Decarbonising the power sector: about myths and real challenges

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Agora Energiewende – Who we are

Think Tank with more than 20 Experts

Independent and non-partisan

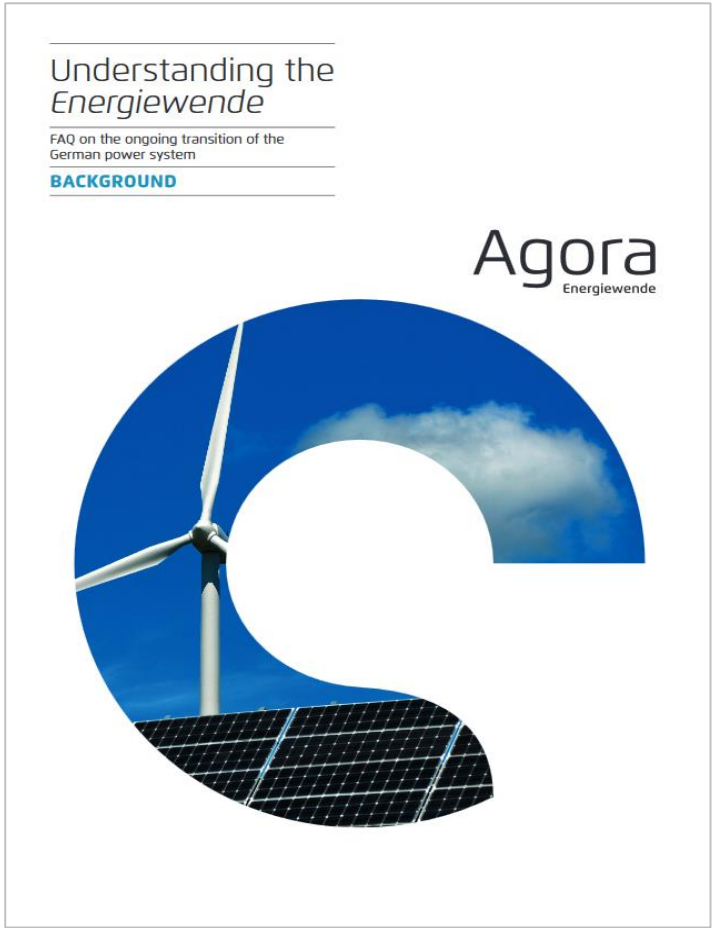
Project duration 2012-2021

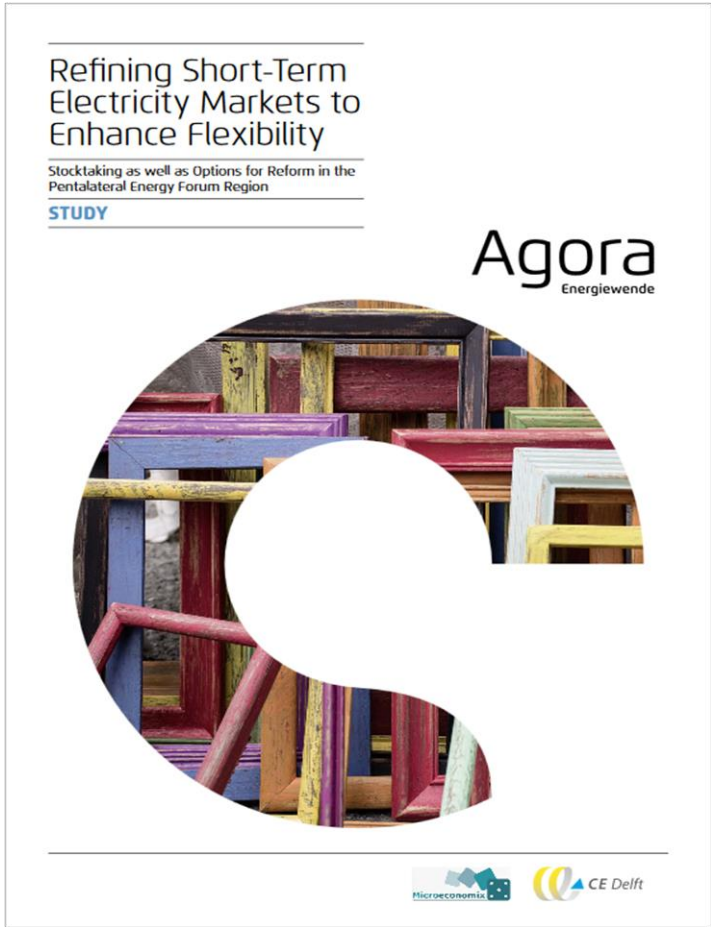
Financed with 29 Mio. Euro by Mercator Foundation & ECF

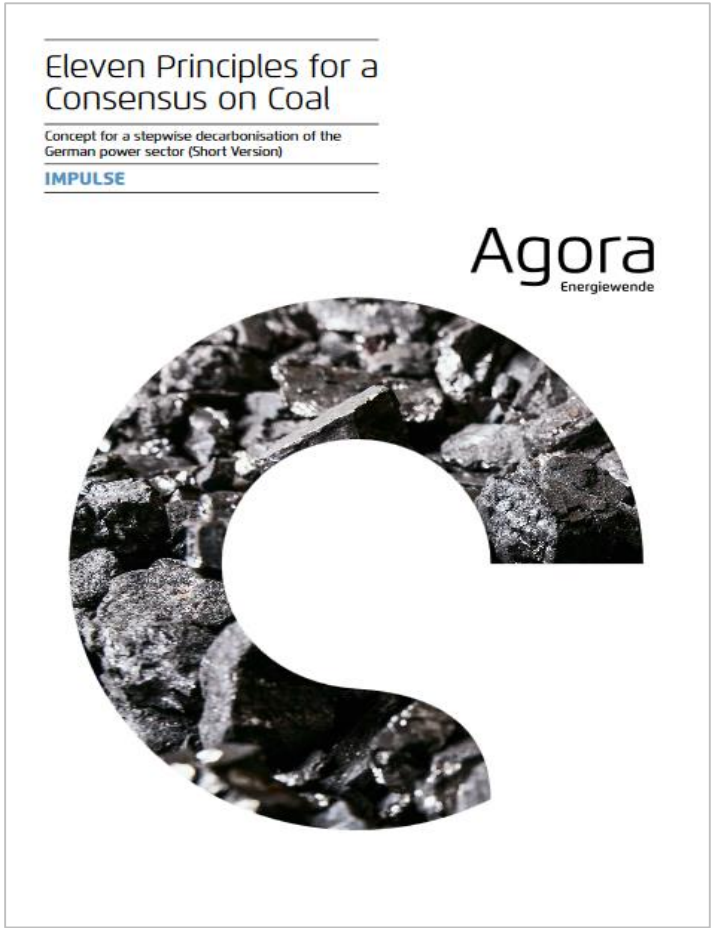
Mission: How do we make the energy transition in Germany and worldwide a success story?

Methods: Analyzing, assessing, understanding, discussing, putting forward proposals, Council of Agora

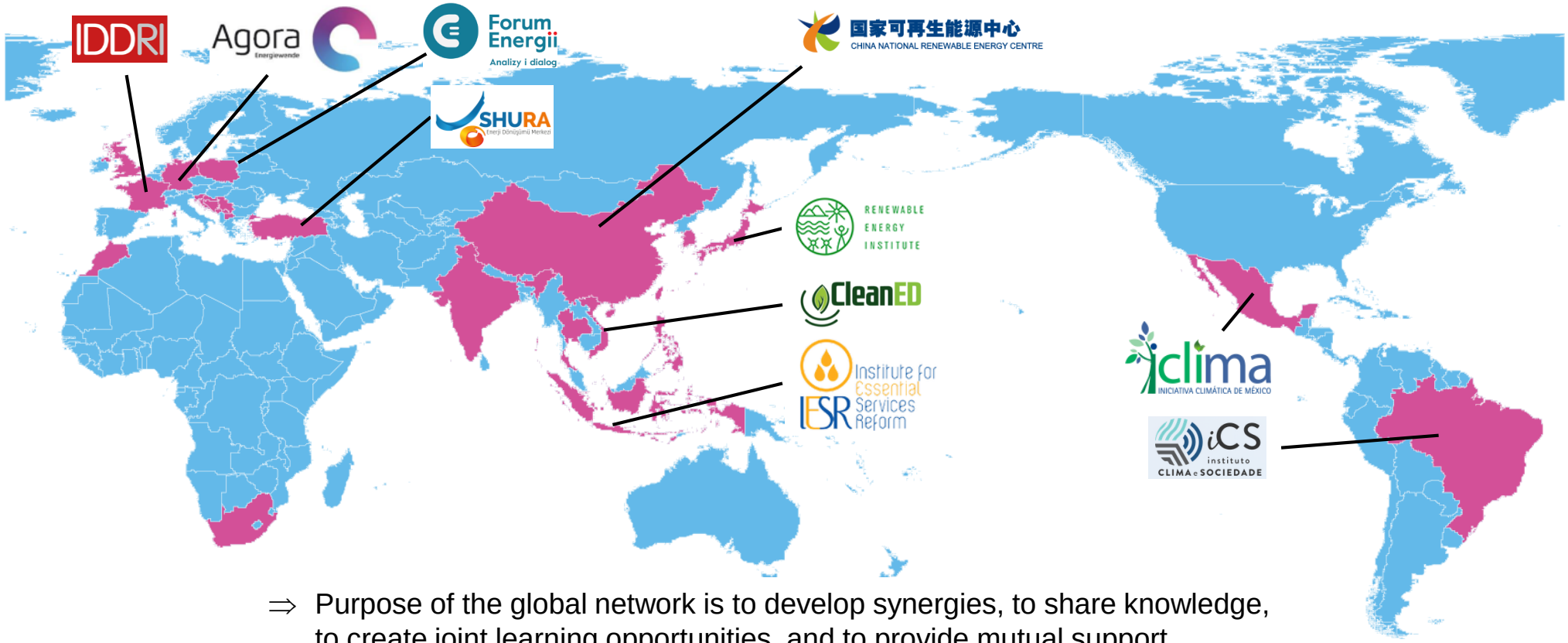
More information and studies available at our website www.agora-energiewende.org





