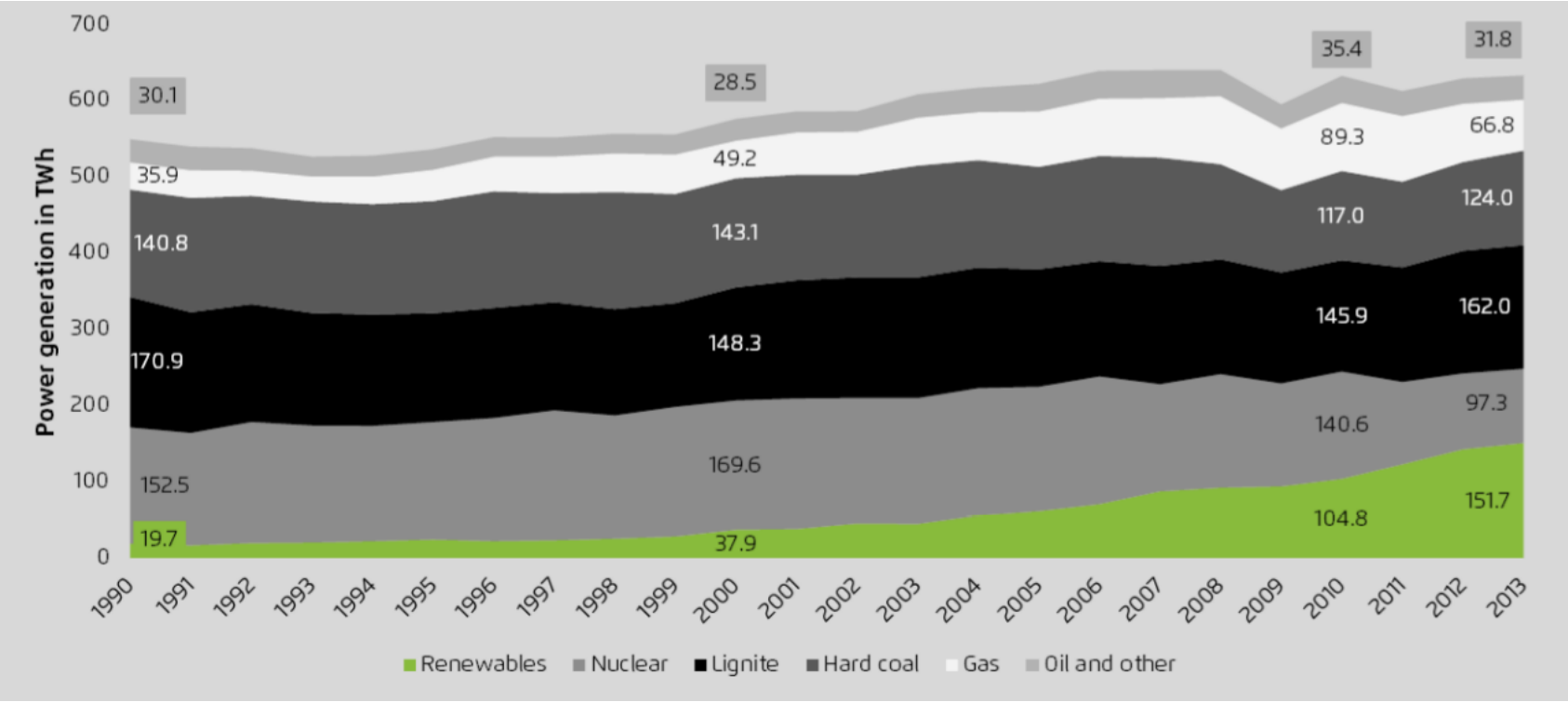
Renewables are rising, Nuclear is phased out, Hard Coal and Lignite are still strong

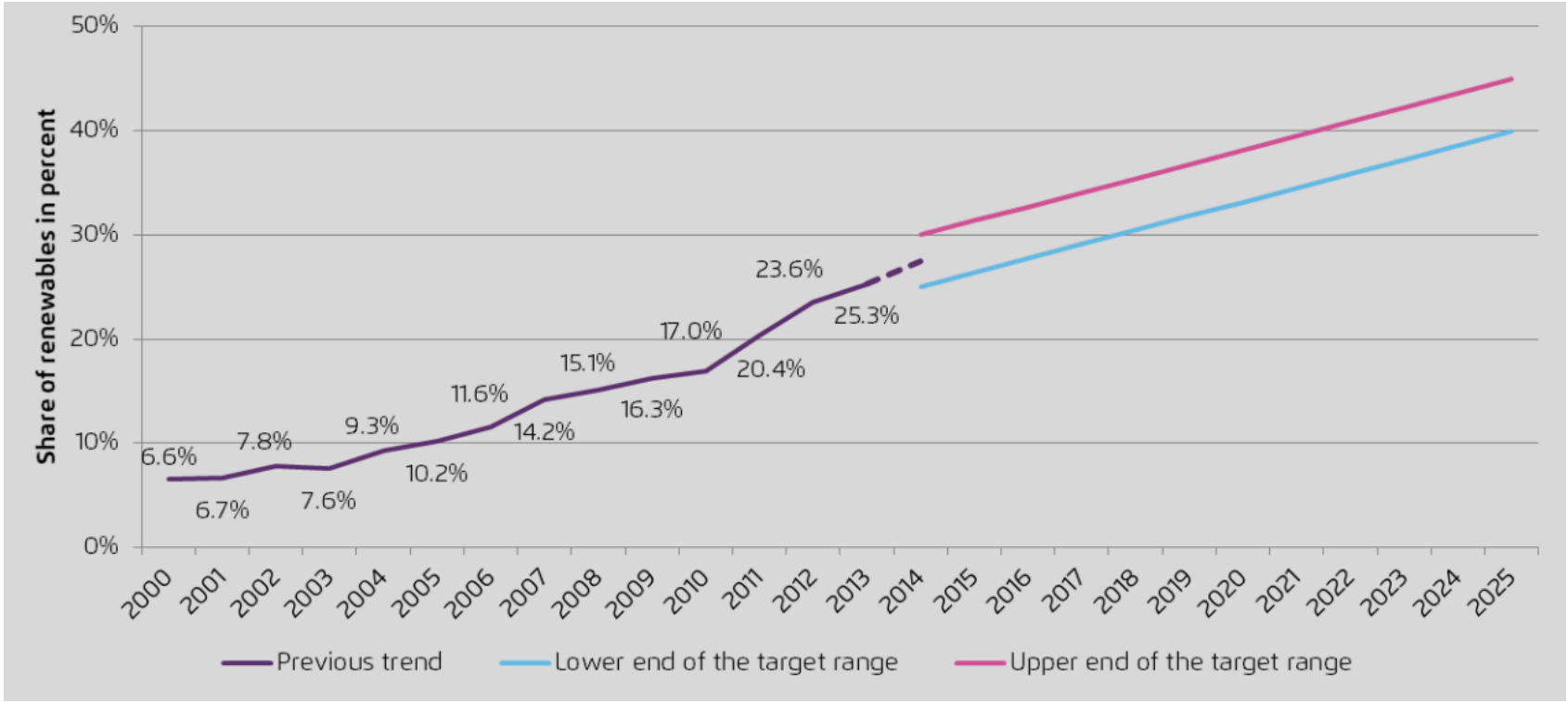
Germany's Power Generation 1990-2013



Source: AG Energiebilanzen 2014

Renewables increased constantly over the last ten years – and are to reach 40-45% by 2025

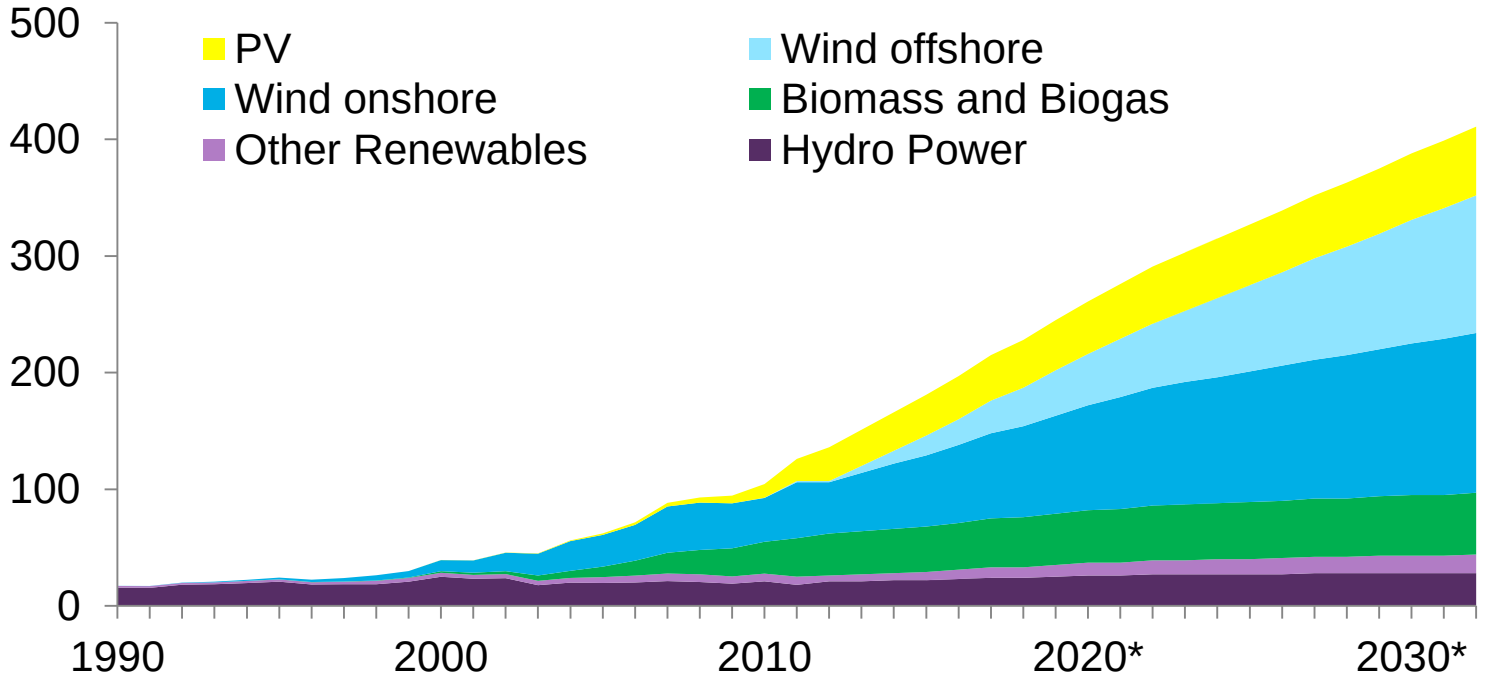
Share of Renewables in Gross Electricity Consumption



