Agora Energiewende

Energy transition planning and implementing

Insights from the German example

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Agora Energiewende – Who are we

Independent think tank with 30 energy policy experts

Independent and non-partisan

Project duration 2012-2021

Financed by the Mercator Foundation and the European Climate Foundation

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

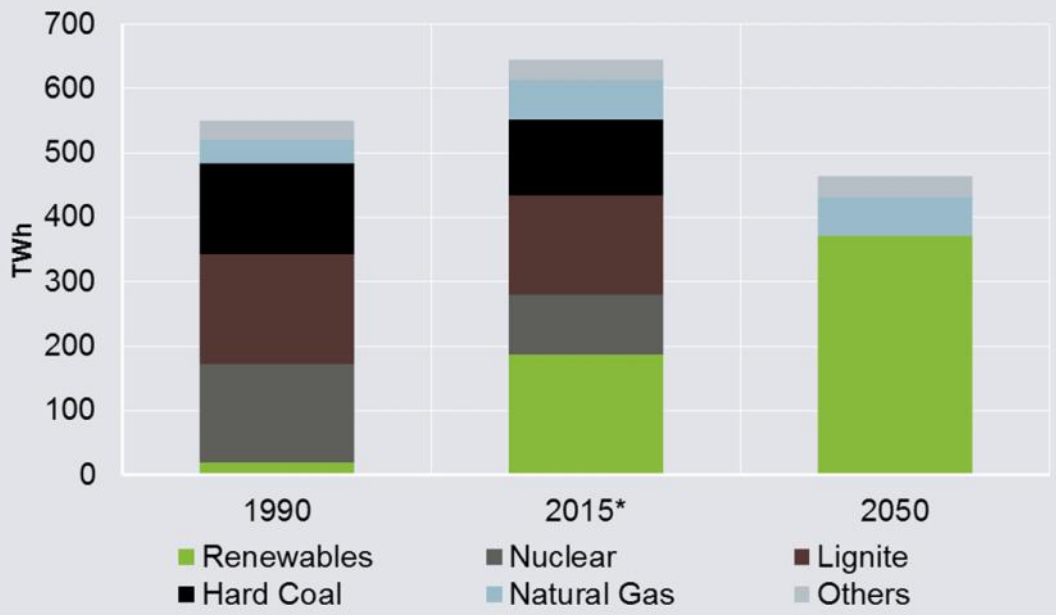
Scientific assessments

Dialogue

Putting forward proposals

The Energiewende is a strategy to phase out nuclear power and reduce greenhouse gas emissions

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

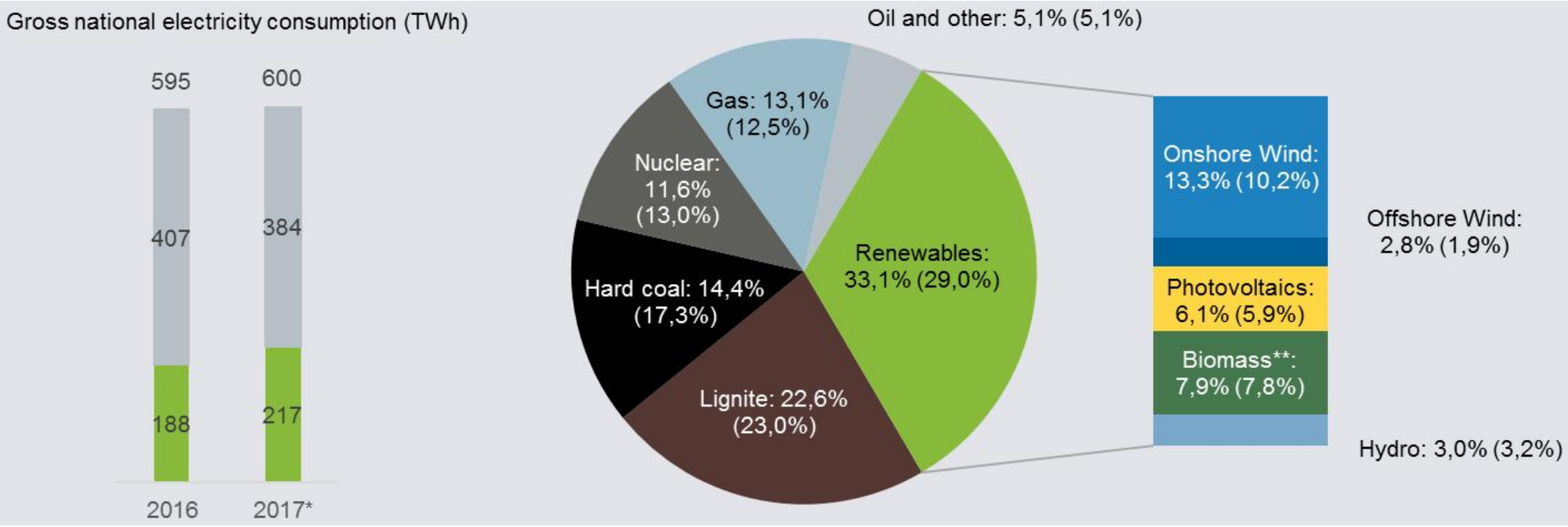
Reduction of Greenhouse Gas Emissions
Reduction targets below 1990 levels:
- 40% by 2020; - 55% by 2030;
- 80% to - 95% by 2050

Development of renewable energies
Share in power consumption to increase to:
65% in 2030; ≥ 80% in 2050

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

The power mix in 2017: Renewables well in the lead; hard coal falls significantly, now behind wind energy