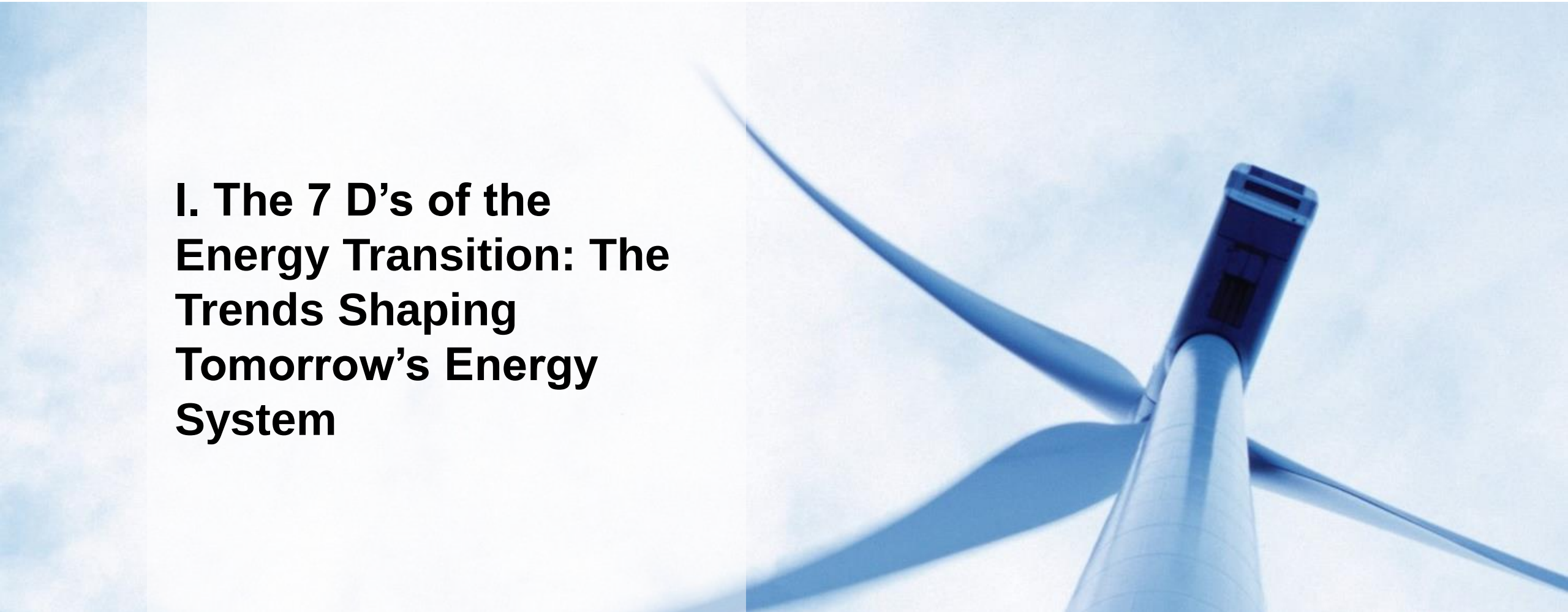


The emerging international energy transition think-tank network



⇒ Purpose of the global network is to develop synergies, to share knowledge, to create joint learning opportunities, and to provide mutual support.

I. The 7 D’s of the Energy Transition: The Trends Shaping Tomorrow’s Energy System



The 7 D's of the Energy Transition: The Trends Shaping Tomorrow's Energy System

1. Decrease in costs
Wind, solar and battery prices are falling

2. Decarbonisation
As global warming accelerates, urgent action is needed

3. Deflation of energy prices
Coal, oil and gas are inexpensive but increasingly volatile

4. Dominance of fixed costs
The energy world of the future will have low operating costs

5. Decentralisation
The energy system is becoming less centralised

6. Digitalisation
The energy system is becoming smarter and better networked

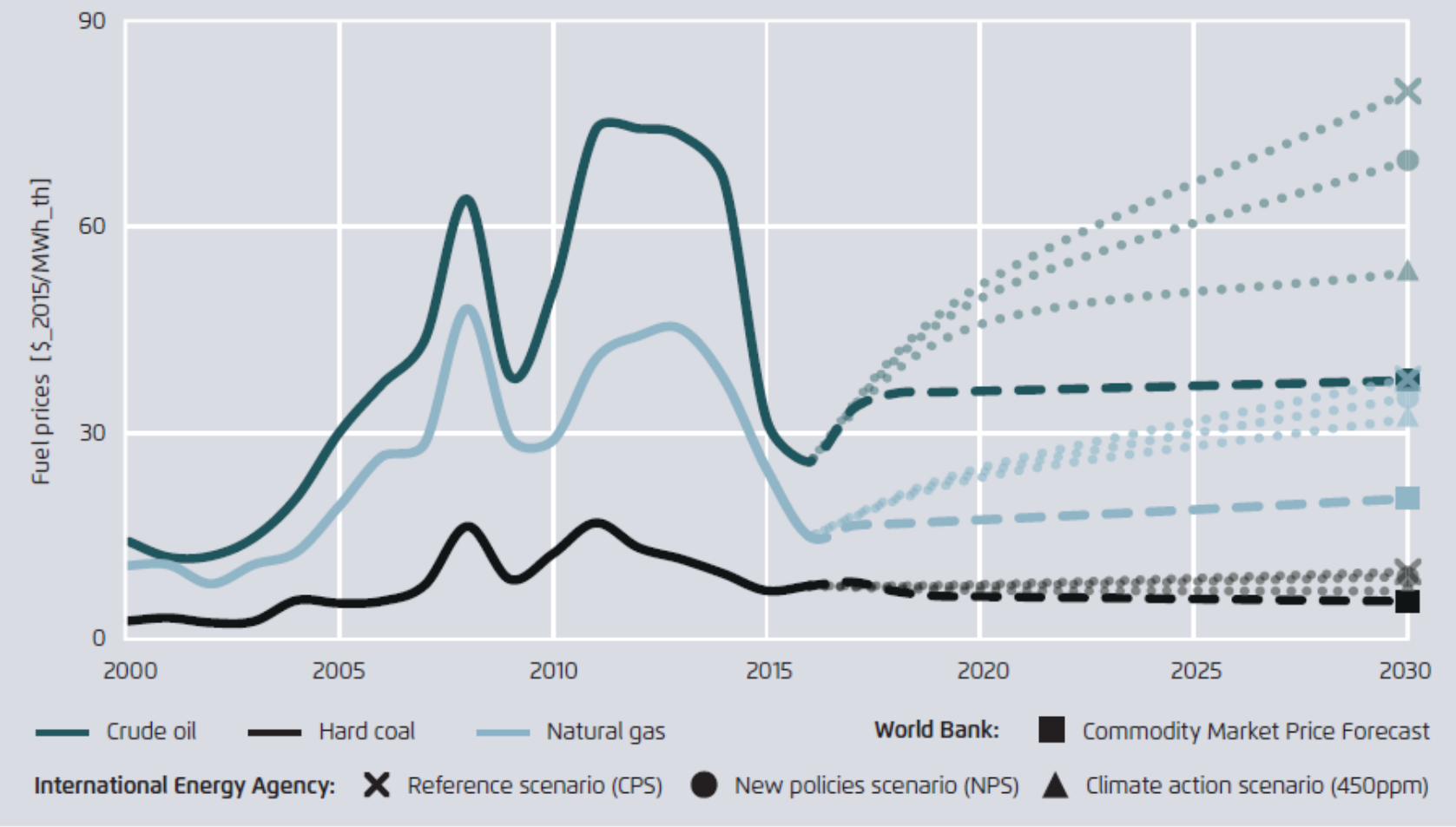
7. Democratisation
The new energy system allows more individual participation

Decrease in costs:
Wind, solar and battery prices are falling

U.S. Department of Energy (2016)

- The price of power from wind turbines and PV installations has fallen drastically in recent years
- In Germany competitive bids for onshore wind, offshore wind and solar energy resulted in prices of only 5 to 6 cents per kilowatt hour
- A similar cost drop has occurred for batteries
- Further cost reductions in these key technologies are foreseeable by 2030

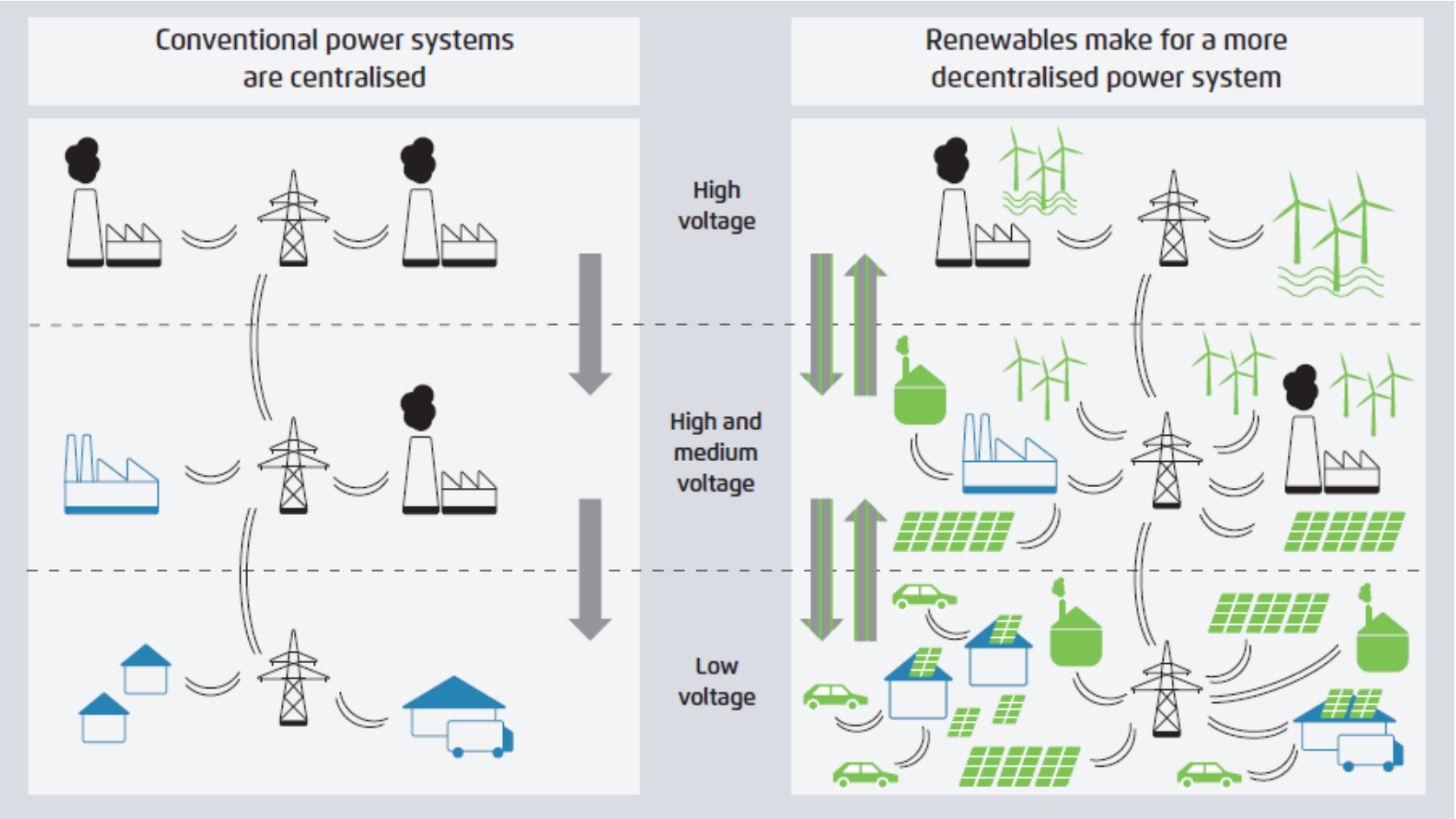
Deflation of energy prices:
Coal, oil and natural gas are inexpensive but increasingly volatile



IEA (2016), World Bank (2017a) and World Bank (2017b)