Source: AG Energiebilanzen 2014

The Key Insight for the *Energiewende*: „It‘s all About Wind and Solar“

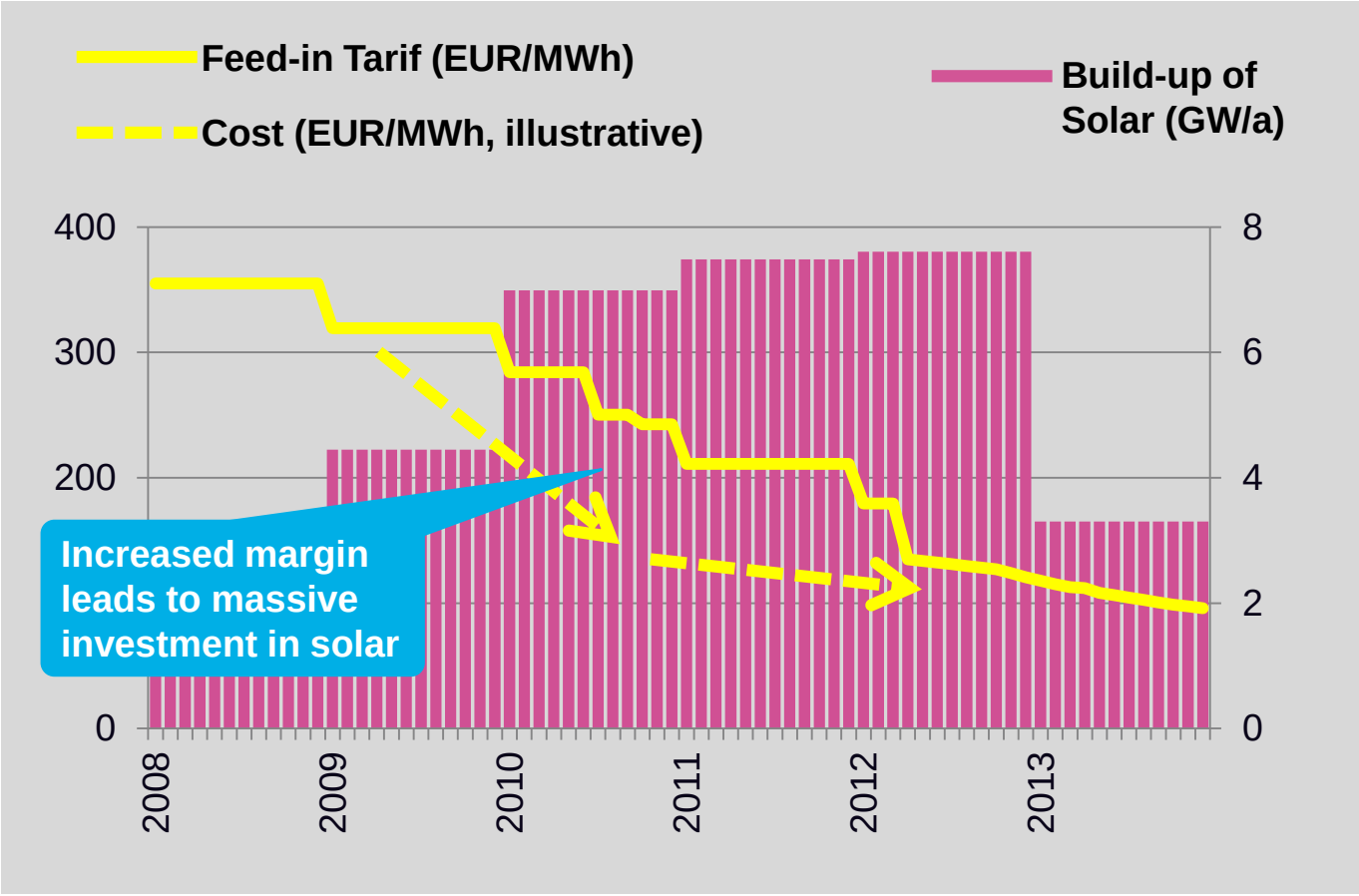
RES-Power Generation in Germany, TWh



	2000	2010	2020*	2030*
% Renewables	**7%**	**17%**	**43%**	**63%**
% Wind and PV			29%	48%

Source: Bundesnetzagentur 2013 – Forecasts for 2020 and 2030 for the grid expansion plan

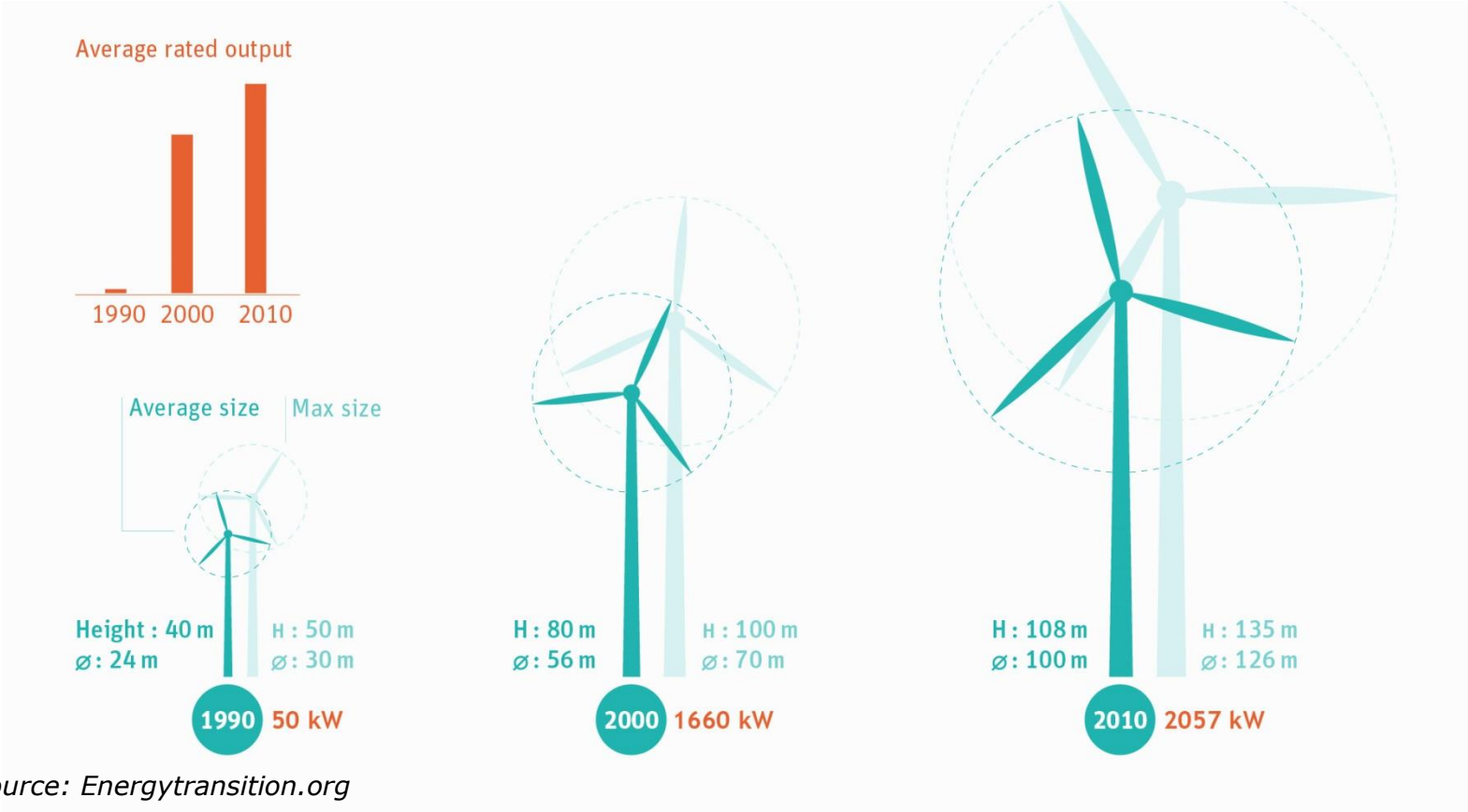
German “solar years” 2009-2012 bought solar photovoltaics down the learning curve.



- ~ 25 GW solar built in 4 years when feed-in tariff was still very high
- „Race“ between investors and policy: market moved faster

Renewables are an innovative technology that is now cost-competitive with fossil fuels (1) Example wind energy