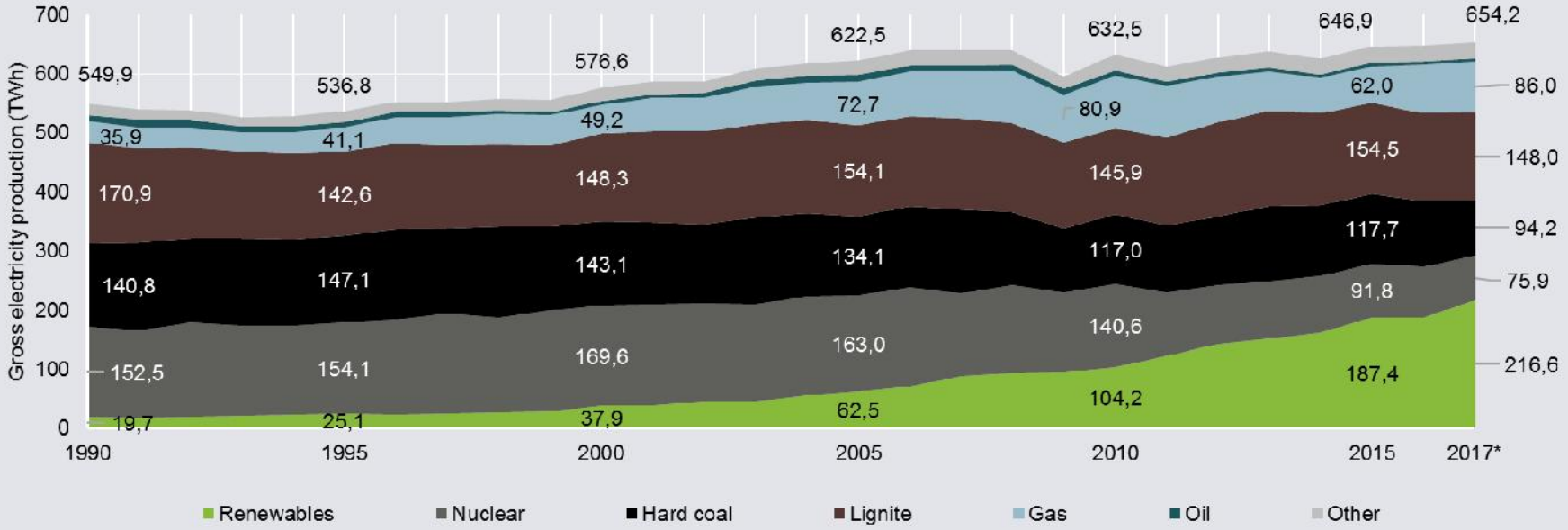
2017 power mix (2016 values in brackets)



AG Energiebilanzen 2017a; *preliminary data; **includes biodegradable household waste

Power production in 2017: Renewables hit record high, hard coal and nuclear at record low

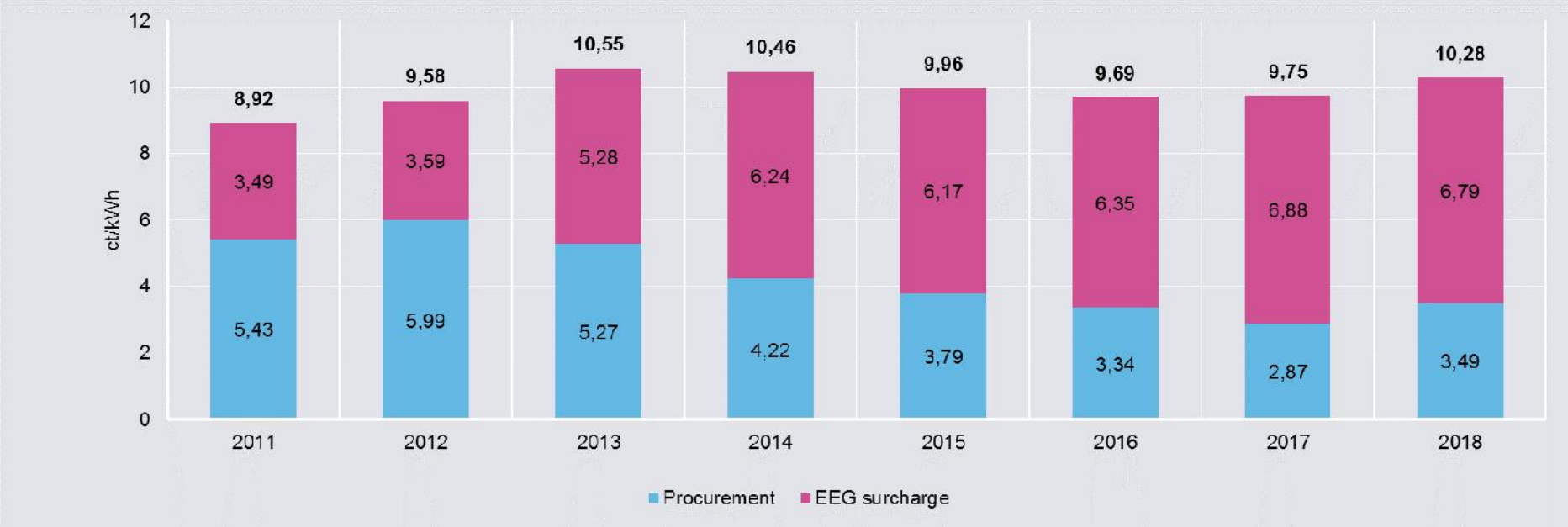
Gross power production, 1990–2017



AG Energiebilanzen 2017a; *preliminary data

Electricity generation costs: Reduction in RES surcharge compensated by increase in electricity procurement costs due to rising wholesale prices

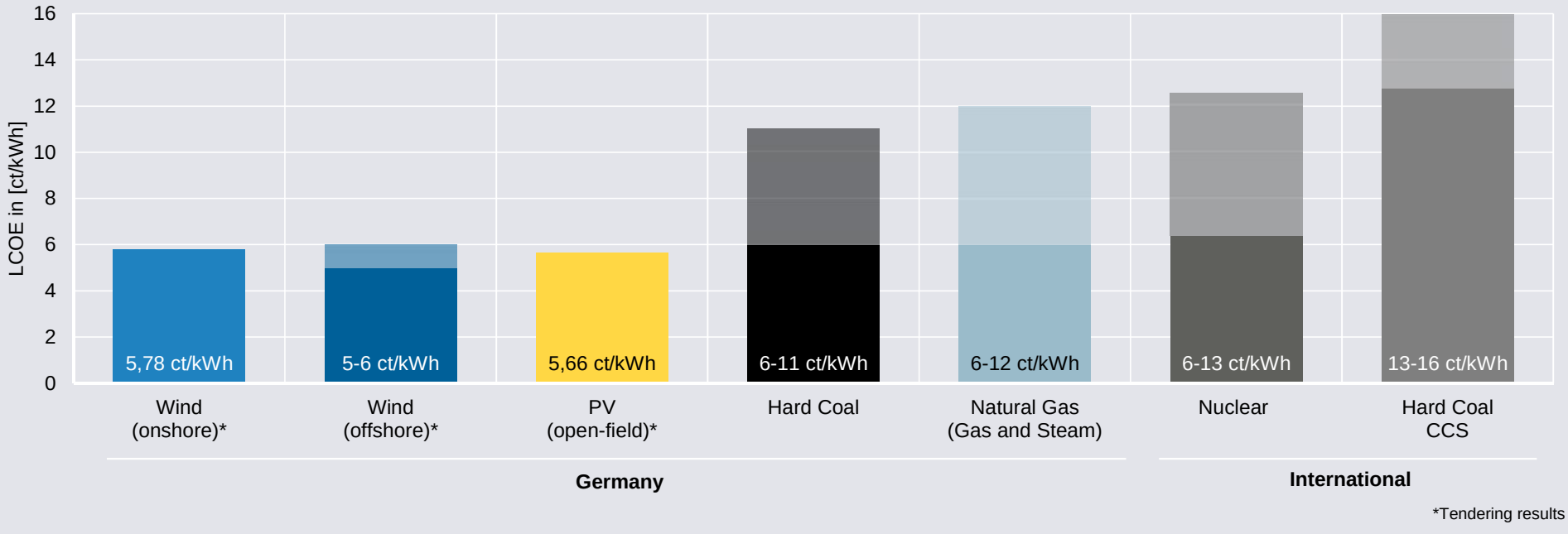
Electricity procurement costs and RES surcharge levy, 2011–2017