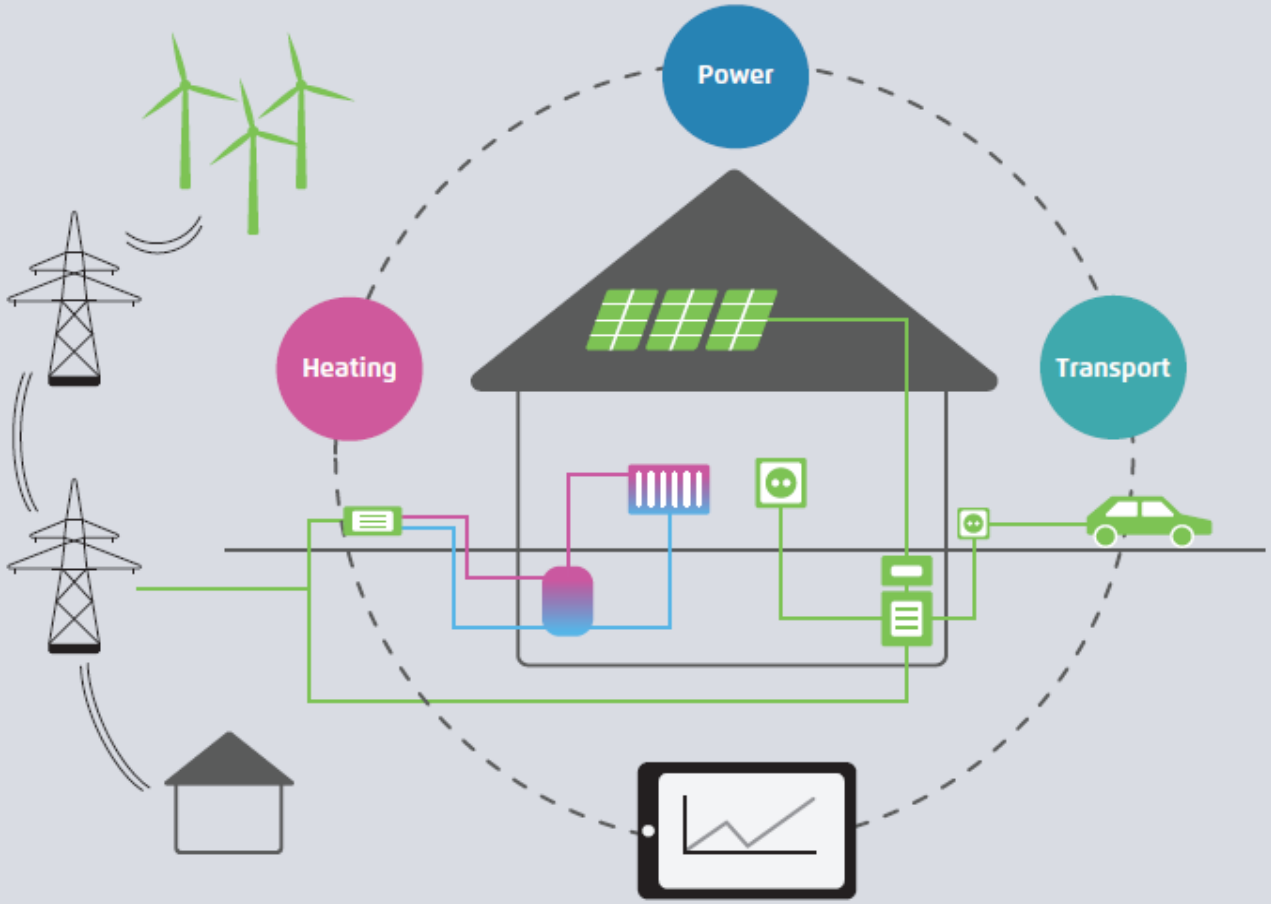
- For decades, conventional wisdom held that the price of fossil fuels would increase as supply decreased – until 2014
- The following factors speak against the return of rising prices for coal, oil and natural gas:
- Costs of shale extraction and costs for wind/PV are an upper price limit for oil and gas
- In the future, the availability of fossil fuels will increase, not decrease

Decentralisation:
The energy system is becoming less centralised



- An energy system based on renewables tends to move towards small, decentralised structures
- The reason is that energy from sunlight and wind is less concentrated than energy from coal, oil and gas
- The new technologies have changed the traditional distribution of roles in the energy system
- This fundamental shift in the energy system has produced a variety of new business models and players in the power, heating and transport sectors

Digitalisation:
Energy is becoming smarter and better networked



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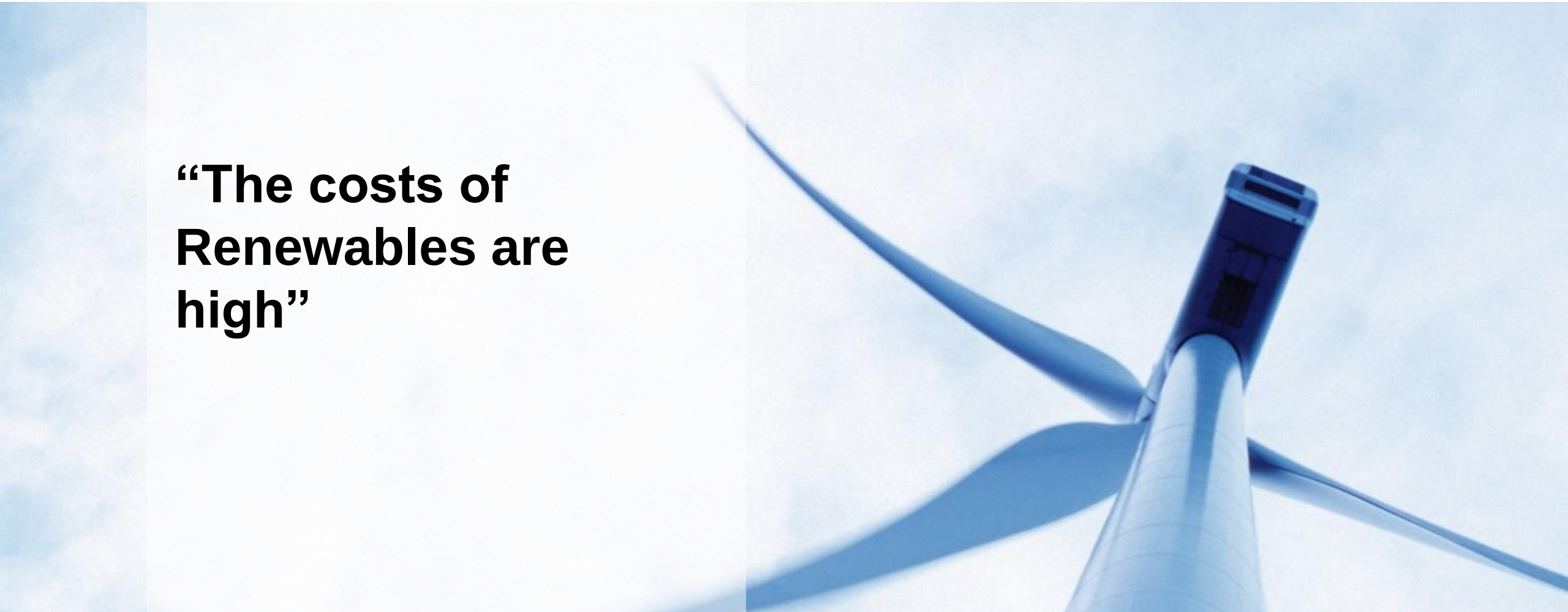
- Modern information and communication technologies are revolutionising the energy and transport industries
- By coordinating generation and consumption, they are enabling the energy system's transition to intermittent, small-scale production
- In the new energy environment value creation will come not, as before, from the sale of kilowatt hours or automobiles but from smart markets, smart homes and smart mobility

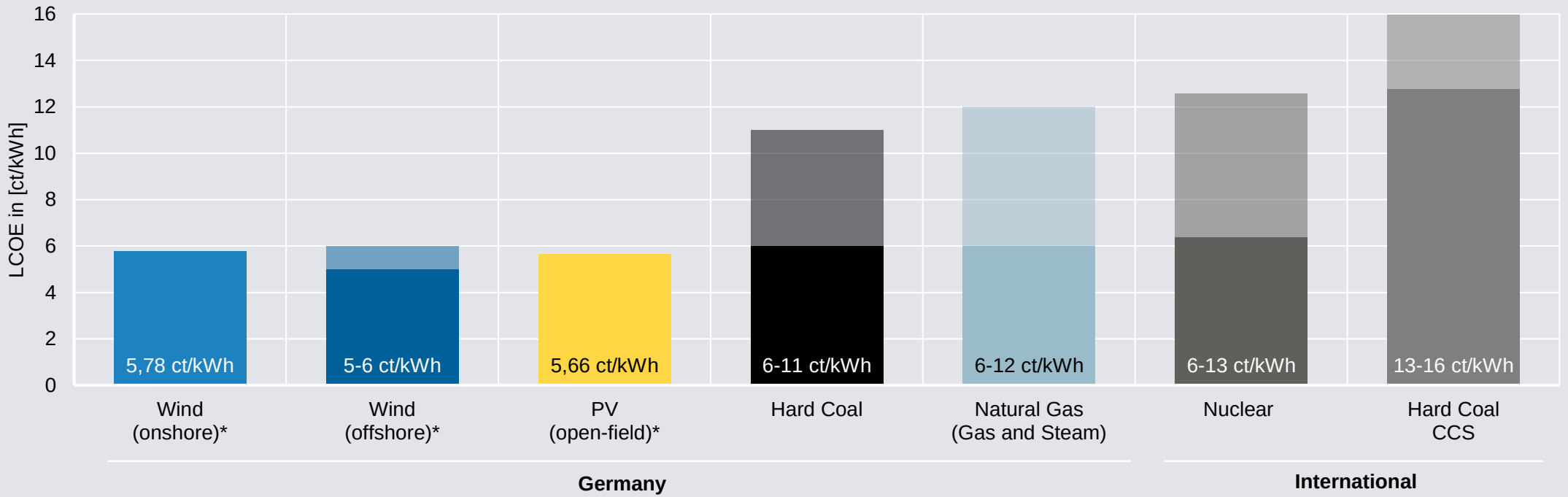
II. Myths about Renewables

“The costs of Renewables are high”



Today, wind and solar are already cost competitive to all other newly built power plants