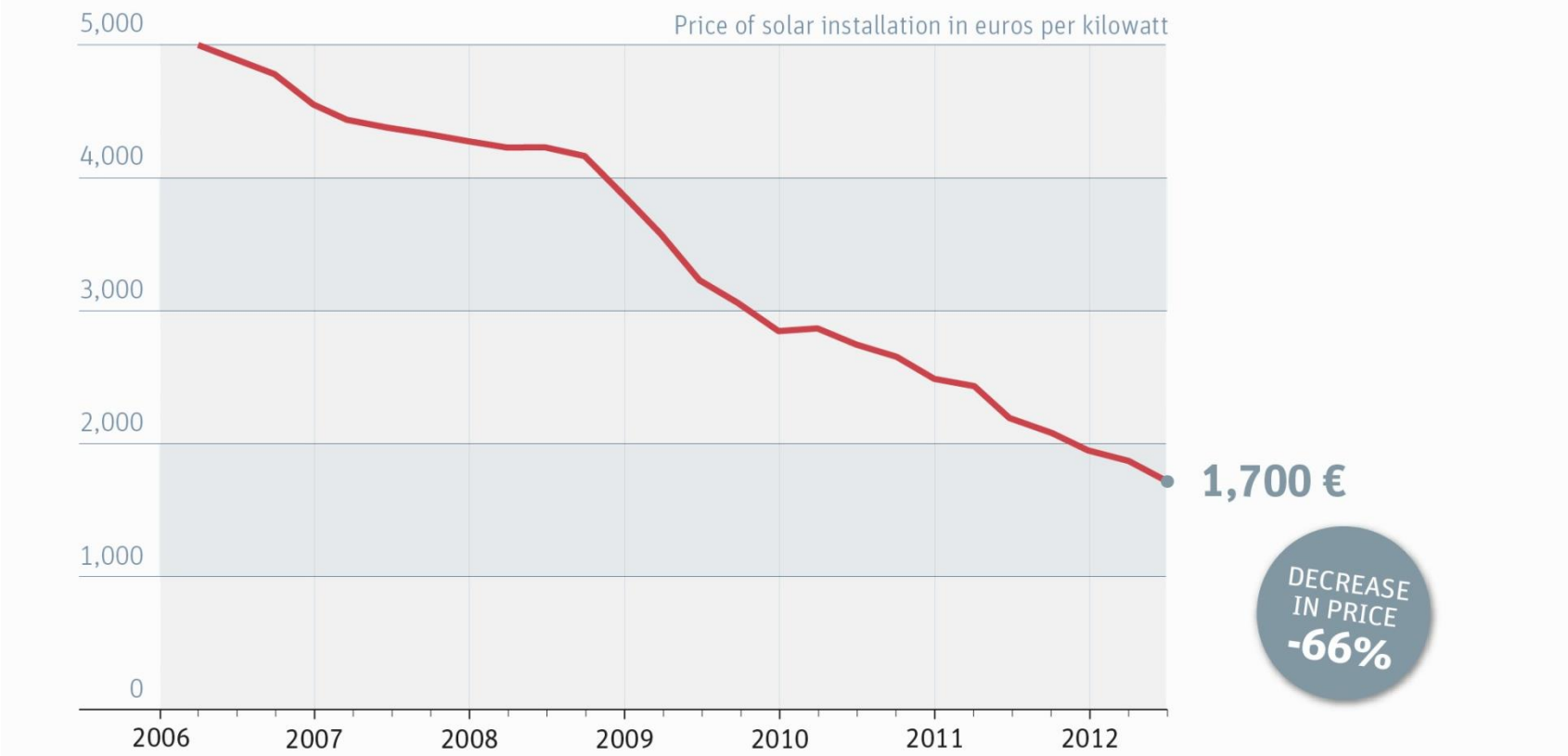
Wind Turbines today 40 times more powerful than 20 years ago



Source: Energytransition.org

Renewables are an innovative technology that is now cost-competitive with fossil fuels (2) Example solar electricity

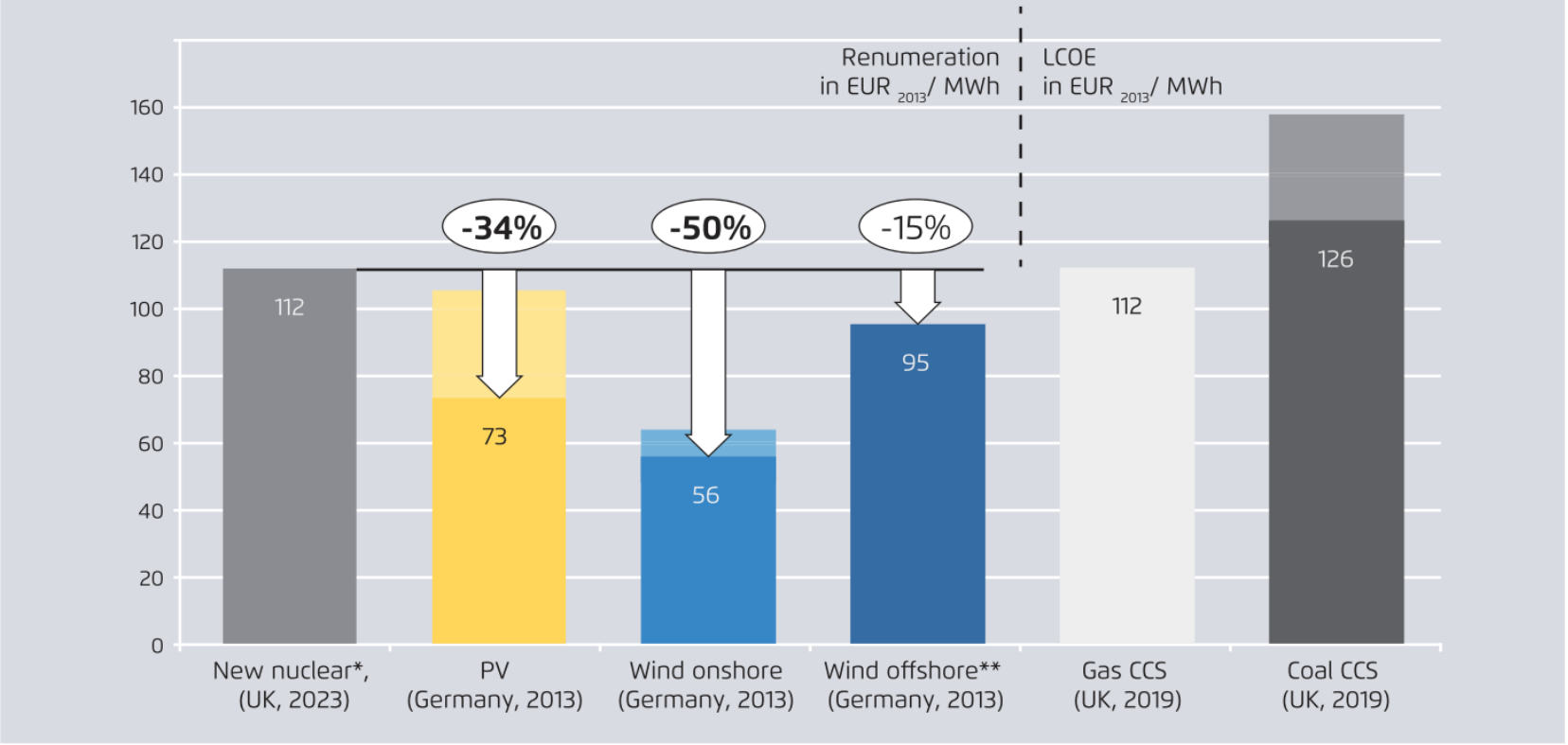
Price for Solar Systems has Decreased by >60% since 2006



Source: Energytransition.org

Today, wind and solar are the cheapest low-carbon technologies

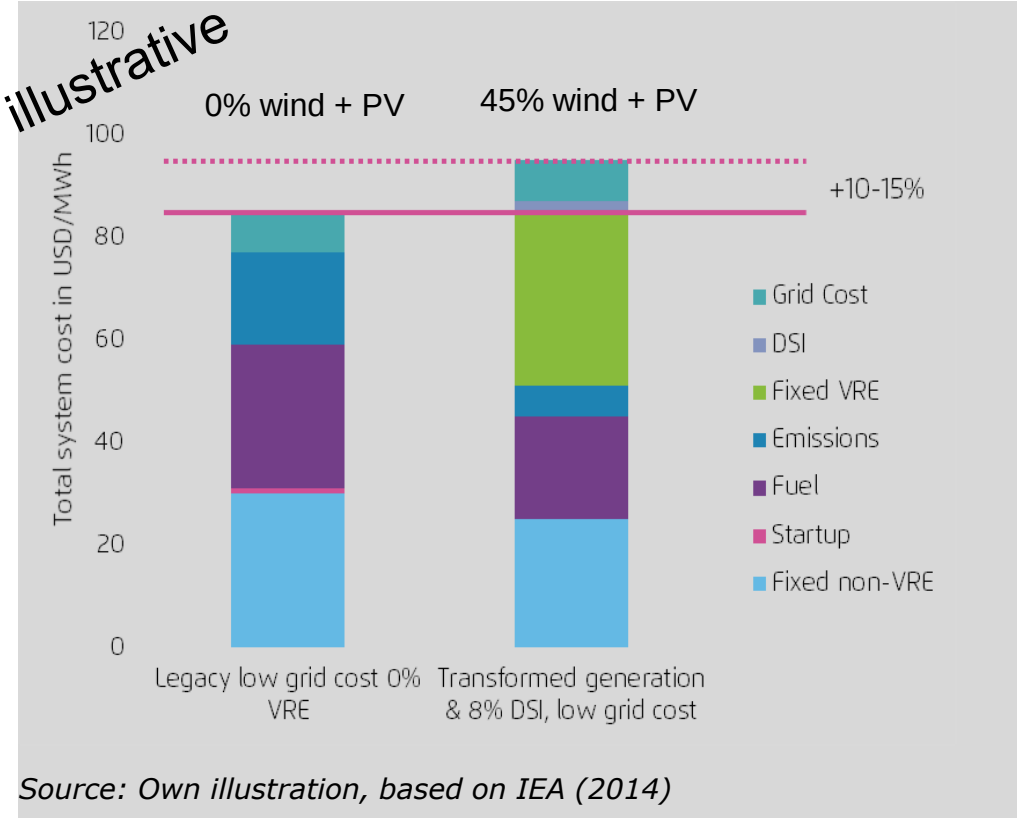
Power Generation Cost for Nuclear, Wind and Coal/Gas-CCS in EUR/MWh



Source: Agora Energiewende 2014

Future *system* costs of a wind & PV-based system are only 10-15% higher than those of a fossil fuel based system