EEX 2018, BNetzA 2017c, *70 per cent one-year future (base), 30 per cent one-year future (peak)

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

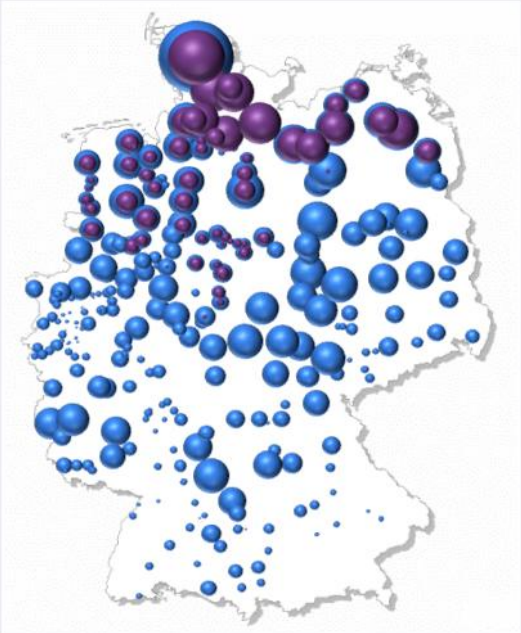
Agora Energiewende (2015e)

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

What are the main challenges of the Energiewende?

Challenge 1: Grids
More grids to transport wind energy to the south of Germany

Installed wind capacity (103 GW, Scenario „Best Sites“) 2033



Fraunhofer IWES (2013)

German network development plan 2024*

BNetzA (2014) * approved Sep 2015

Wind power will be installed mainly near the coast in the north of Germany, but key consumptions centres are located in the south

Additional power lines are necessary to transport wind electricity from north to south (3 HVDC corridors)

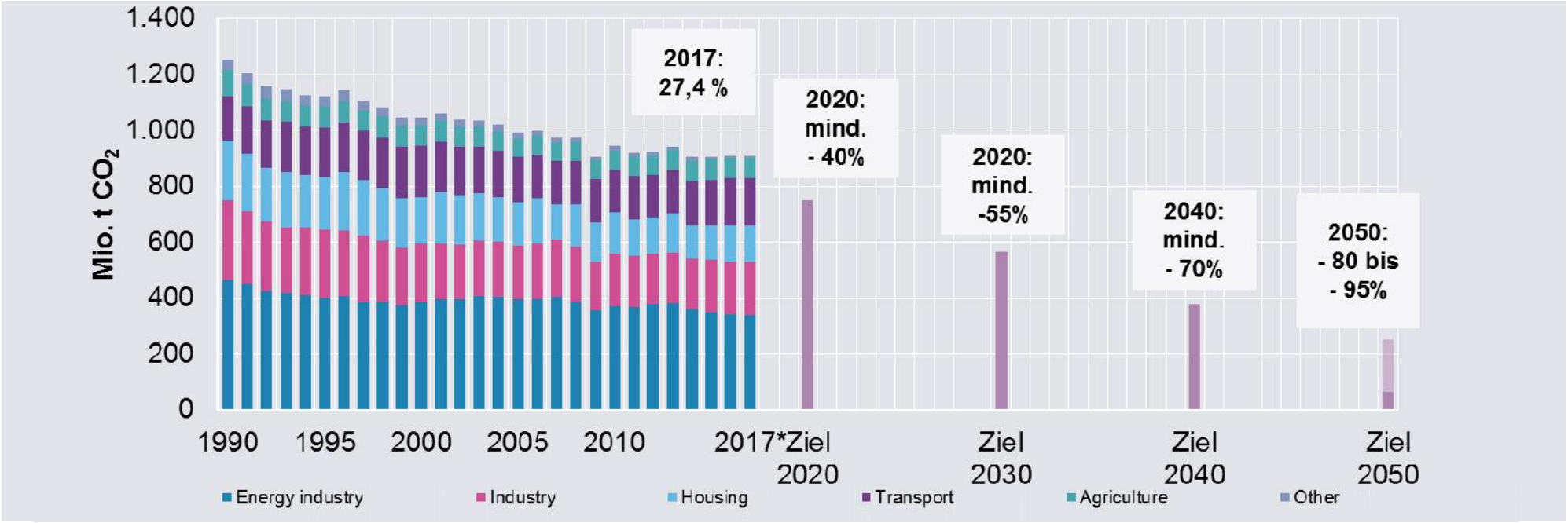
There has been a delay in grid expansion, thus redispatch and curtailment have increased significantly

New policy to use underground cables whenever necessary. Measures to reduce consternation and compensation for concerned parties need to be considered from the very beginning

Challenge 2: Climate Targets

As use of petroleum and natural grows, greenhouse gas emissions stagnate at a high level. The 40% reduction goal by 2020 is far away

Greenhouse gas emissions by sector, 1990–2017, together with 2020 and 2030 targets