Range* of levelized cost of electricity (LCOE) 2017



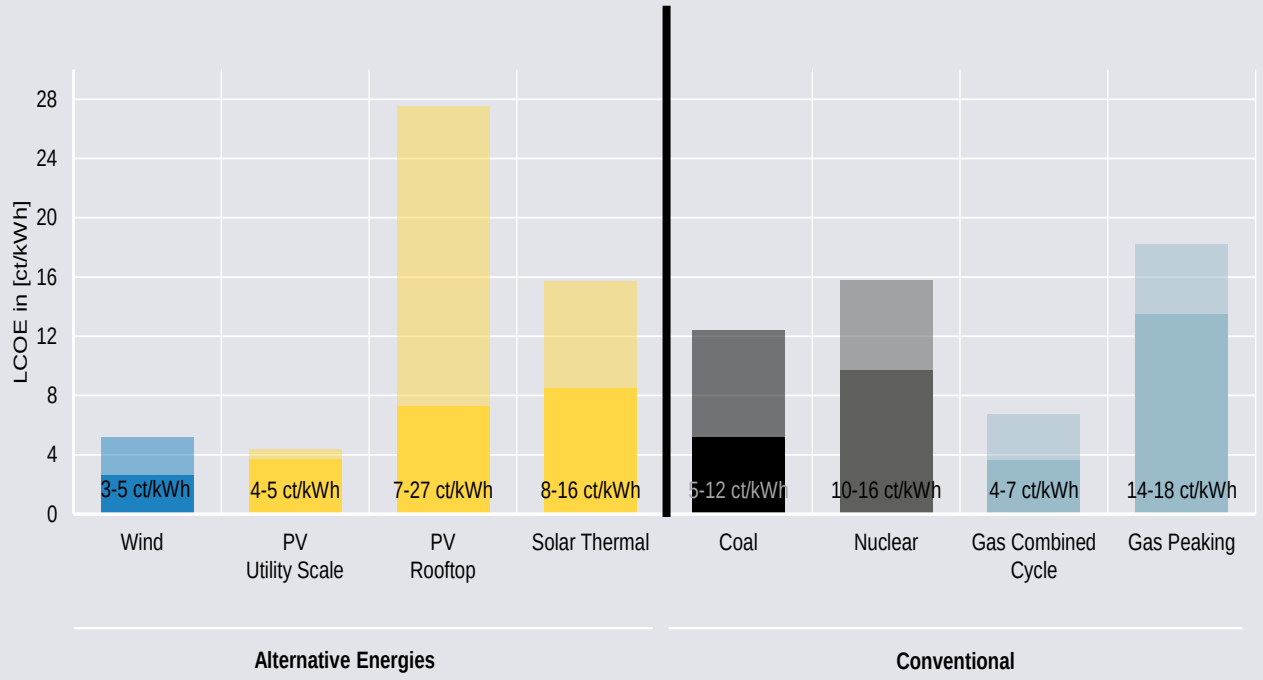
*Tendering results 2017

Agora Energiewende (2015e)

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

Today, wind and solar are already cost competitive to all other newly built power plants

Range* of Unsubsidized Levelized Cost of Electricity (LCOE) 2017



Agora Energiewende based on Lazard (2017)

LCOE
Compares the cost for generating one kWh of electricity based on the cost, utilization and life-time of different technologies

Range*
Illustrates the range of cost of capital and utilization for one specific technology

Cost of Capital
Reflects global, illustrative costs of capital, which may be significantly higher than OECD country costs of capital

Global Cost of Capital Assumptions

- 60% debt at 8% interest rate
- 40% equity at 12% interest rate

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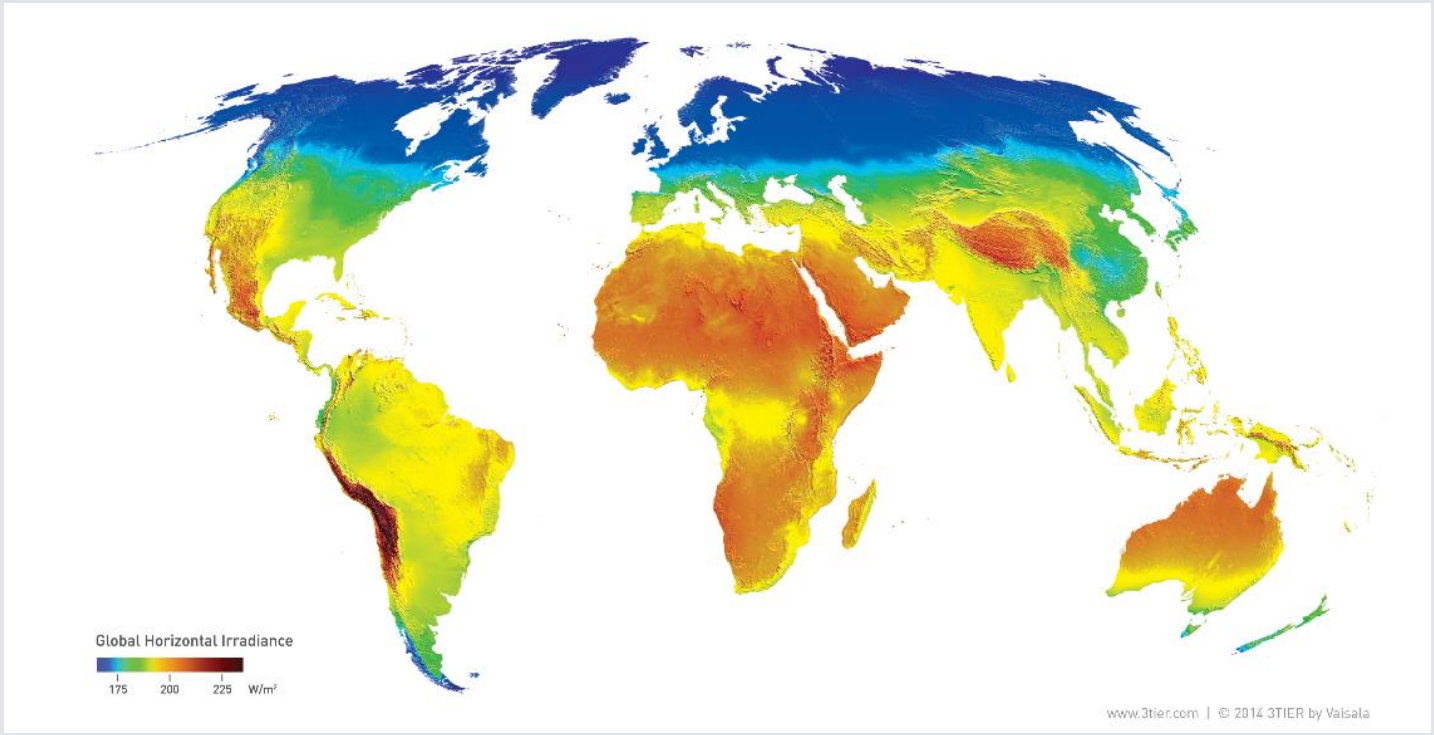
“Many countries do not have adequate resources“

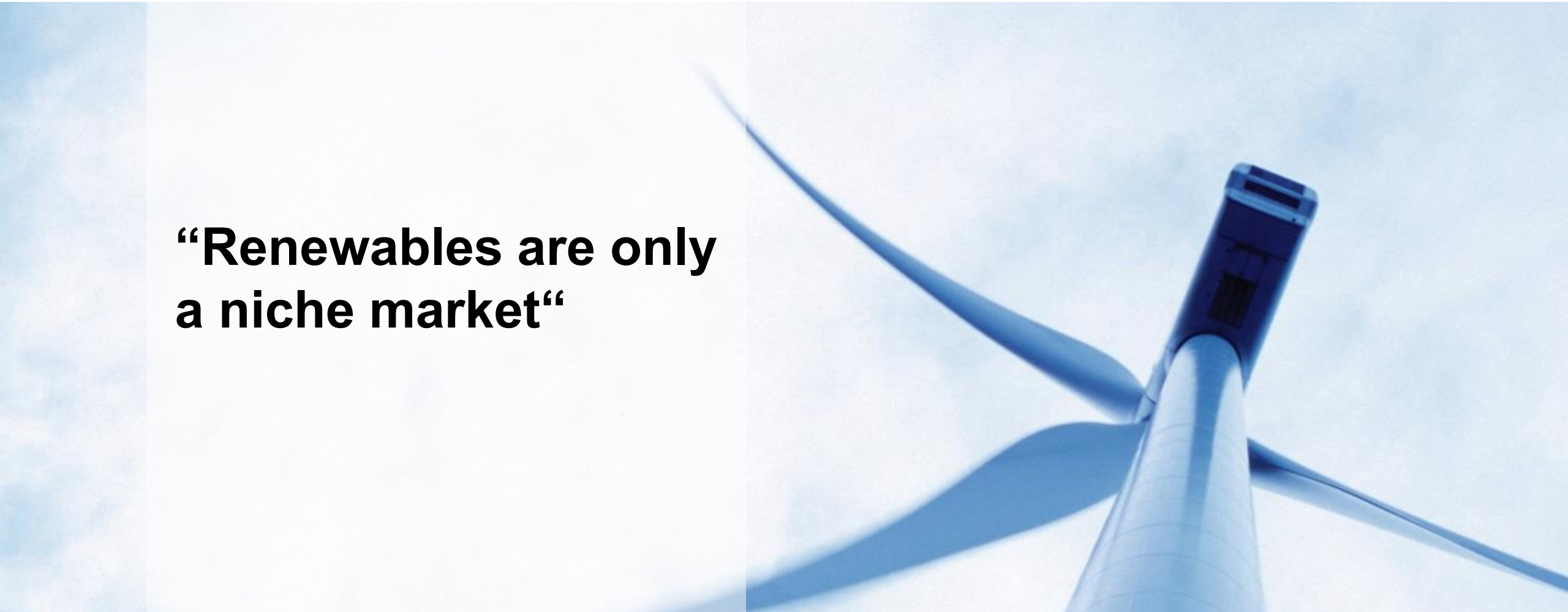
…and almost everywhere there is more sun than in Germany

Global horizontal irradiance



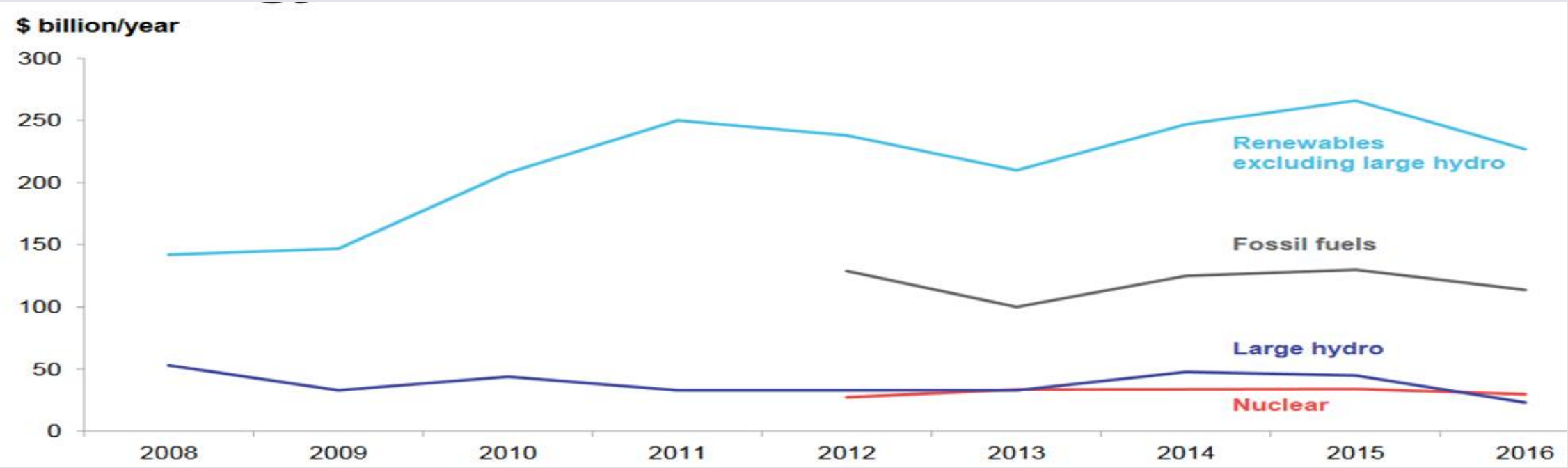
3TIER (2011)