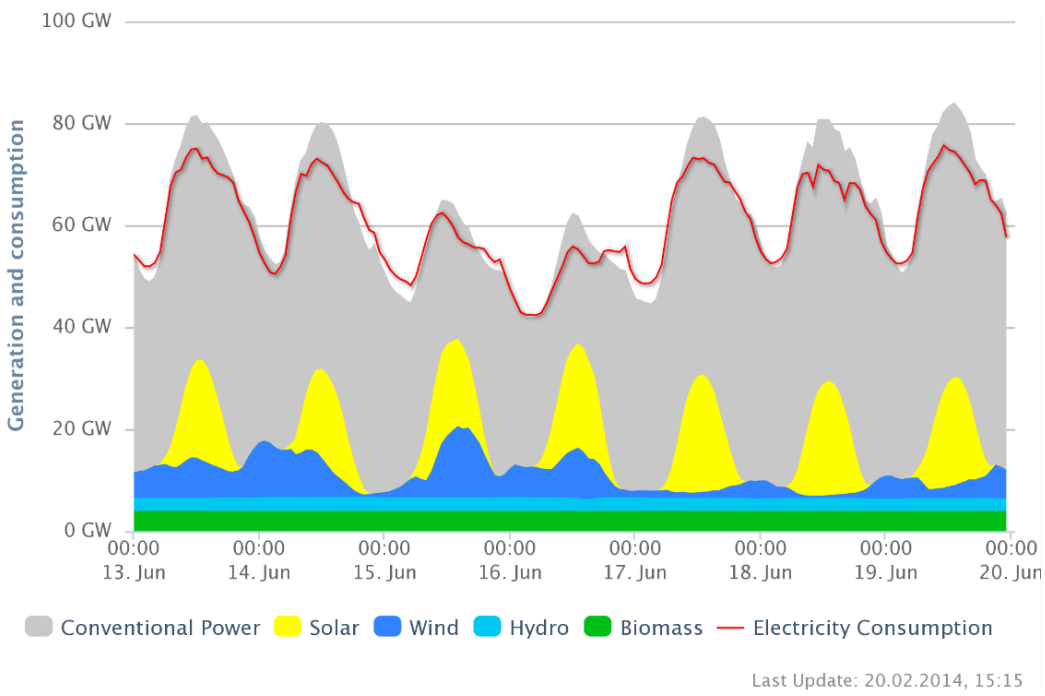
Future costs depending on the flexibility of the entire system



Source: Own illustration, based on IEA (2014)

- In the long run, high shares of Variable Renewable Energy may come at zero additional costs (IEA 2014)
- "Integration is not simply about adding wind and solar on top of 'business as usual'. **We need to transform the system as a whole to do this cost-effectively**." (IEA Ex. Director Maria v.d. Hoeven)

Interim conclusion: Wind and PV will fundamentally change the power system



Source: EEX 2014, ENTSO-E 2014

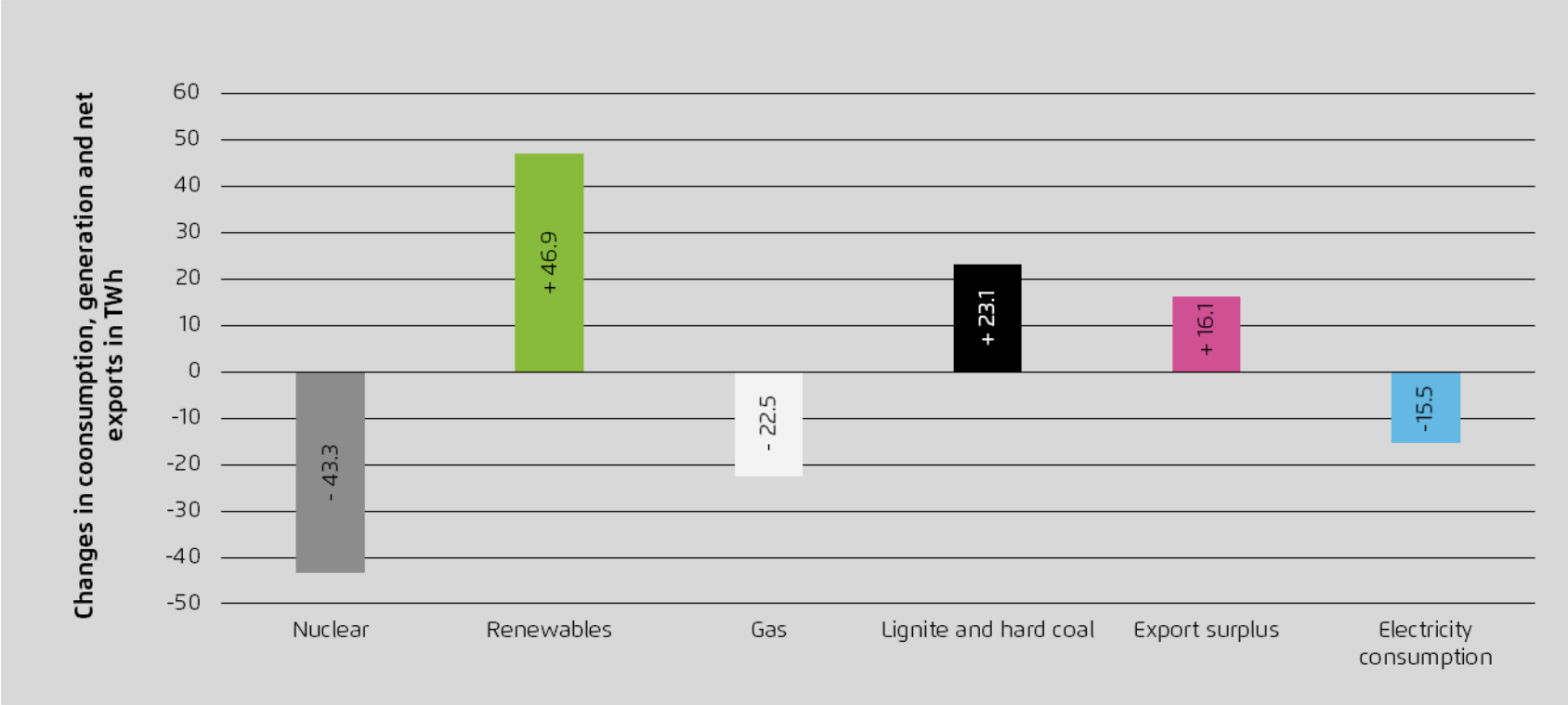
Wind and Solar…

- …are capital-intensive technologies,
- …have near-to-zero operating cost,
- … will see further decreases in LCOE (lifetime cost ./. kWh)
- …but produce electricity depending on the weather situation

(Some of the) Challenges

The development since 2010: Renewables offset nuclear, coal replaces gas – both domestically and abroad…

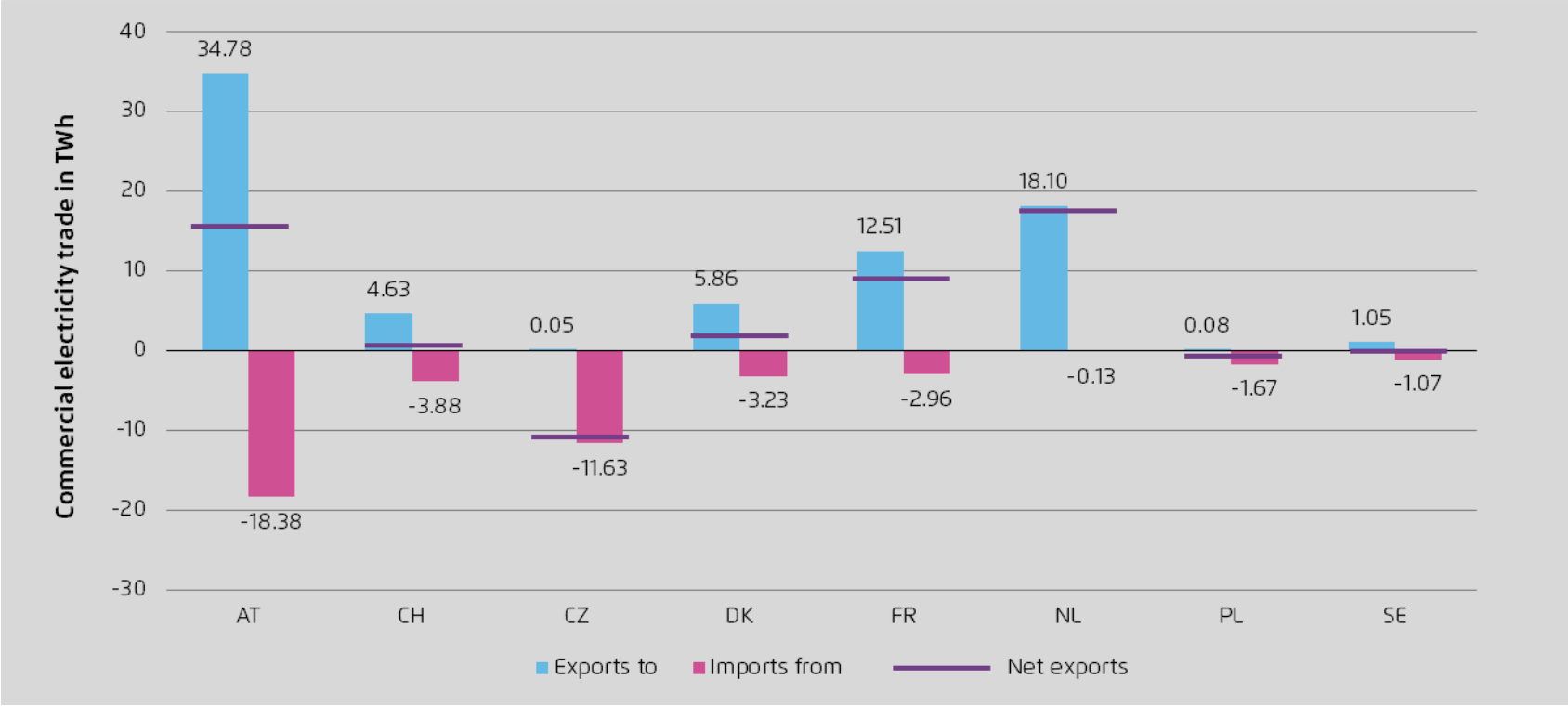
Changes in power generation and consumption 2010-2013



AGEB (2014)

…especially in the Netherlands and Austria.