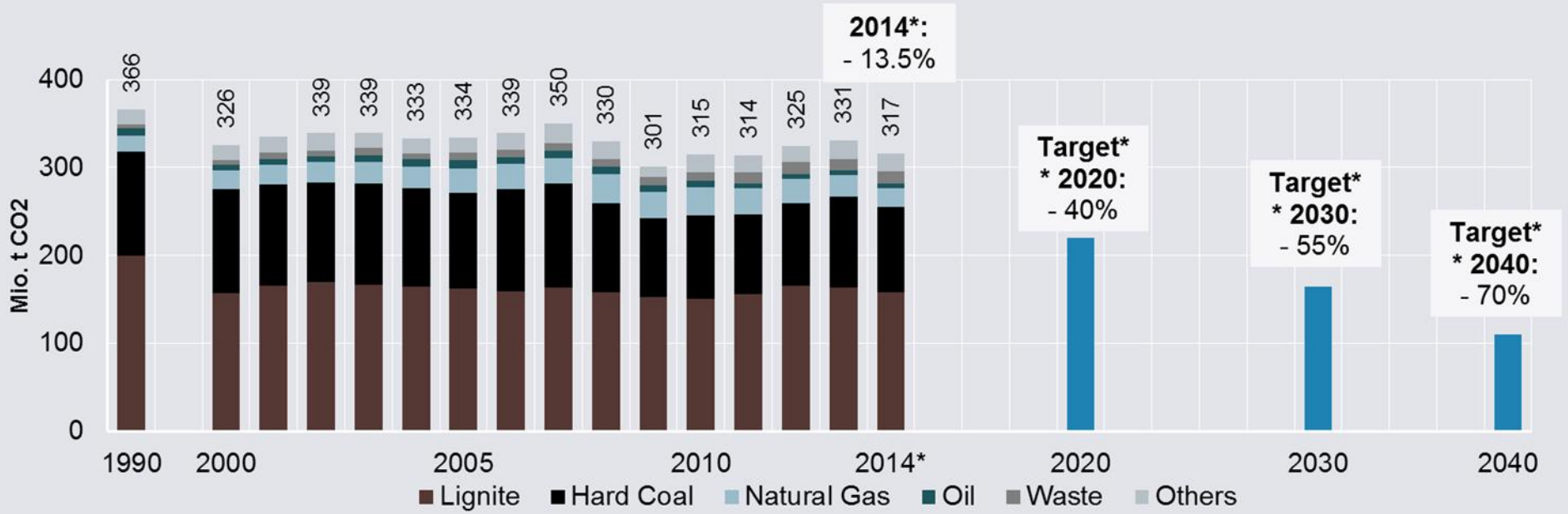


UBA 2017a; own calculations; *preliminary data; **own estimation

Challenge 2: Climate Targets

Reduction of coal use is needed. As of 2017a “lignite reserve” is implemented, for 2030/2040 we need a “coal consensus”

CO_2 emissions from electricity generation 1990 - 2014 and climate targets** 2020 - 2040



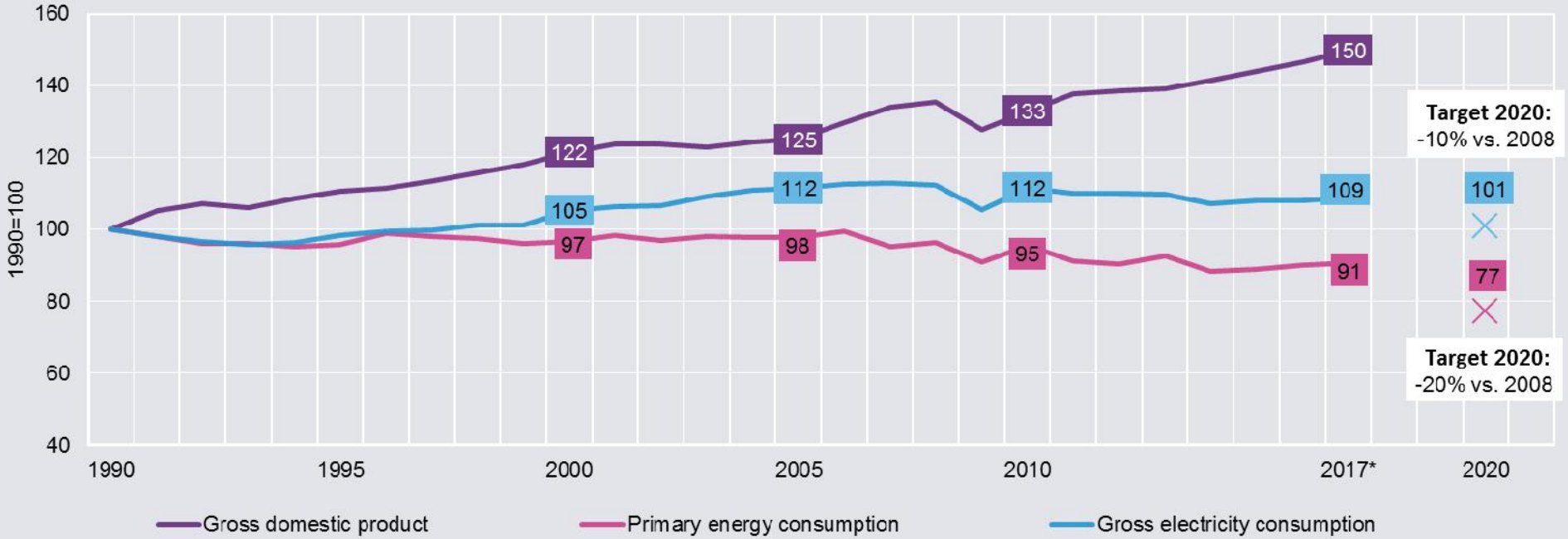
UBA (2015), own calculations

*preliminary, **application of a sectoral 40%-target

Challenge 3: Energy efficiency

Energy and electricity use begin to rise again as decoupling from economic growth remains only partial

Gross domestic product, primary energy consumption, and gross domestic electricity use, 1990–2017 (indexed, 1990=100)

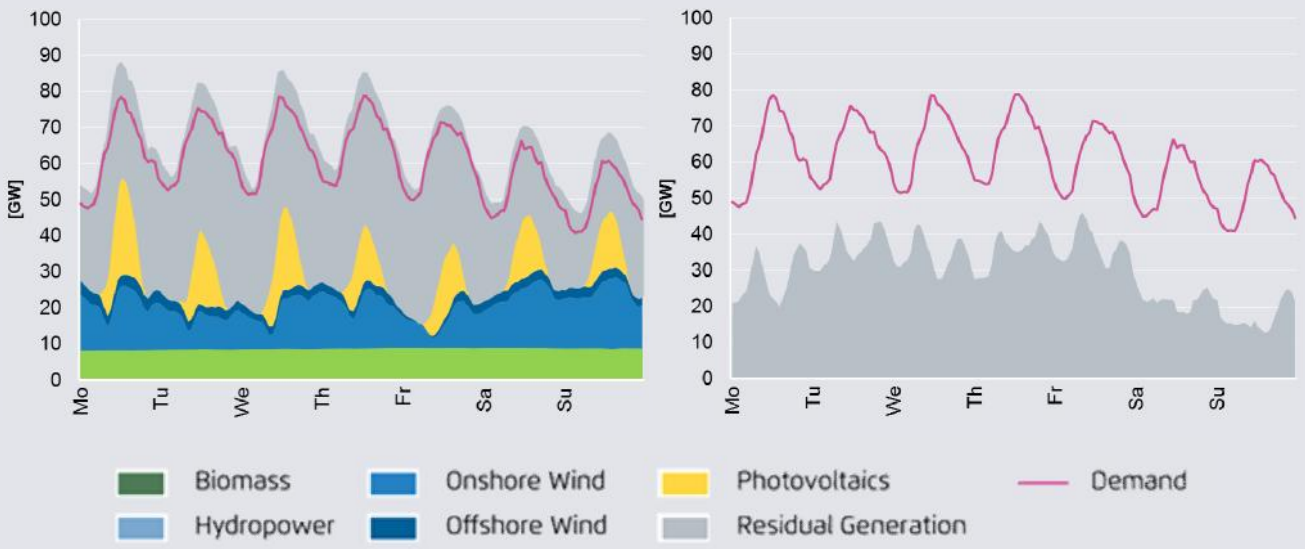


AG Energiebilanzen 2017a, Destatis 2017a; *preliminary data using own calculations