“Renewables are only a niche market“



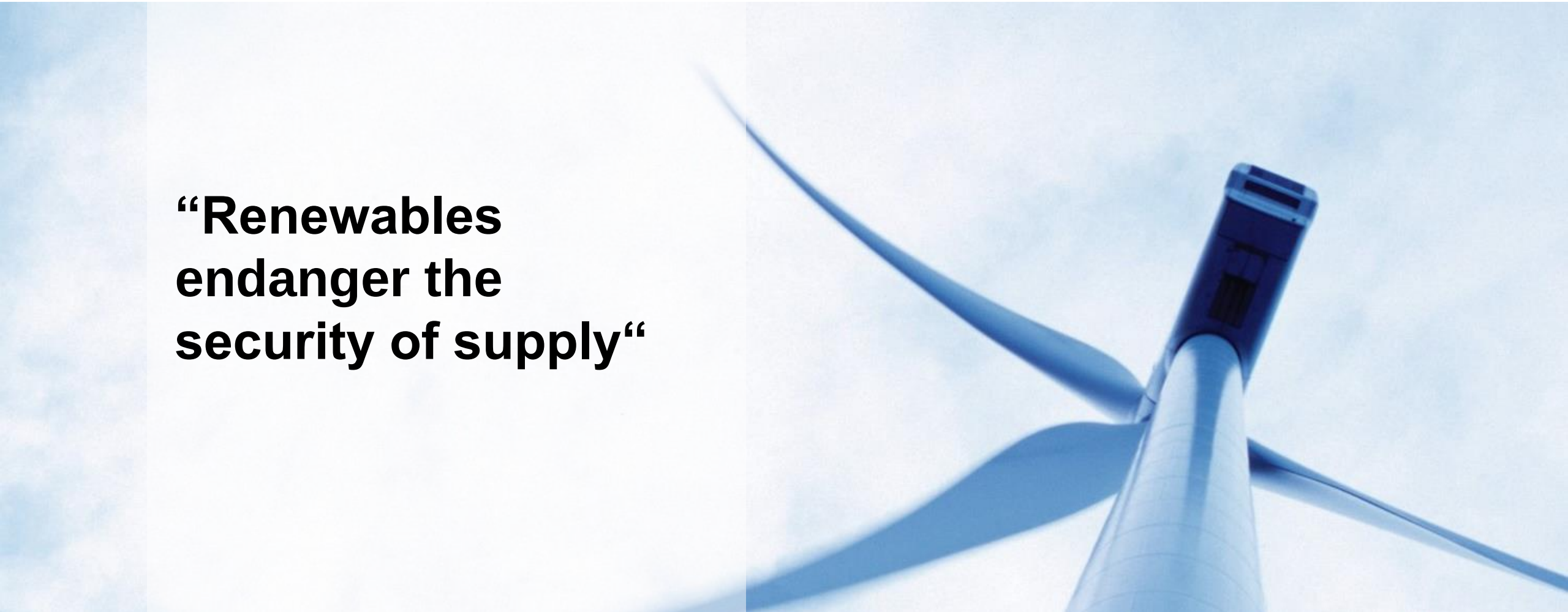
The energy transitions is now a global development – with more investment in renewable capacity per year than nuclear, coal and gas together

Investment in power capacity, by technology



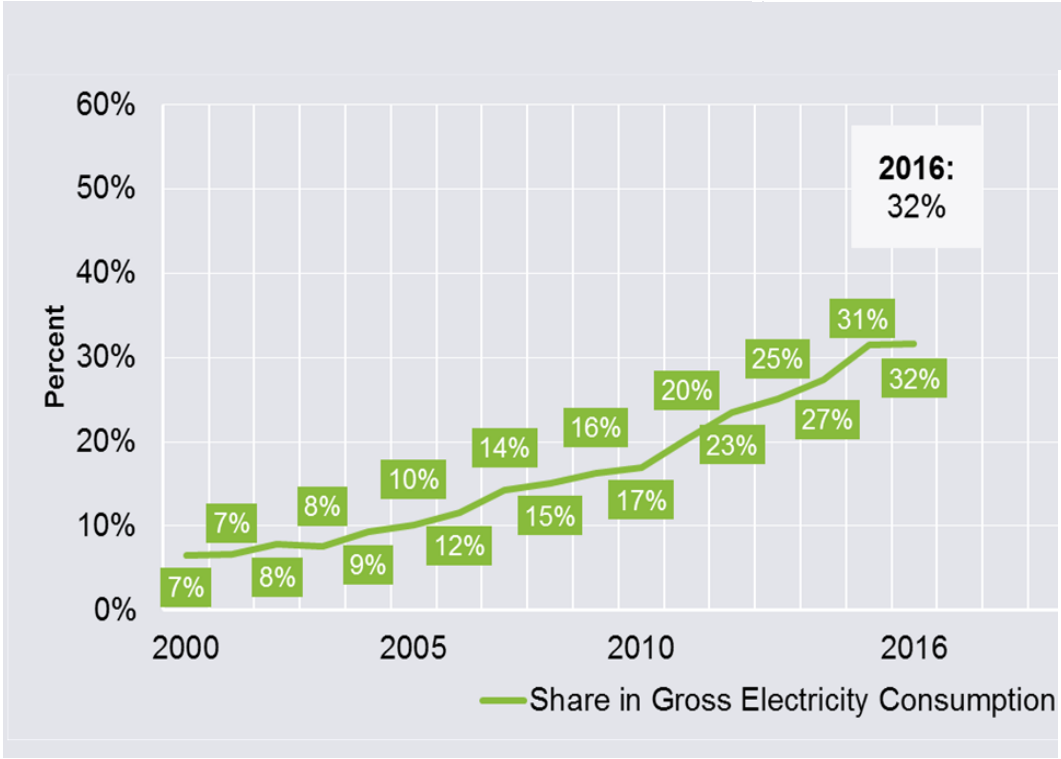
Bloomberg New Energy Finance Summit, UNEP

“Renewables endanger the security of supply“



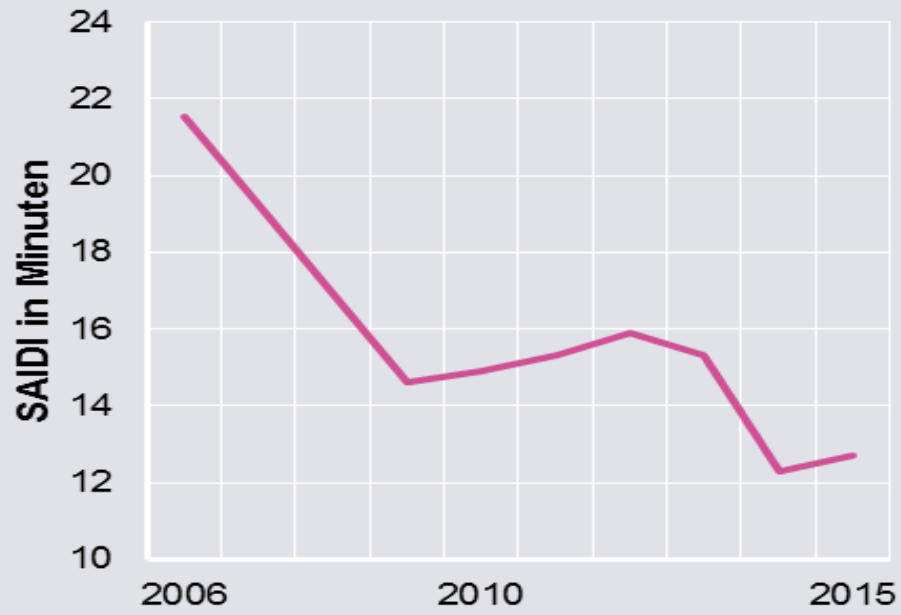
Blackout time in Germany are very low despite growing shares of renewables

Share of renewable energies in gross electricity consumption 2000 - 2016



AGEB (2017), EEG (2017)

SAIDI (System Average Interruption Duration Index) in Germany

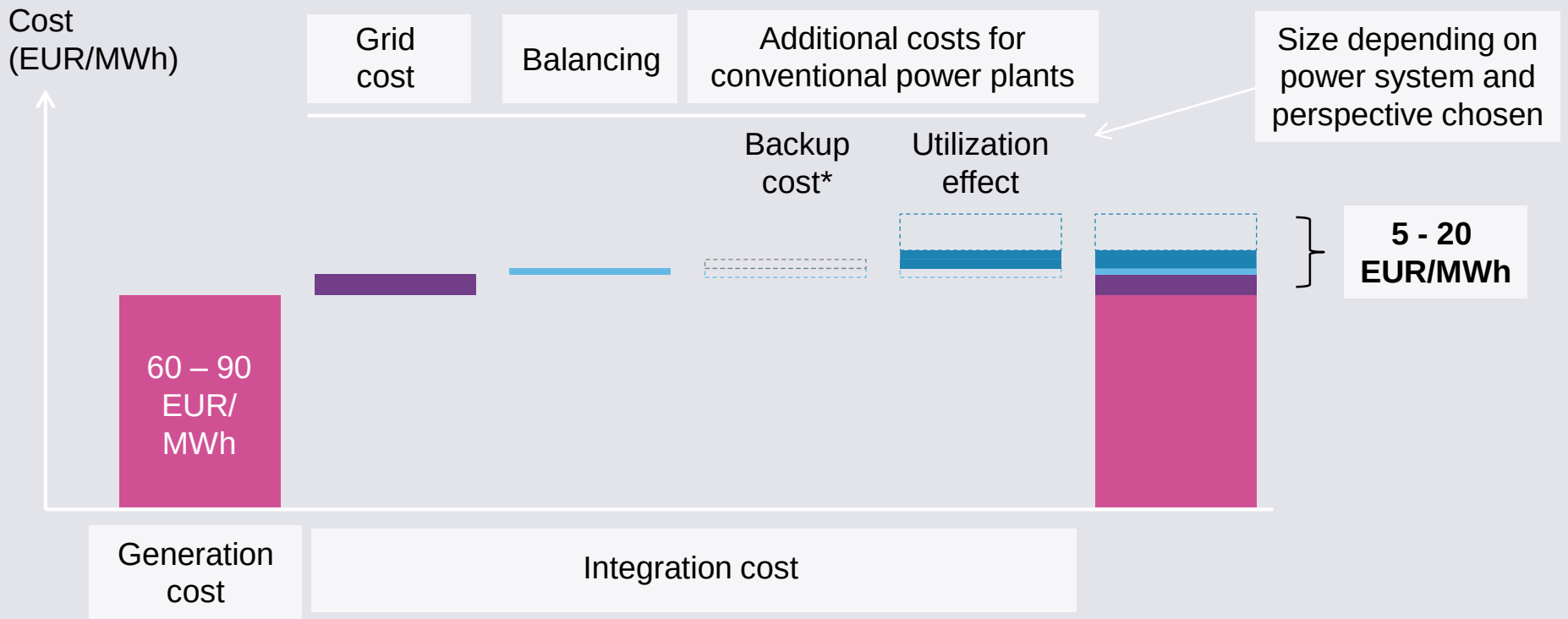


BNetzA (2016)