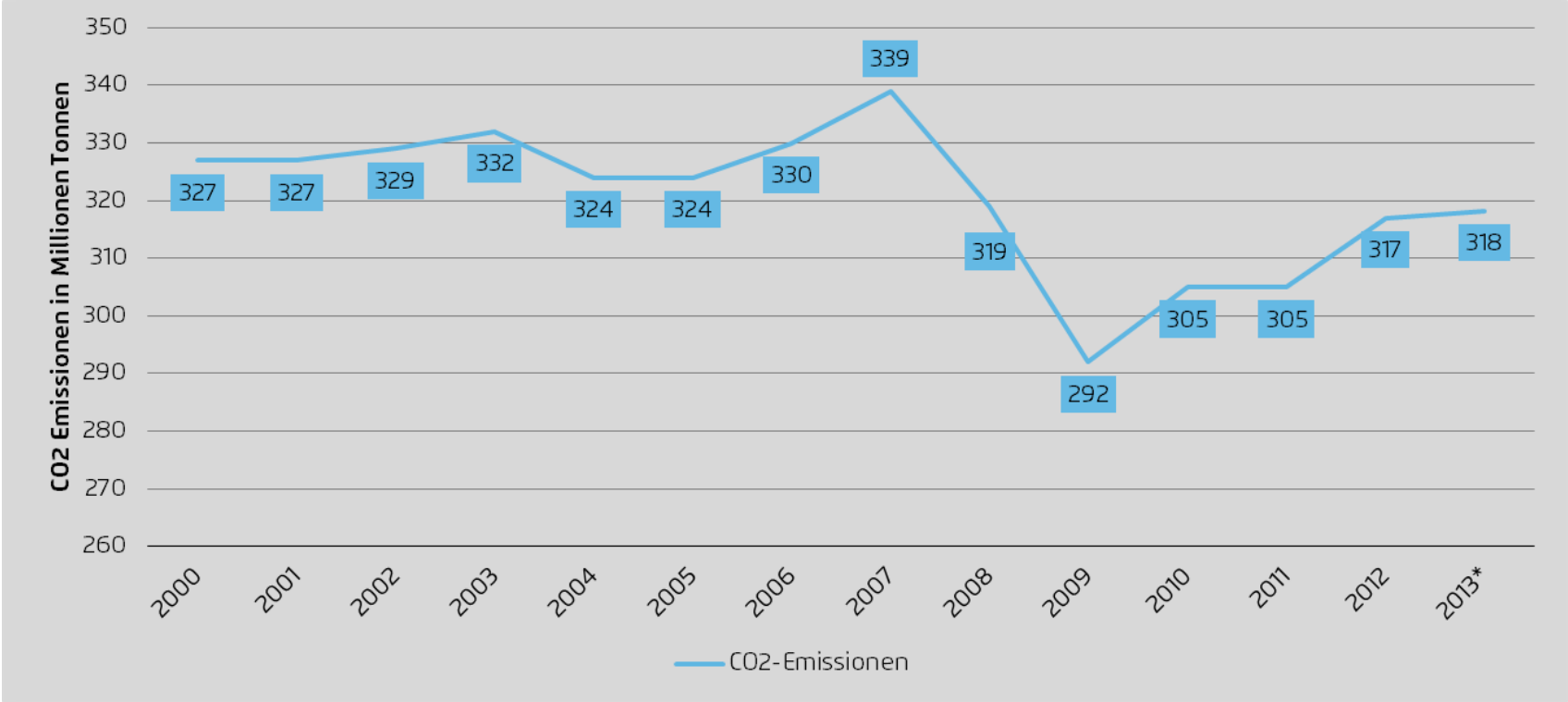
Commercial cross-border electricity trade in 2013



ENTSO-E (2014), own calculations

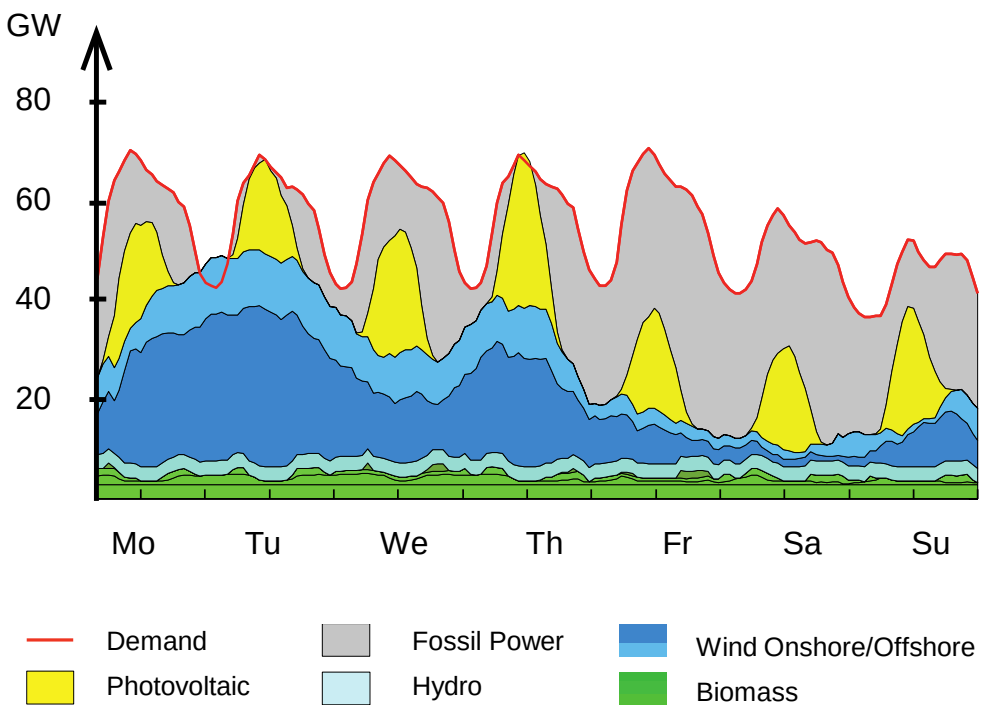
Challenge 1:
We need a new approach to reduce CO2 emissions (which have recently been raising)

Greenhouse gas emissions from power generation 2000-2013



Source: UBA, own estimations for 2013

Challenge 2:
We need a power system based on flexibility…

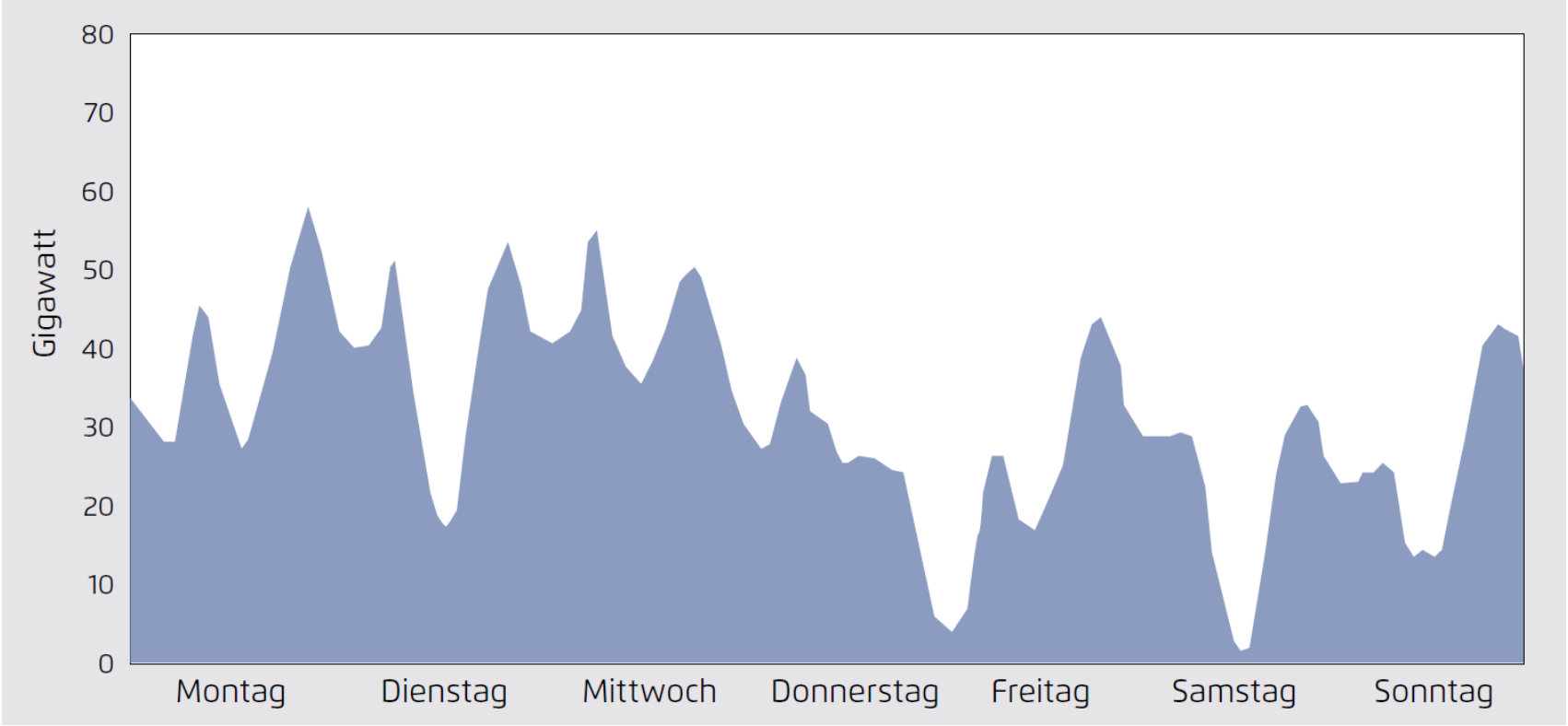


Flexibiilty options:

- Flexible fossil Power Plants incl. CHP
- Curtailment of Wind and PV
- (Smart) Grids
- Load Management / Demand Response
- Storage