Insights from the German example

Flexibility is the paradigm of the new power system to ensure security of supply

Power generation and consumption in Germany, 9 to 15 May 2016 (50% RES-E share)



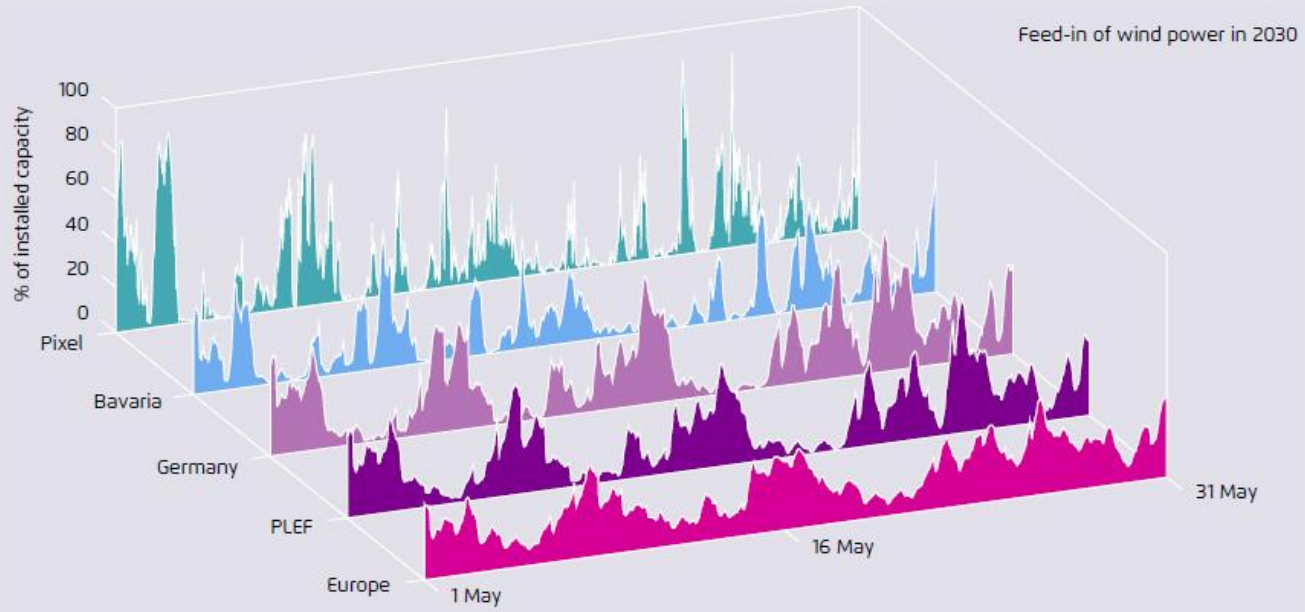
Key flexibility options

- Flexible fossil and bioenergy power plants (incl. CHP)
- Electricity grid infrastructure (domestic and cross-border)
- Demand Side Management
- Storage technologies (Hydro storage, batteries)
- Integration of the power, heat and transport sectors (P2H, electric mobility, P2G)

Agorameter

Cross-border cooperation between neighbouring countries significantly reduces the flexibility challenge

Time series of onshore wind generation in May 2030 at different levels of aggregation