“Renewables lead to very high grid integration costs“

Integration cost of wind and solar are manageable and do not change the picture

Components of integration costs

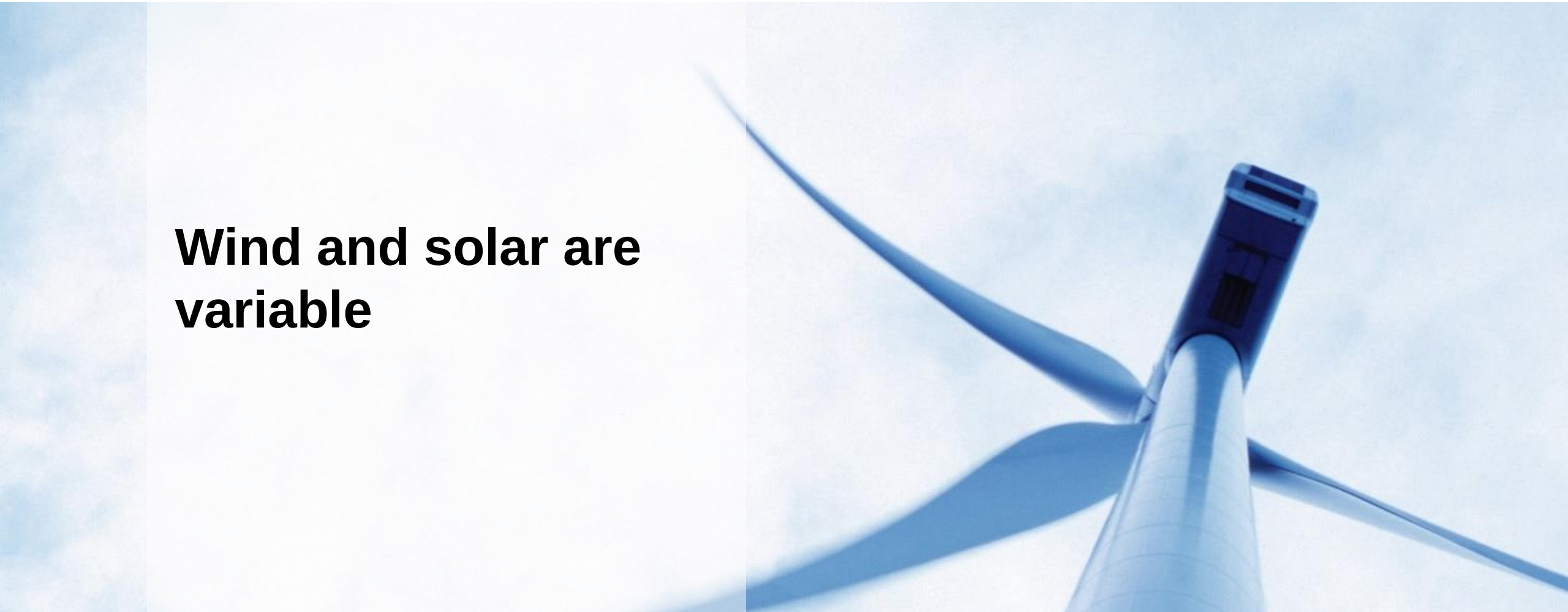


Agora Energiewende (2015a)

* part of utilization effect

III. Real Challenges of high Shares of Renewables

Wind and solar are variable

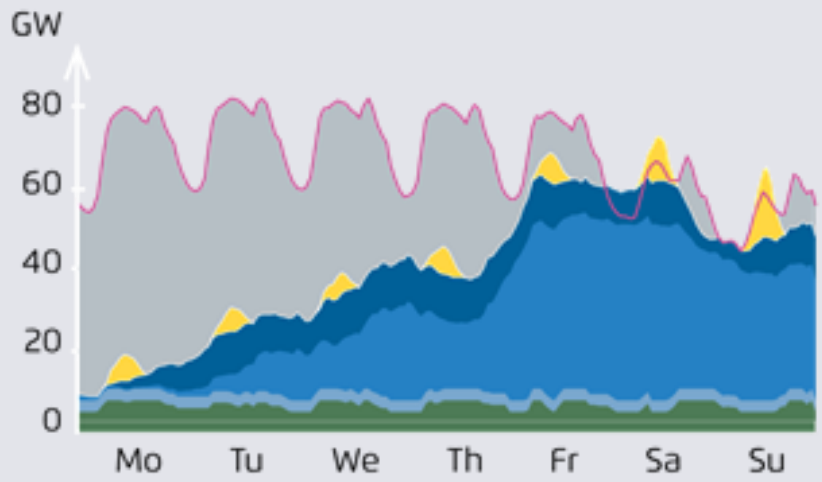


Variability of wind and solar require large flexibility of the power system

Specific characteristics of Wind and Solar PV

1. Intermittent
2. High capital costs
3. Very low variable cost

Electricity generation and consumption in a sample week 2023



Fraunhofer IWES (2013)

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)

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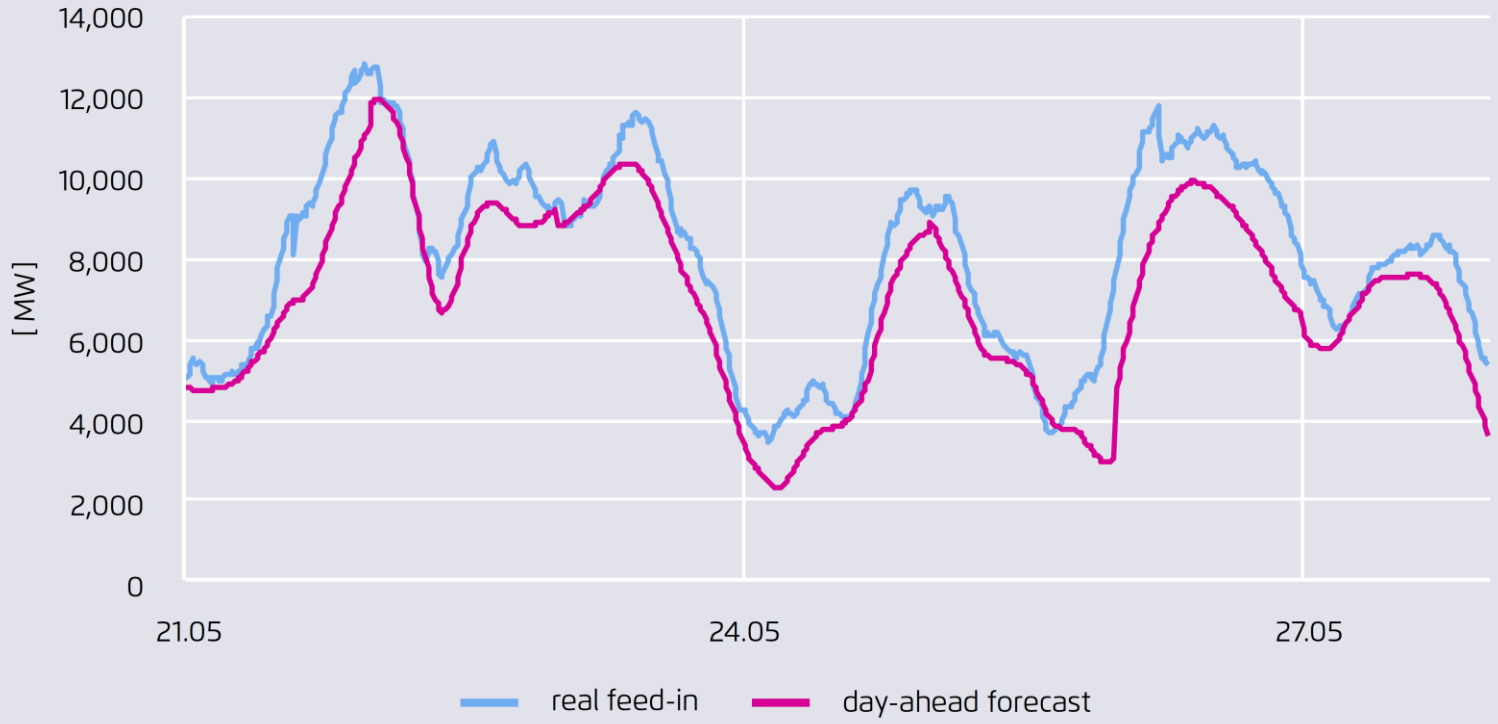
Variable output must not be confused with uncertain output

Difference between day-ahead wind energy forecast and real feed-in (week in May 2015 in the North-East of Germany)

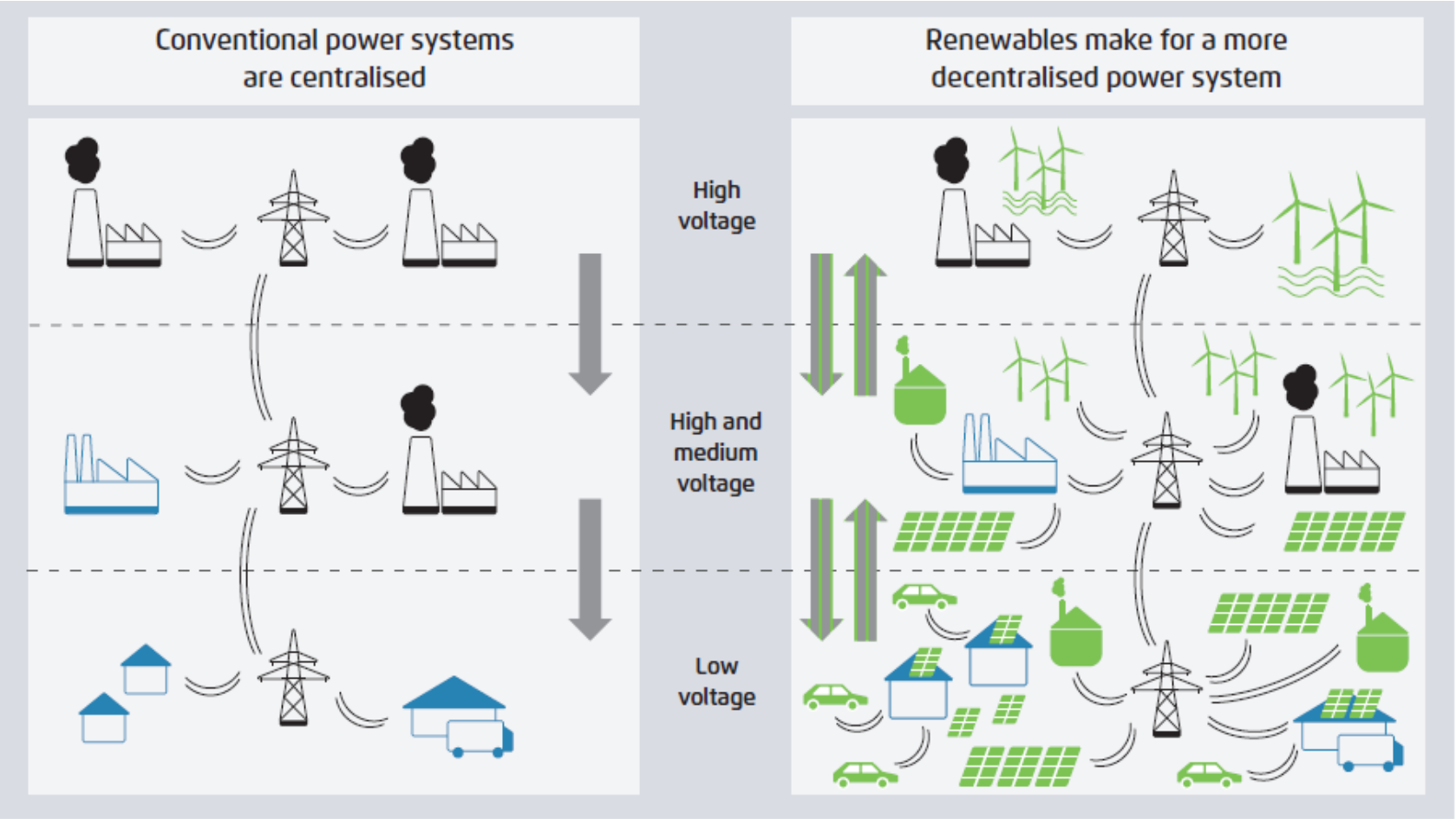


Improved forecasting, highly responsive control systems and well-functioning short-term markets (intraday and balancing) enable the integration of high share of renewables.