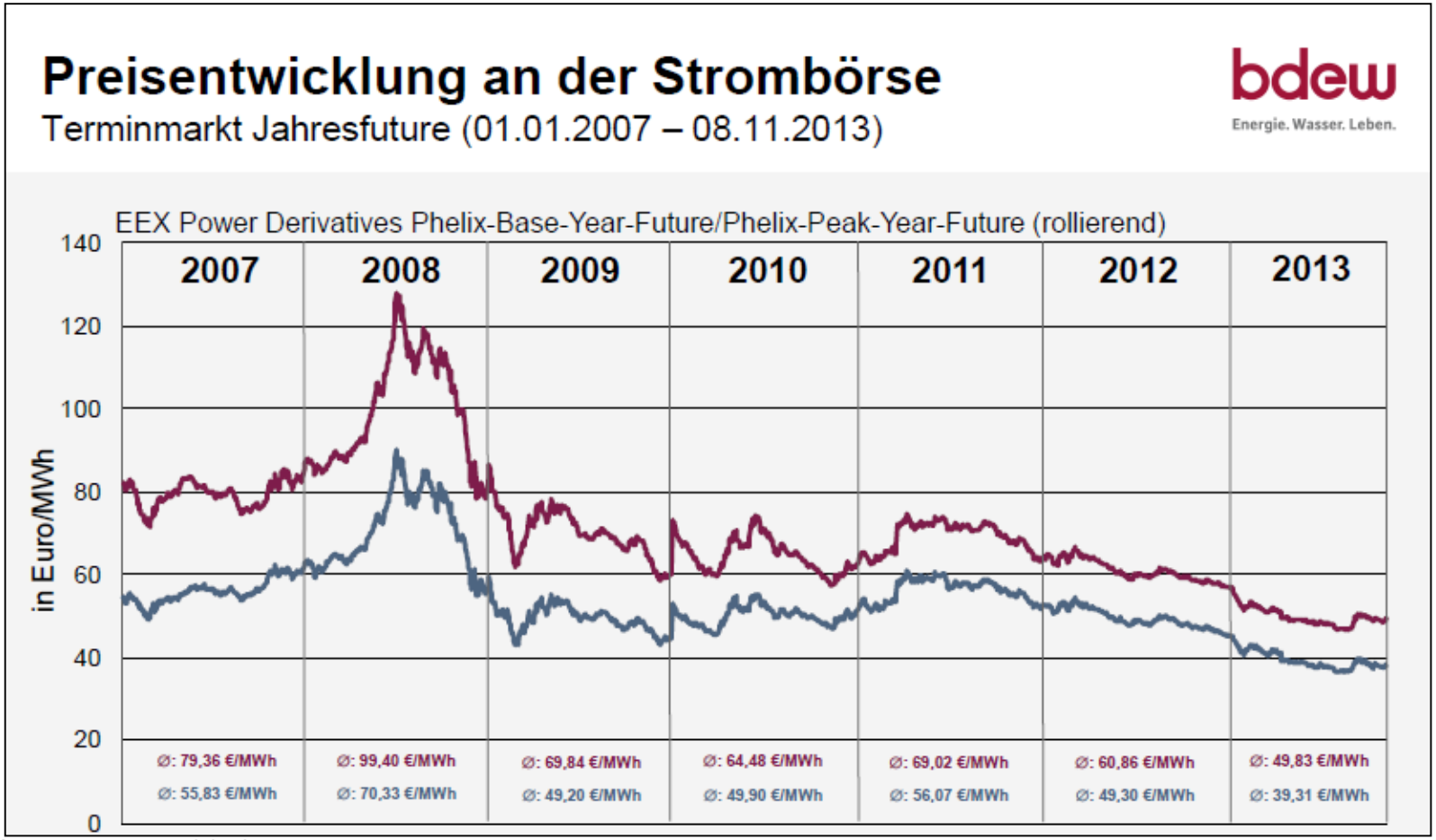
…with little or no baseload - rather we need flexible power capacities to cover residual load

Residual load (= load minus renewables) in a sample week in April 2022



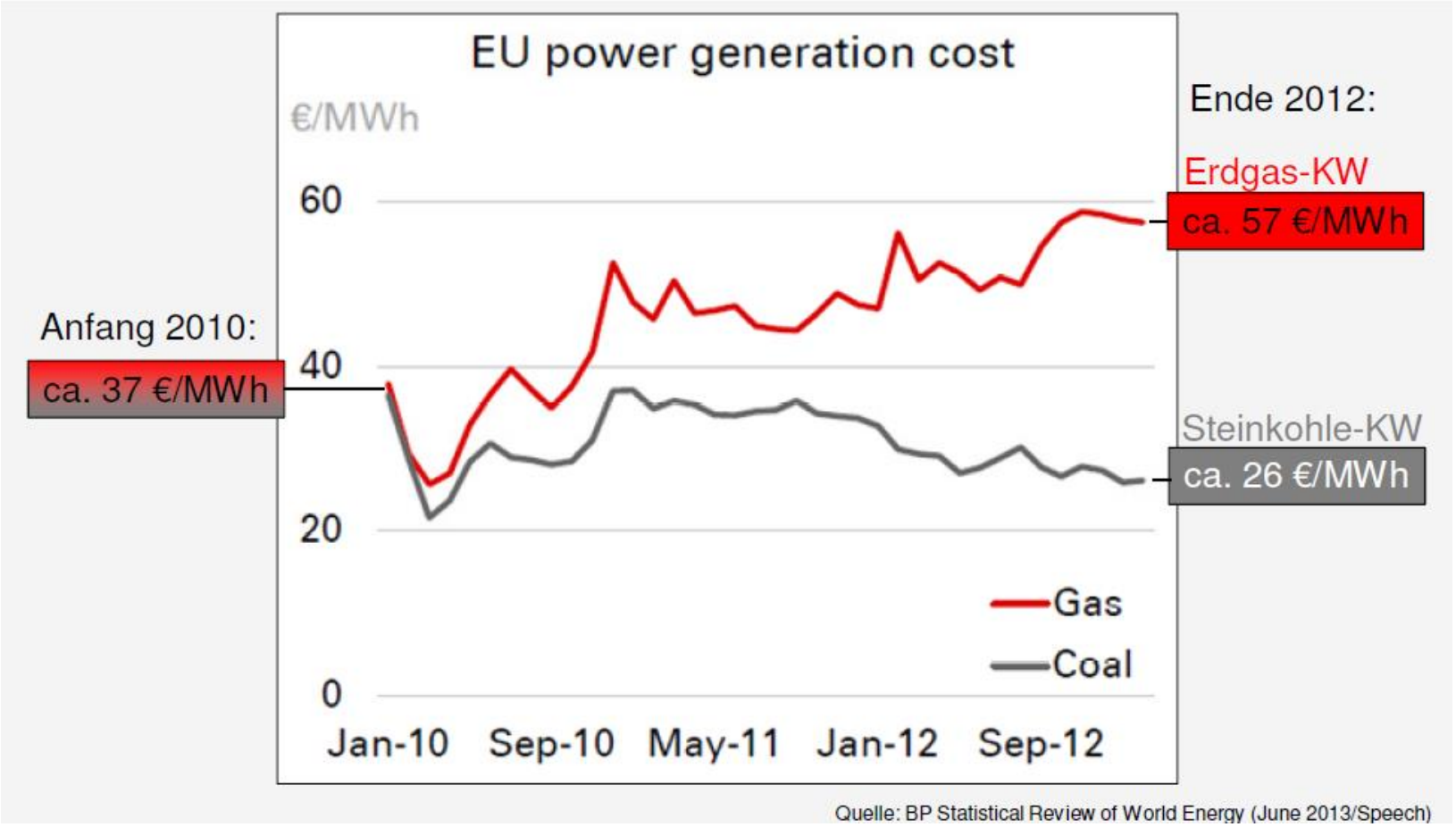
Source: RAP/Agora Energiewende, 2014

The problem:
Wholesale electricity prices on low levels…



Source: BDEW 2013

…… with the result that (climate friendly, flexible) gas power units (and other flexibility options) face problems



Challenge 3:
Redesign the market such that it triggers both efficient dispatch and investment decisions

Synchronise supply and demand

Energy-only market
Fossil fuel power plants, renewable energy systems, demand side

Ensure system reliability and climate protection

Investment market

Flexible capacity
Fossil fuel power plants, demand side, storage systems

?

Carbon-neutral Capacity
Renewable Energies

Safeguard system stability

Market for ancillary services (e.g. reserve and balancing energy)
Fossil fuel power plants, renewable energy systems, demand side, storage systems

Activating flexibility: How much of what is needed?

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What are the technological flexibility options and their cost? The case of storage

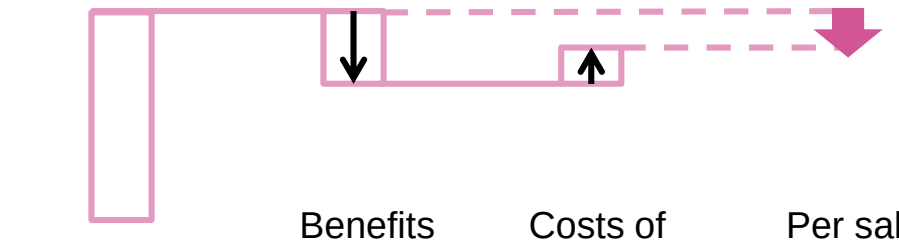
Preliminary

Agora looked at flexibility options in a recently commissioned study and asked whether a clear prioritisation of different flexibility options is possible

Flexibility options considered in the study

- Grid extension towards neighbouring countries
- Flexibilisation of CHP
- Flexibilisation of demand side
- Short term storage options
- Long term storage options

Approach: Comparison of cost and benefits for each option



Total cost of electricity suppy – reference case

Benefits of option X (savings)

Costs of option X (investment cost)

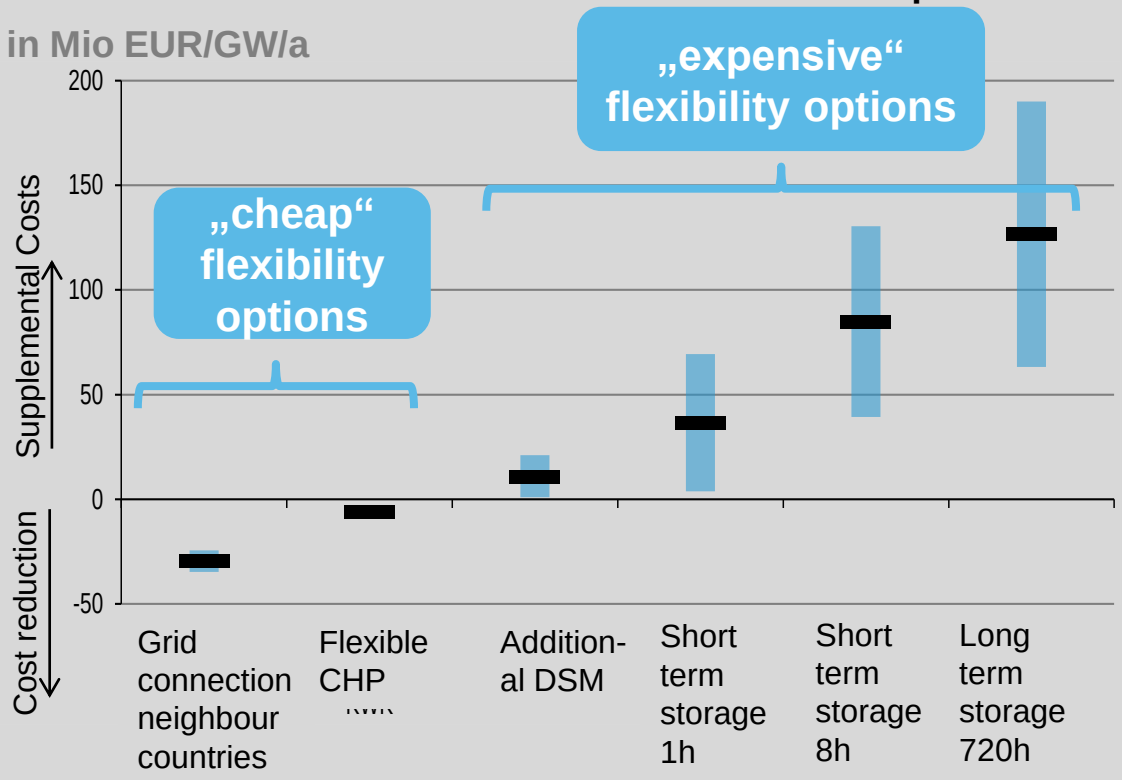
Per saldo effect of option X on total cost of supply