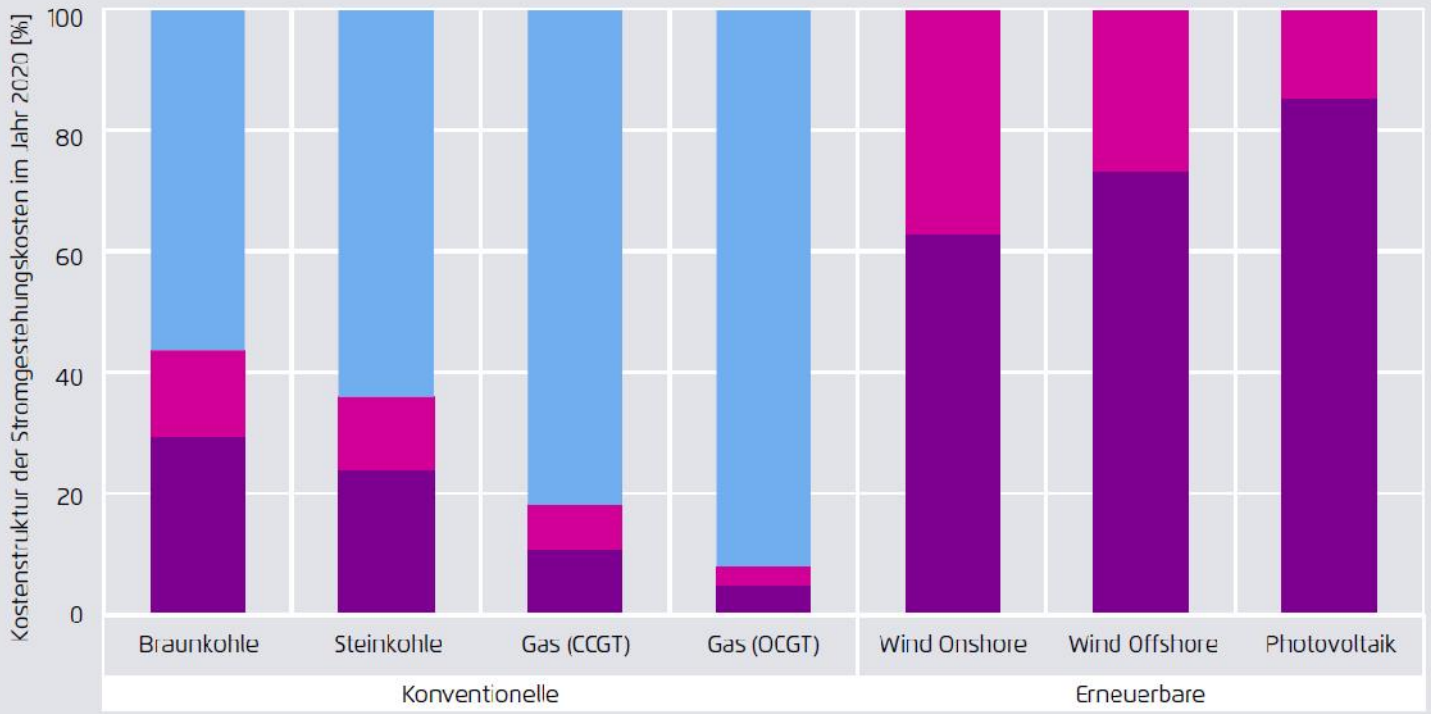


- Power system integration mitigates flexibility needs due to smoothing effects
- Hourly wind ramps decrease by ~50% comparing the national and European scale
- Reduced residual load gradients & balancing requirements; Minimised renewables curtailment
- Cross border system integration key for minimising flexibility challenge
- ➔ Grid interconnections, cooperation in system operations and market design

Fraunhofer IWES (2015)

* One pixel is equivalent to an area of 2.8 x 2.8 km; PLEF are the countries AT, BE, CH, DE, FR, LU, NL

Wind power and solar PV have high upfront investment cost and very low operating cost. Financing conditions for upfront investment are critical for economic viability of RES projects

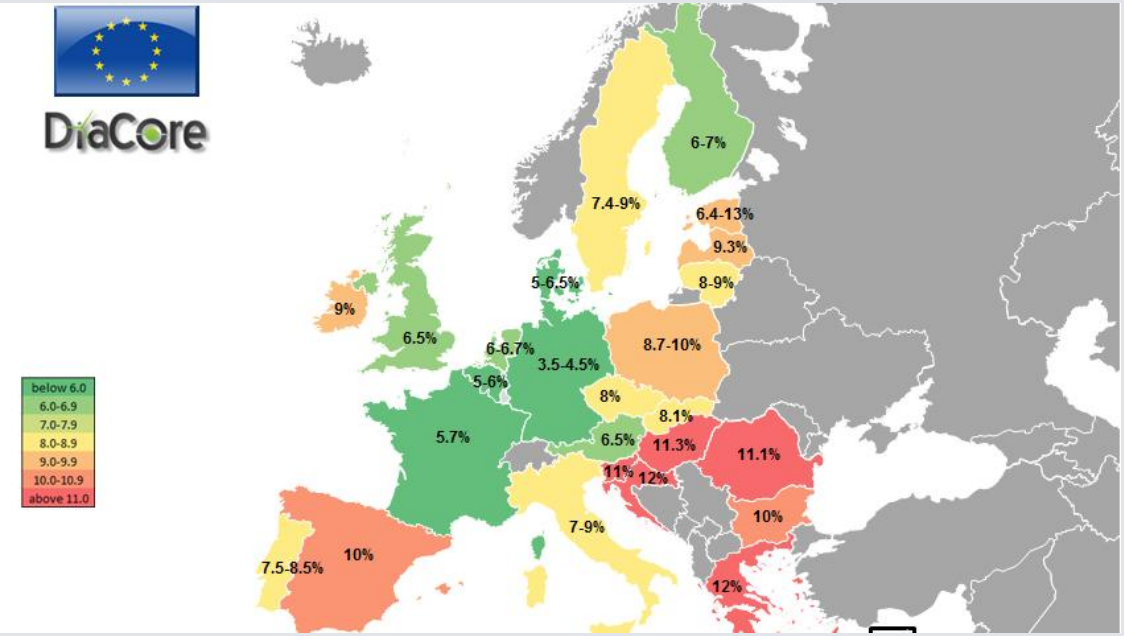


Variable Betriebskosten sind v.a. Kosten für Brennstoffe und CO_2-Ausstoß, fixe Betriebskosten v.a. Personal, Wartung und Instandhaltung
Eigene Berechnungen auf Basis von IEA/NEA (2015)

- Solar, wind and hydro power are characterized by a high share of fixed costs and very low (often close to zero) variable operating costs
- Conditions for the financing of the initial investment are major determinant of cost of generated electricity
- Financing conditions reflect ex ante risk perception
- Reducing ex ante risk is key to reducing investment cost
- Targets, stable regulatory frameworks, technology-specific pathways and innovative financing significantly reduce risk and thereby investment costs

High financing cost in Central and South-East Europe make renewables comparatively less attractive than conventional technologies, despite dramatic reductions in technology cost

Cost of capital estimations for onshore wind projects in Europe in 2014



DiaCore (2016)

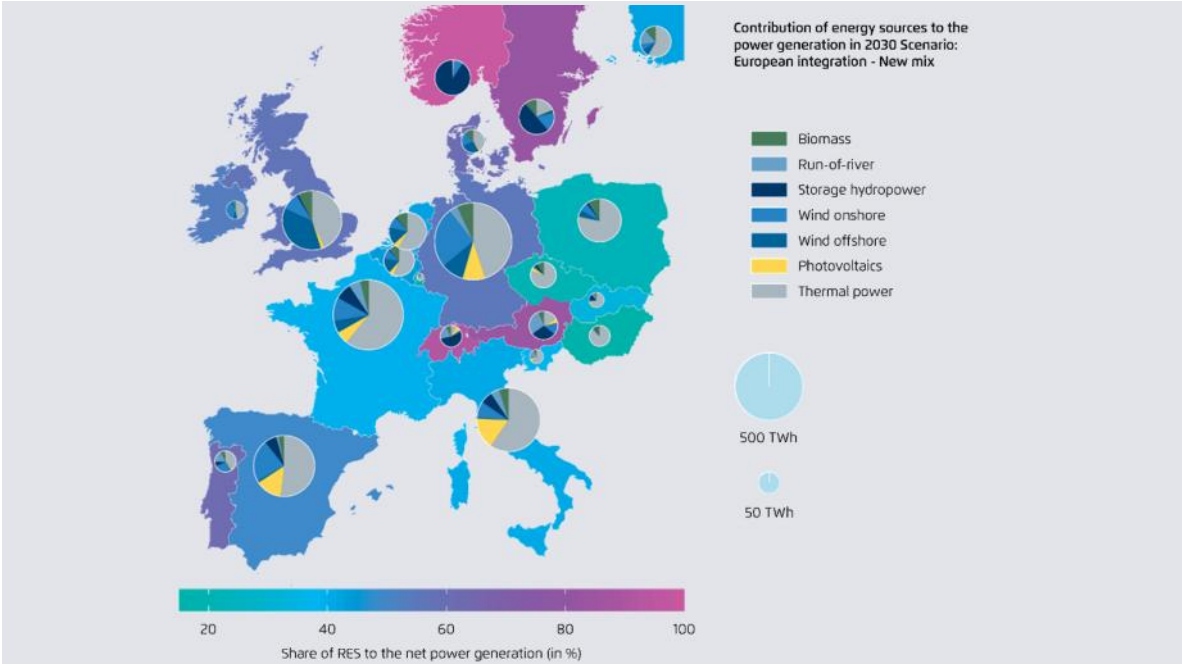
High cost of capital

- → particularly affect capital intensive RES;
- → create economic disadvantage vis a vis conventional technologies (coal, gas)
- → increase RES project cost in low GDP Member States;
- → reduce RES opportunity.