50 Hertz

Re-organize responsibilities in a decentralized system

Decentralisation:
The energy system is becoming less centralised

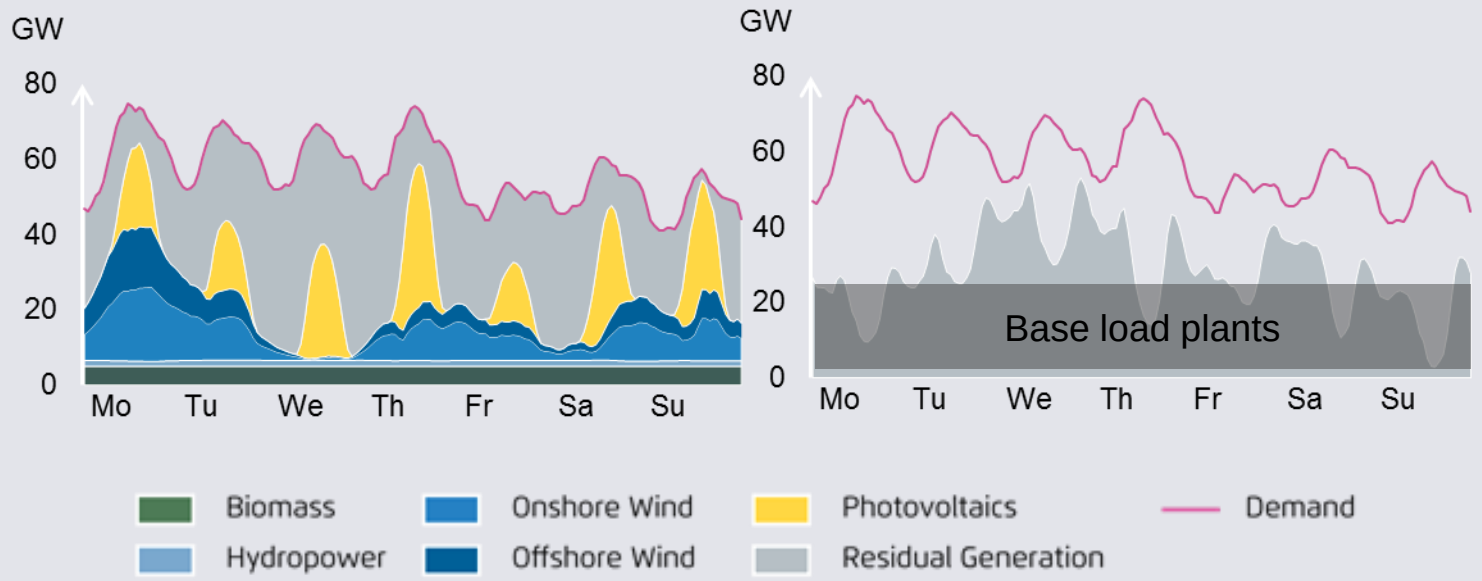


- Central system managment versus
- decentral systen management
- Further reserach neeed!

Renewables pose challenges for the rest of the power system

Flexibility is the paradigm of the new power system; base load is not needed any longer

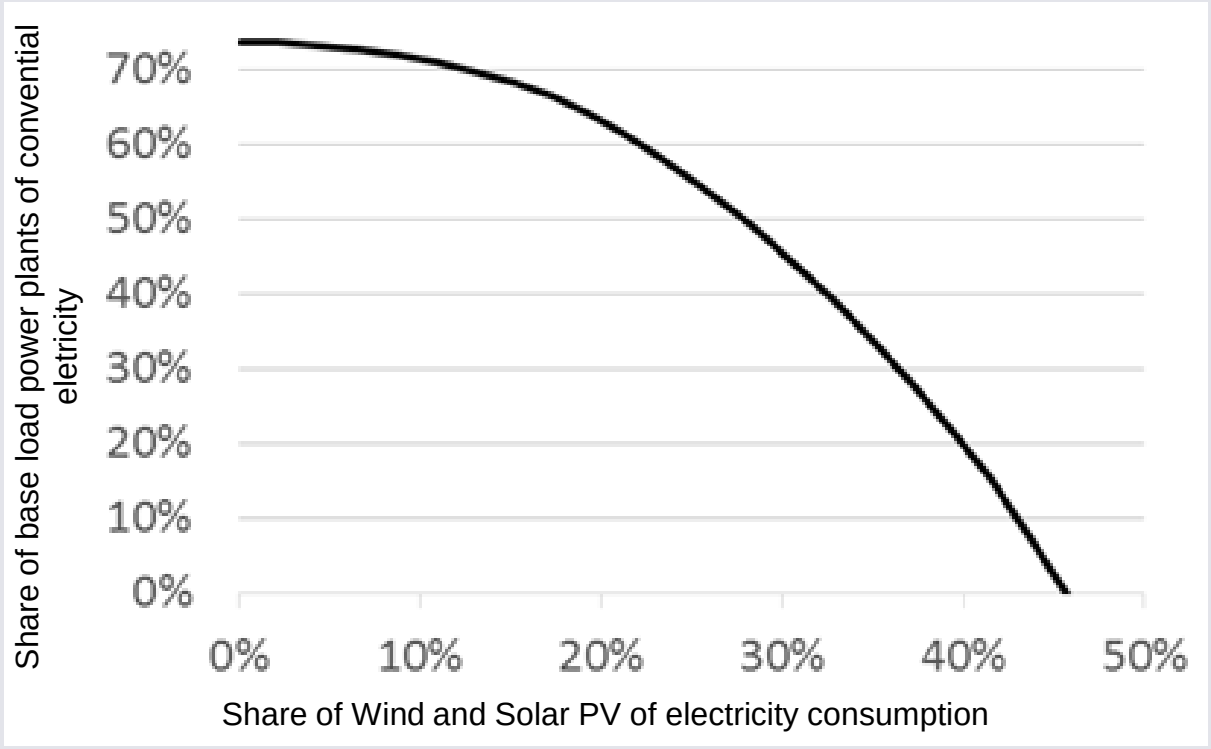
Electricity generation and consumption in a sample week with 50% RES share



Own calculations on basis of Agora Energiewende (2015b)

The need for baseload power plants is significantly reduced with growing shares of Renewables

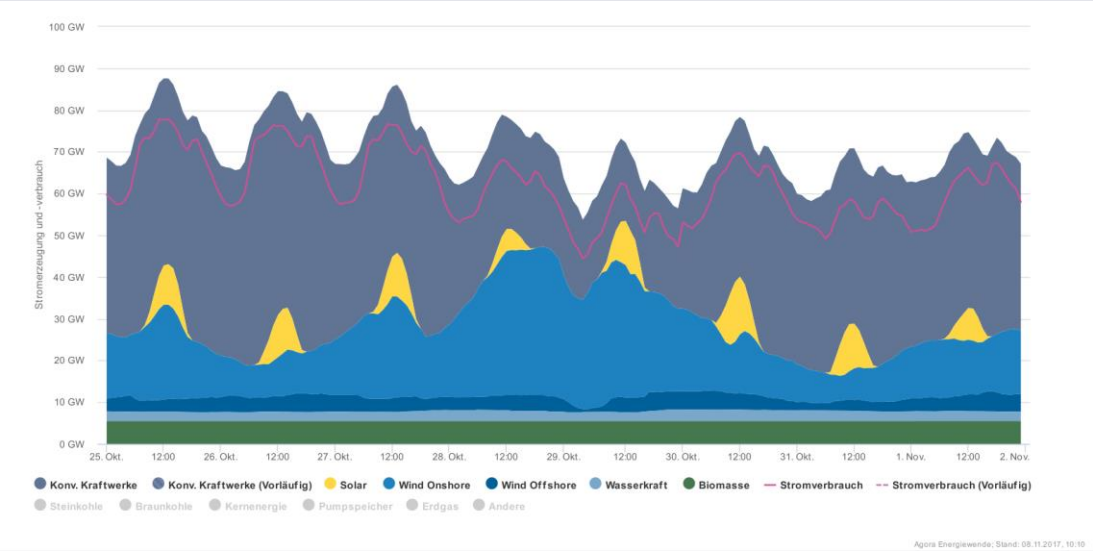
Base load is disappearing when VRES increase



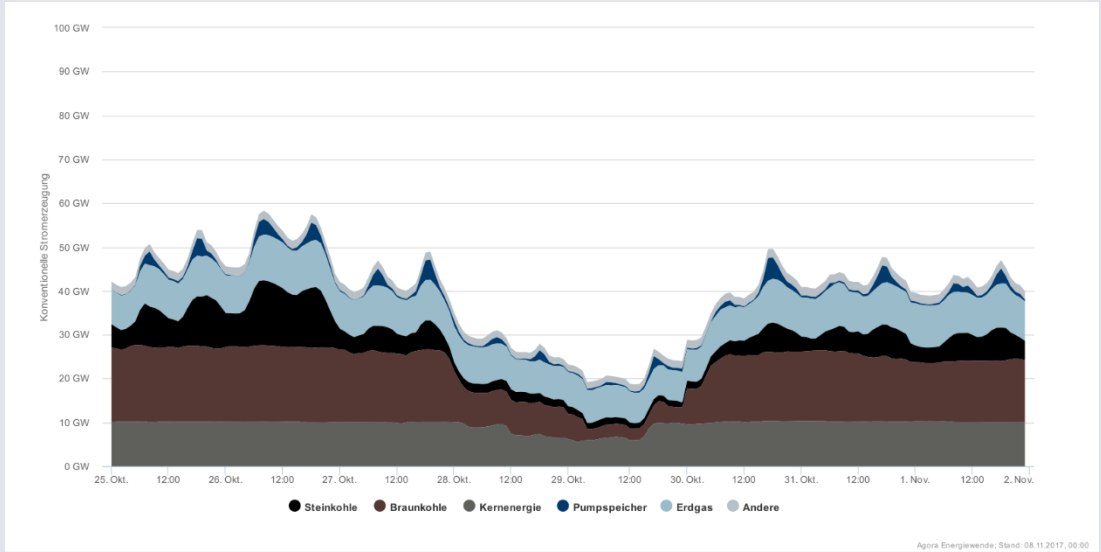
Hirth et al. (2014)

Hard Coal and Gas Power Plants react flexibly to the inflow of Renewables

Power generation and consumption from October 25th to November 1st 2017



Power production from Hard coal, Lignite, Nuclear, Pumped hydro and Natural gas from October 25th to November 1st 2017