Preliminary results for next 10-20 years: No need to wait for storage technologies, no relevant surplus energy to justify storage…

Vorläufig

Cost reduction vs. Cost increase for different flex options

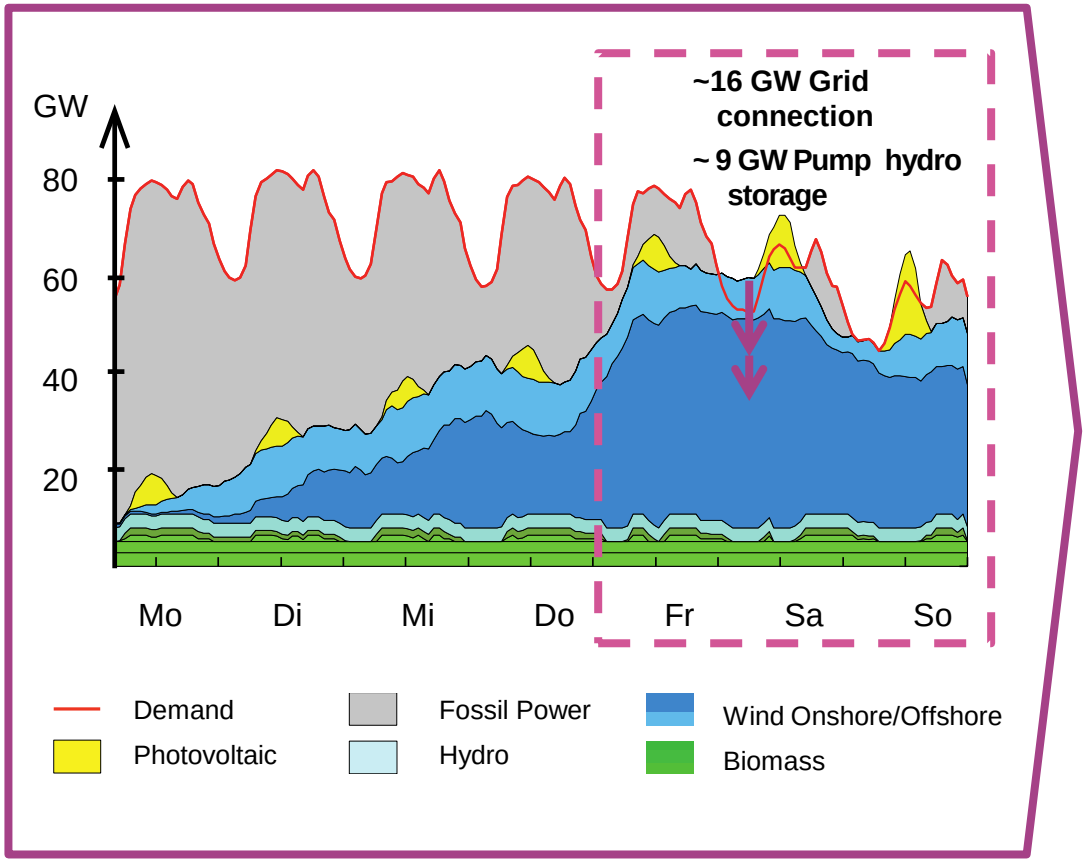
in Mio EUR/GW/a



A prioritisation of different flex options for the next 10 years is possible:

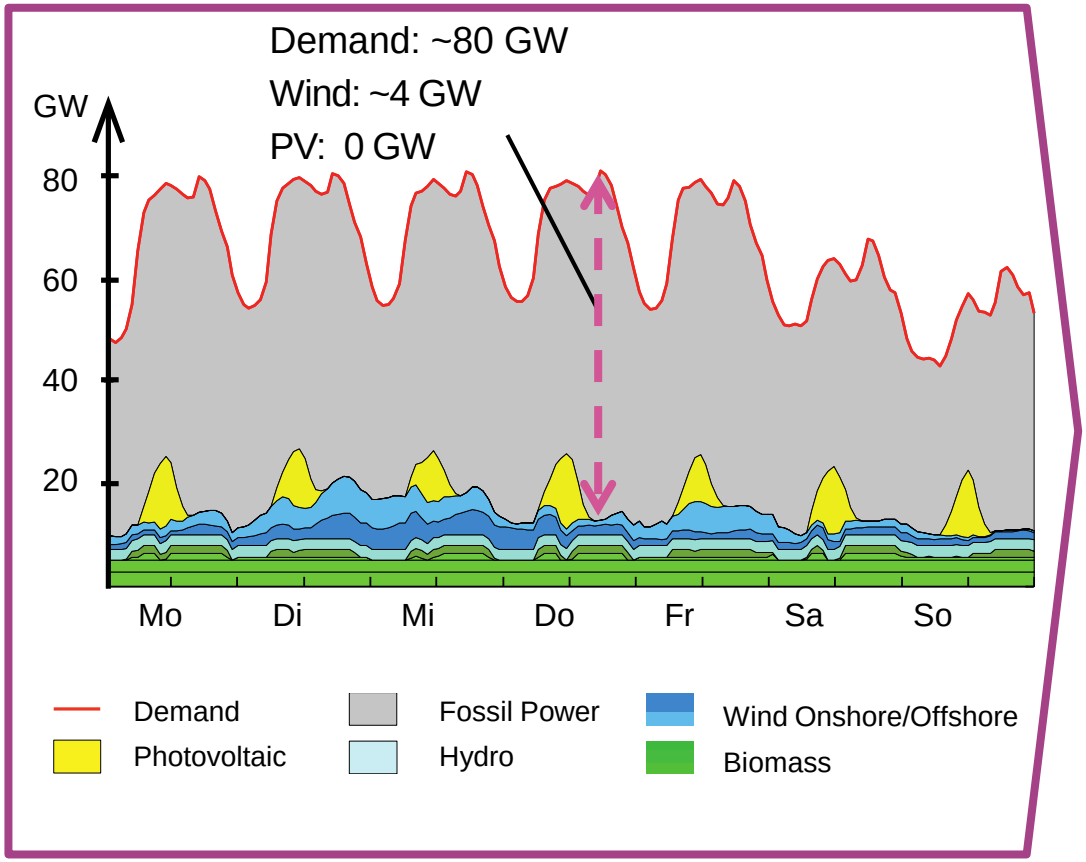
- Improve grid connection capacities to neigbouring countries
- Increase flexibility of CHP
- Only little positive impact of more DSM
- Storage causes significant supplemental cost because of high investment cost

…. as new storage technologies are needed only beyond 65-70% share of renewable elec



- Grids decrease the need for new storage technologies
- Other flexibility options are available and cheaper until ~70% RES (from a system perspective)
- Batteries may provide a business case earlier - by saving taxes and fees (in „grid parity“ world)

…. and securing supply in times of peak load does not cost that much in the 2020s



- In 2020, 15-25 GW controllable resources are needed which operate **less than 200 hours a year**
- Open cycle gas turbines can meet this demand cheaply (35–70 million EUR per year per GW)
- Demand-side measures and European resource sharing will further reduce cost

Conclusions for Governance

Time? Cost? Action? Governance?

1. Flexibility options are available and not too costly.
2. There is time to think and consider approaches to activate flexibility options.
3. Yet not too much time.
4. There are some principles that should lead thinking about future governance of flexibility for reliable electricity.

(1) A well-designed energy-only-market is likely to deal better with complexity than planning methods.

- Complexity of the energy system, once moderate, is rising:
  - Increasing number of generation units
  - Generation from wind and PV forces the entire system to react constantly
  - Demand side needs to be and will be more flexible
  - Demand and flexibility from heating and mobility need to be integrated
- The enormous number of dispatch- and marketing-decisions can only be coordinated by reliable price signals sent out from the energy-only-markets. This is also true for renewables (there is no direction of integration).

(2) Price signals are distorted. This is due to historical decisions and path dependencies. Hence there is a need to rethink market design.

- The recent reform of the renewable energies act (EEG) addressed this by strengthening direct marketing.

- However, price signals today are still distorted, creating many inefficiencies, among them:
  - Renewables selling energy at times of negative prices
  - Investments in generation units and storage facing different price signals before than behind the meter

- Access of renewables to balancing markets is still limited.

(3) Flexibility should include better incentives for supply and demand to react to negative prices

Negative prices are not bad per se, they are (more or less) the efficient market results of a given system.