Transitional support is needed!

The EU's 2030 climate and energy targets imply an annual share of at least 50% RES-E in the EU's power mix

RES-E Anteile in Europa in 2030



Fraunhofer IWES (2015): Annahmen basieren auf nationalen Energiestrategien und ENTSO-E Szenarien im Einklang mit den EU-2030 Zielen

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 reduce by 65% by 2030 compared to 1990*
- → EU's target of >27% by 2030 will largely be delivered by power sector, as biofuels and RES heating sources are limited

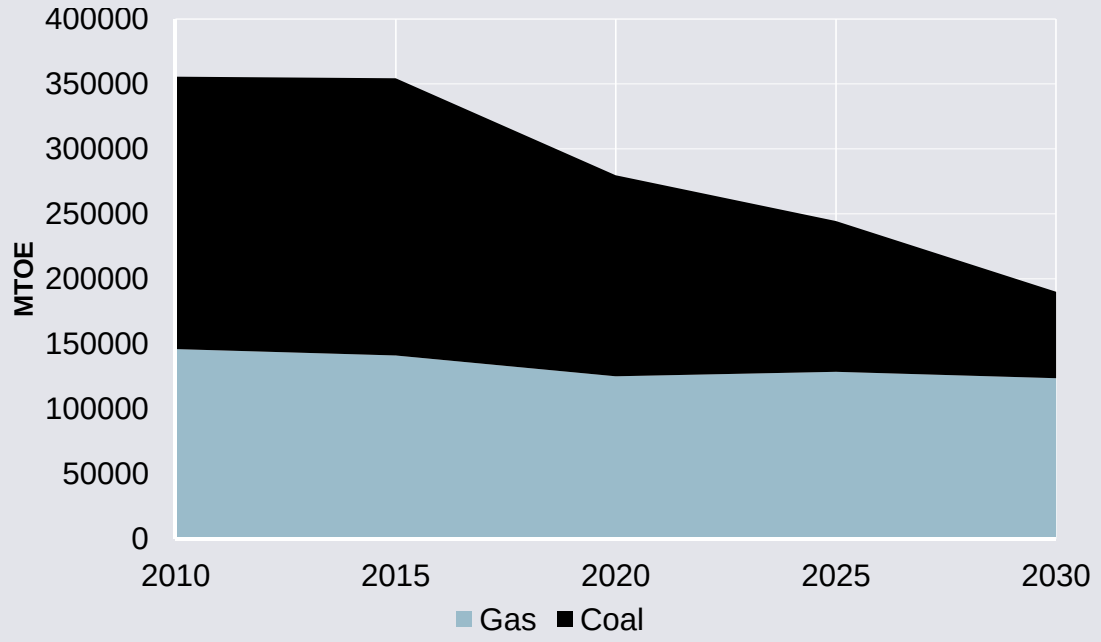
Thus, EU 2030 climate and energy targets imply

- → > 50% Renewables 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")

The EU's 2030 climate and energy targets imply decommissioning of half of Europe's coal fleet by 2030

Historische und projizierte Nutzung von Kohle im EU-Stromsystem



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

Reduced coal use in power generation is key to the EU's 2030 strategy:

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

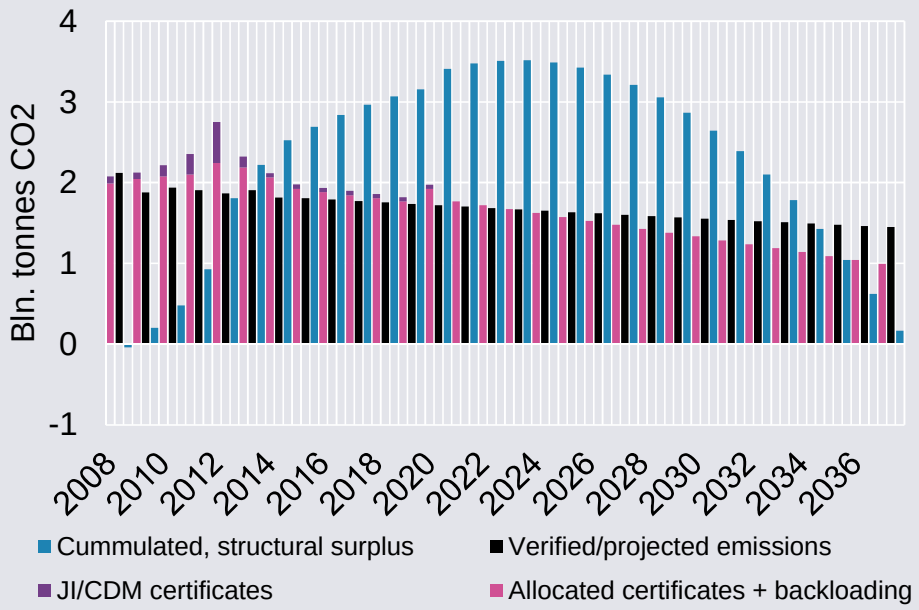
The EU 2030 climate and energy targets imply for coal

- → Minus 68% of coal power generation*
- → Decomissioning of half of the coal fleet