Agorameter (2017)

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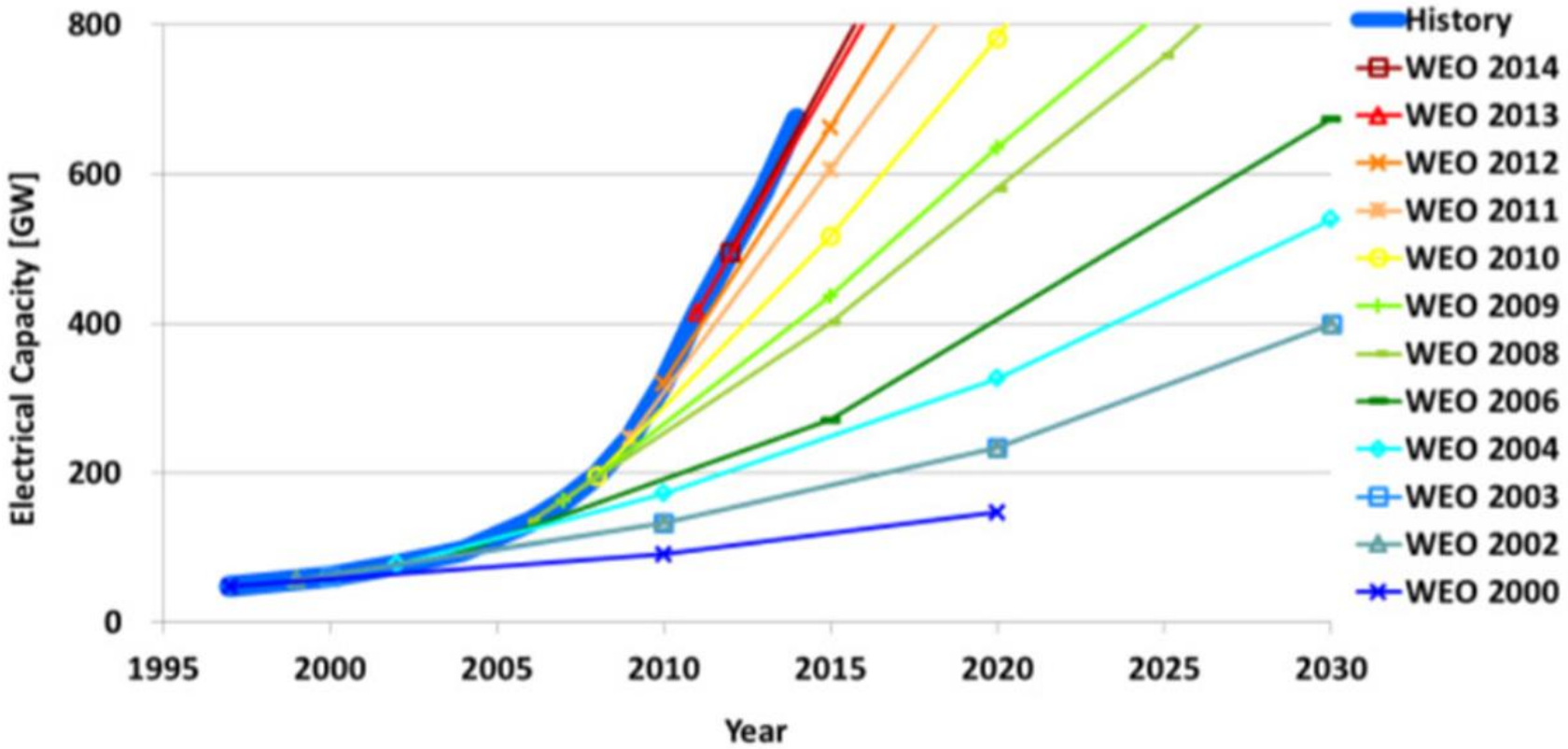
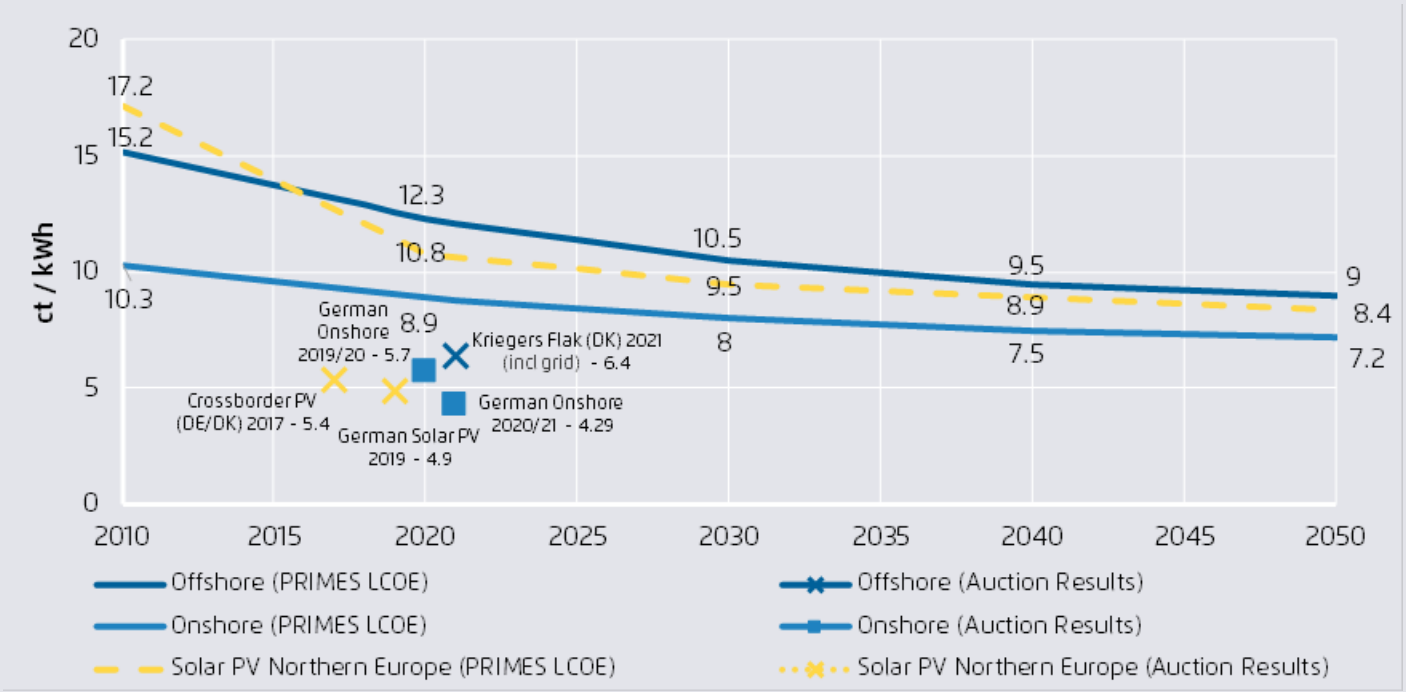
Renwables are going to win this!

Wind and solar have been consistently underestimated in the past



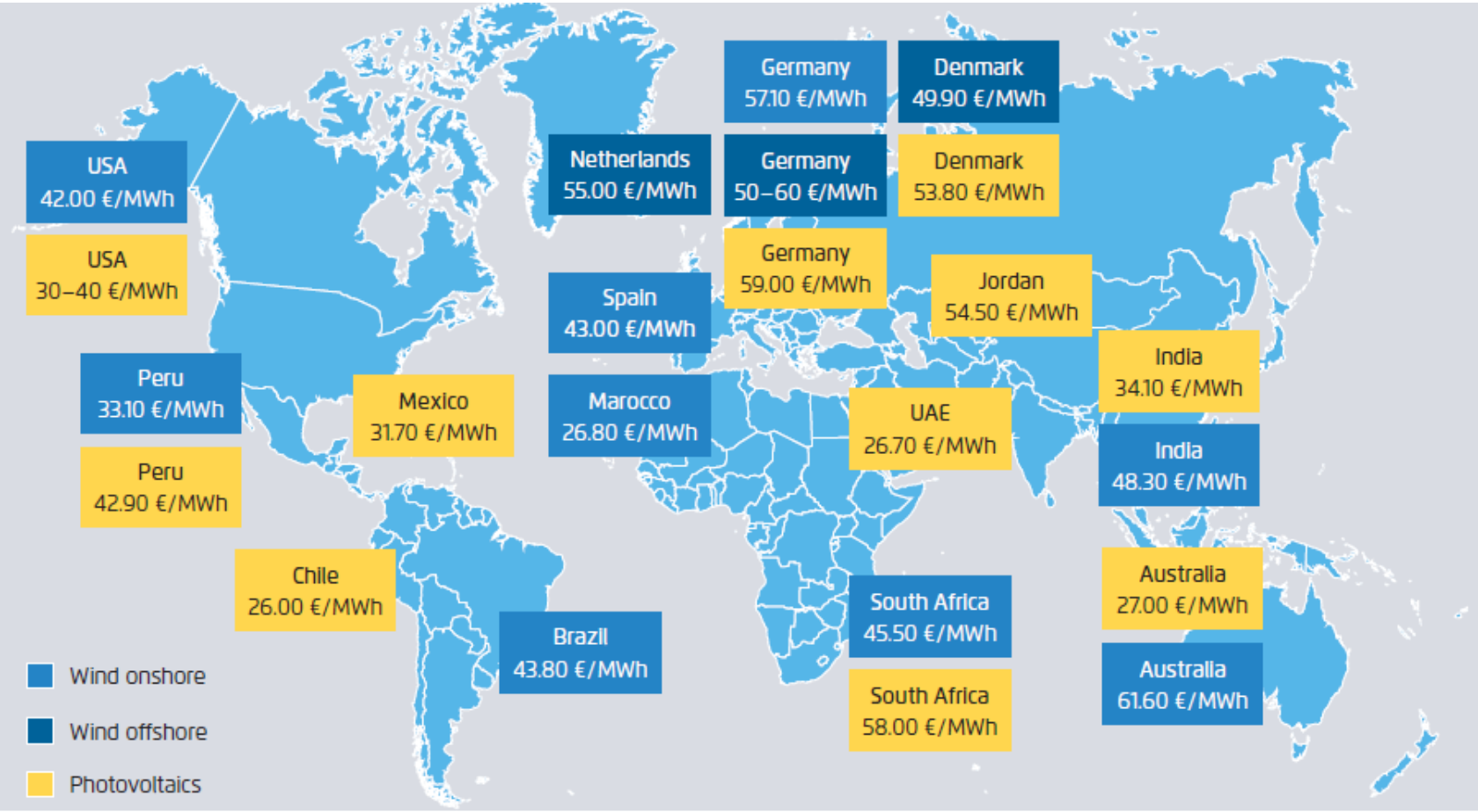
Source: Energy Watch Group

EU also underestimates renewables in their models



Comparison of auction results to COM PRIMES model assumptions

The global race towards a new energy future has already started



This figure shows the auctions result and power purchase agreements from 2016/2017. See Fortum (2016).
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- The global race for the clean energy market has already begun
- California, the sixth largest economy in the world, plans to have all its power from renewable energy by 2045
- China installed 64 gigawatts of renewable power in 2016 alone
- India has announced a plan to increase new renewable capacity four-fold by 2022, for a total of 175 gigawatts

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