But negative prices

- drive up the EEG-surcharge (and have a negative impact on public acceptance because the mechanism is not well understood)
- indicate a lack of flexibility of the system: In none of these hours, renewable generation accounted for more than 65% of the load (2022: 1.200 hours)

➔ Identify economic means to avoid curtailment of renewables

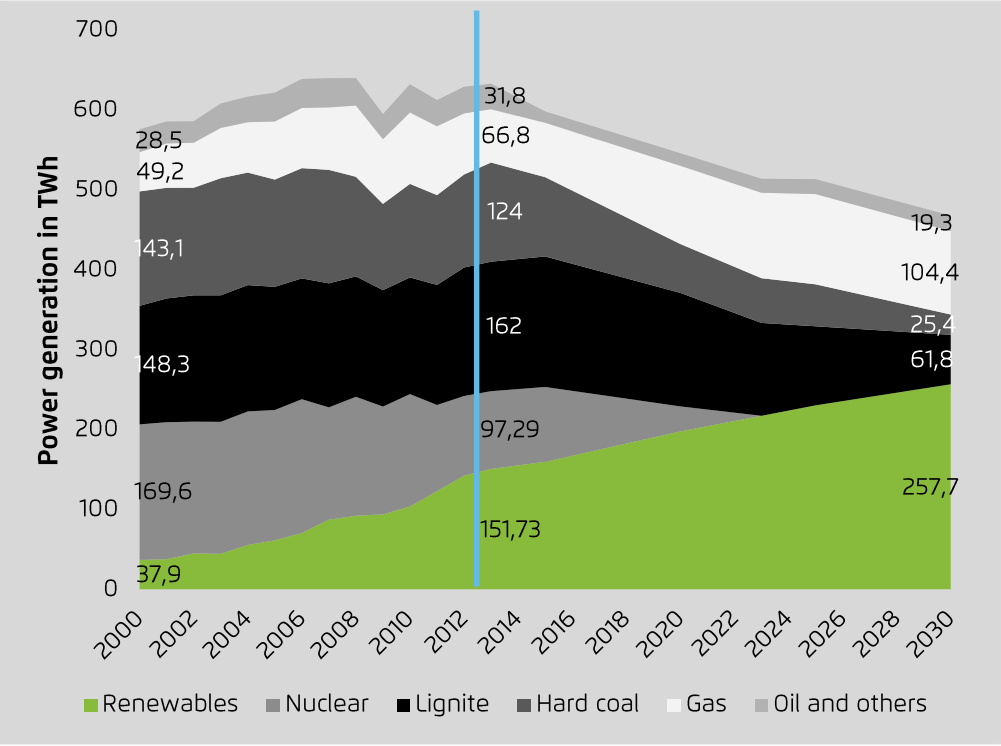
➔ Discourage conventional generation running at negative prices

We suggest a “Flexibility Law” to improve flexibility and to reduce existing barriers

- Spot market: Introduce more short-term oriented trading options
- Better integration of spot market and balancing markets
- Improve balancing markets by better integrating load management
- Open balancing power markets to renewables and to storage
- Incentivise flexible backup technologies, including flexible cogeneration
- Reduce negative incentives from grid fees for load management and self generation/consumtion in industry and households
- Allow power to heat to use otherwise lost renewable electricity

Is coal experiencing a renaissance?

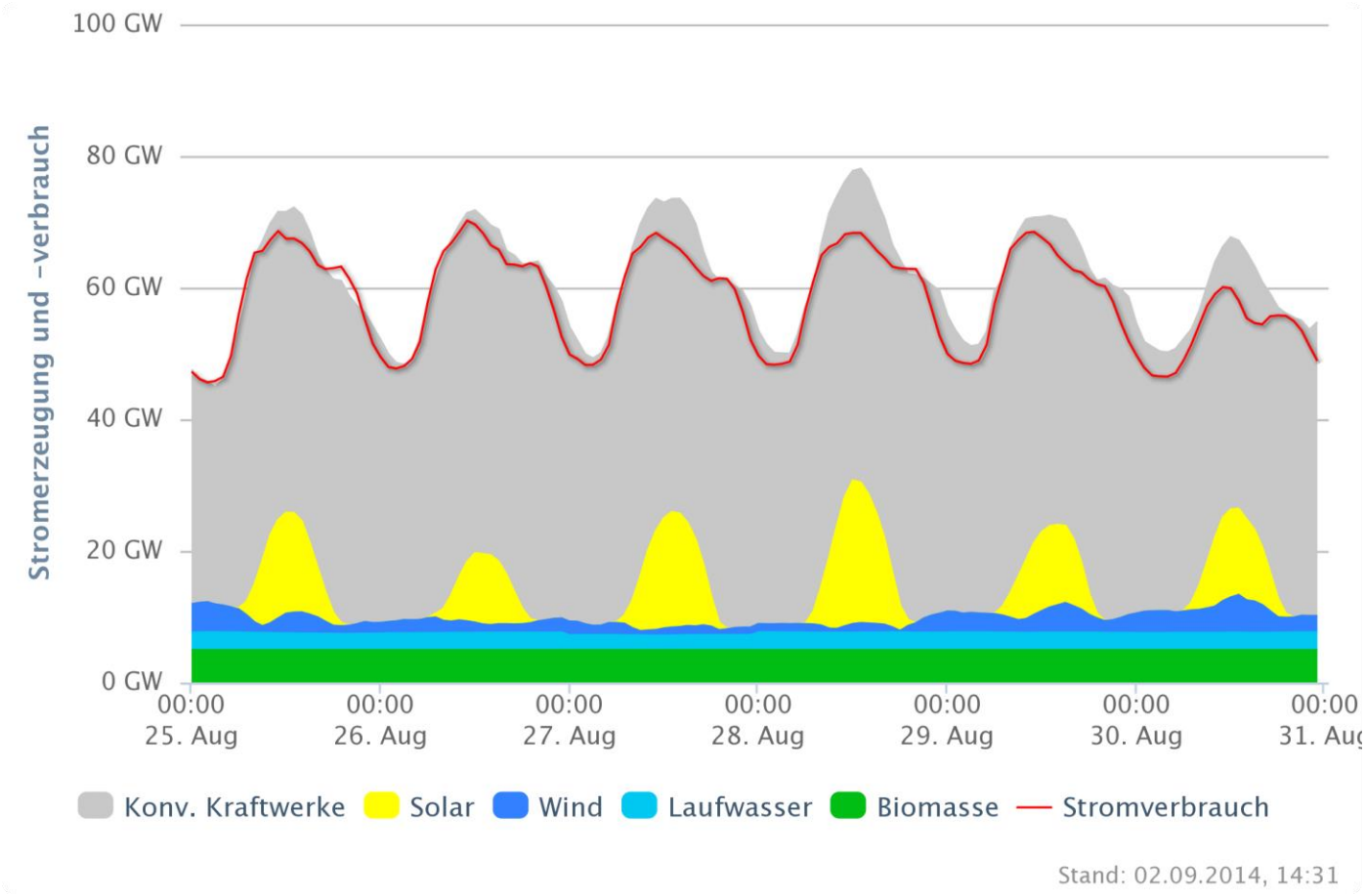
No future for coal in spite of increasing use in the short term



- In the short term, coal use increases due to favorable economic conditions and new fossil generation capacity that have been planned since 2007.
- However, the market environment does not provide incentives for building new coal plants as the wholesale market price level is expected to remain too low.

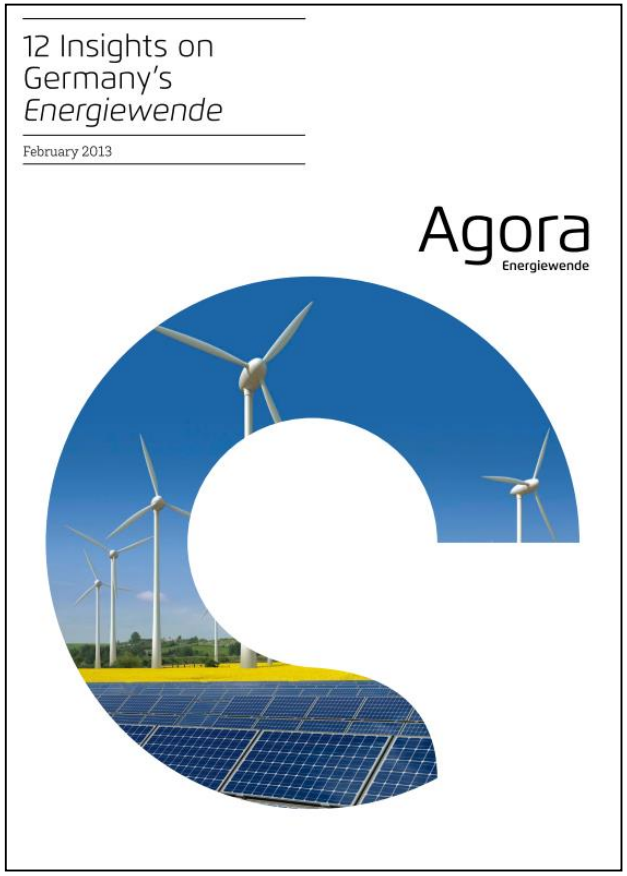
Source: AGEB 2014, Prgnos/EWI/GWS 2011

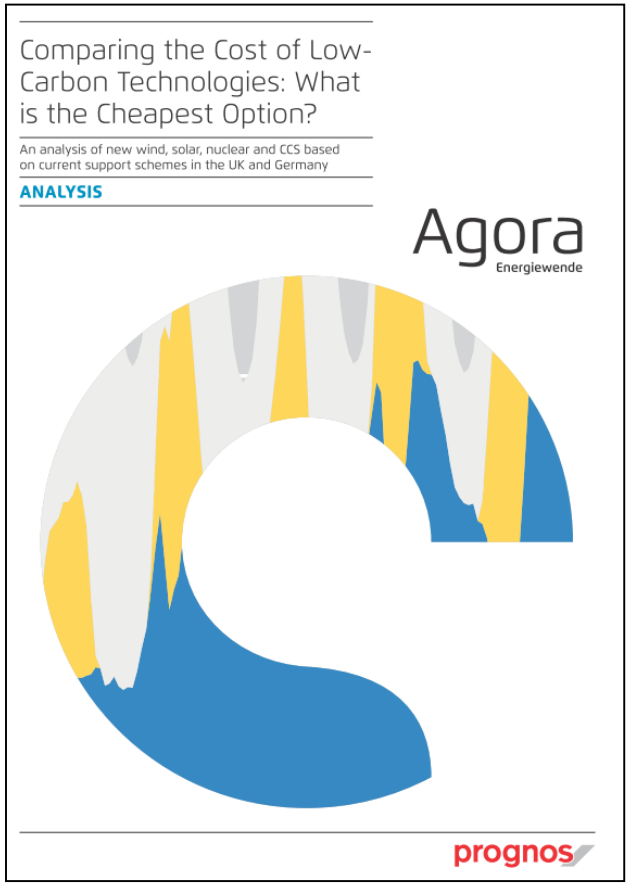
What is the *Energiewende* doing today?
Last week‘s power production



What is the *Energiewende* doing *tomorrow*? Help avoiding adaptation trainings!

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





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Alle Informationen auch zum Download unter www.agora-energiewende.de

Vielen Dank für Ihre Aufmerksamkeit!

Kommentare sind herzlich willkommen:
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Agora Energiewende ist eine gemeinsame Initiative
der Stiftung Mercator und
der European Climate Foundation im Rahmen
der Smart Energy for Europe Platform (SEFEP)