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

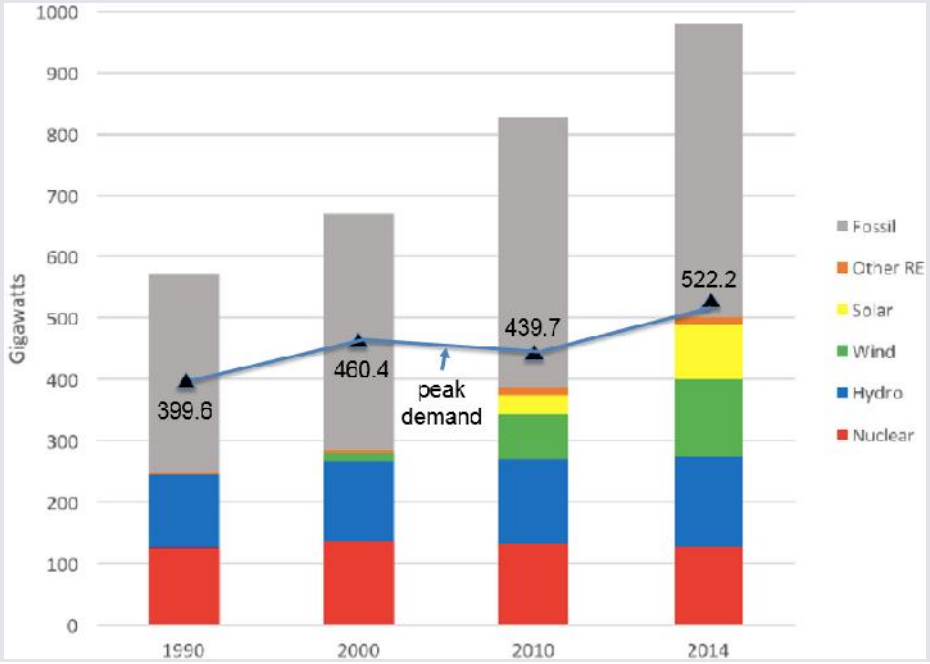
The need for “Smart & Managed Retirement” policies to actively remove old, high carbon, inflexible capacity

Cumulated allowance surplus in the EU Emissions Trading System



Agora Energiewende (2016)

Installed capacity vs. peak demand EU



Michael Hogan, RAP (2016)

Some conclusions

- An energy transition based on efficiency, renewables and reducing use of coal is economically sound, enhances energy security and delivers on climate change objectives
- All of Europe has a large economically attractive renewable energy potential and a large potential to enhance energy efficiency
- Renewables and efficiency investments come with significant co-benefits, in particular employment and clean air
- Countries in Central-East and South-Eastern Europe have relatively high inter-connection levels. A cooperative approach could significantly reduce the flexibility challenge from higher shares of renewable power
- RES investors in Central-East and South-Eastern Europe face relatively high financing cost. An EU-level instrument to guarantee national RES support payments could drastically lower the financing cost of investors and allow Central-East and South-Eastern Europe countries to reap the benefits of low-cost renewables

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Thank you for your attention!

Questions or Comments? Feel free to contact me:

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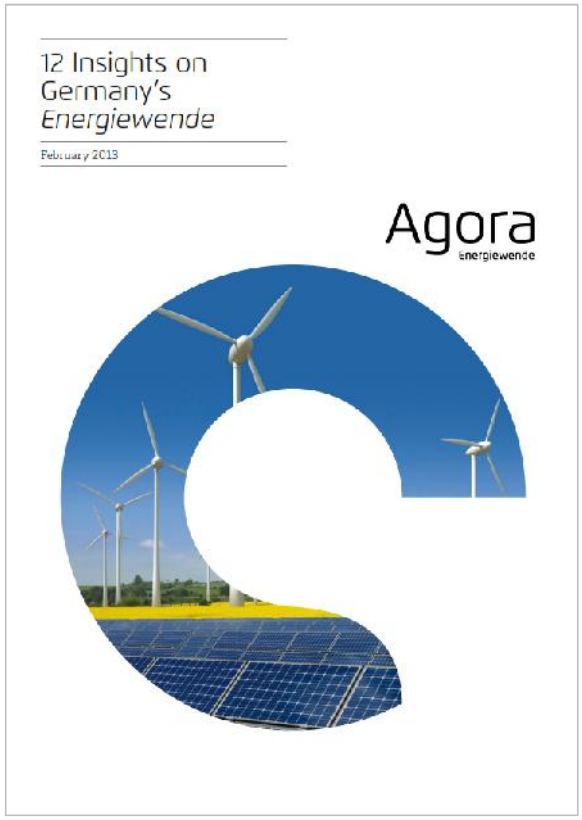
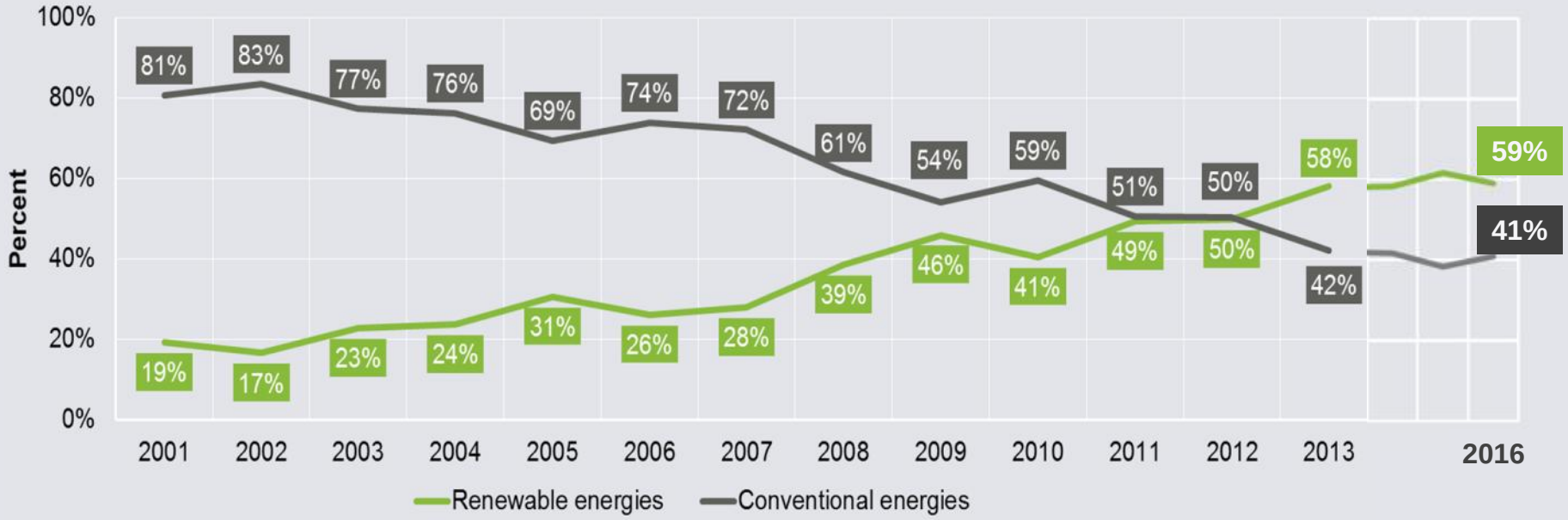
Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.

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



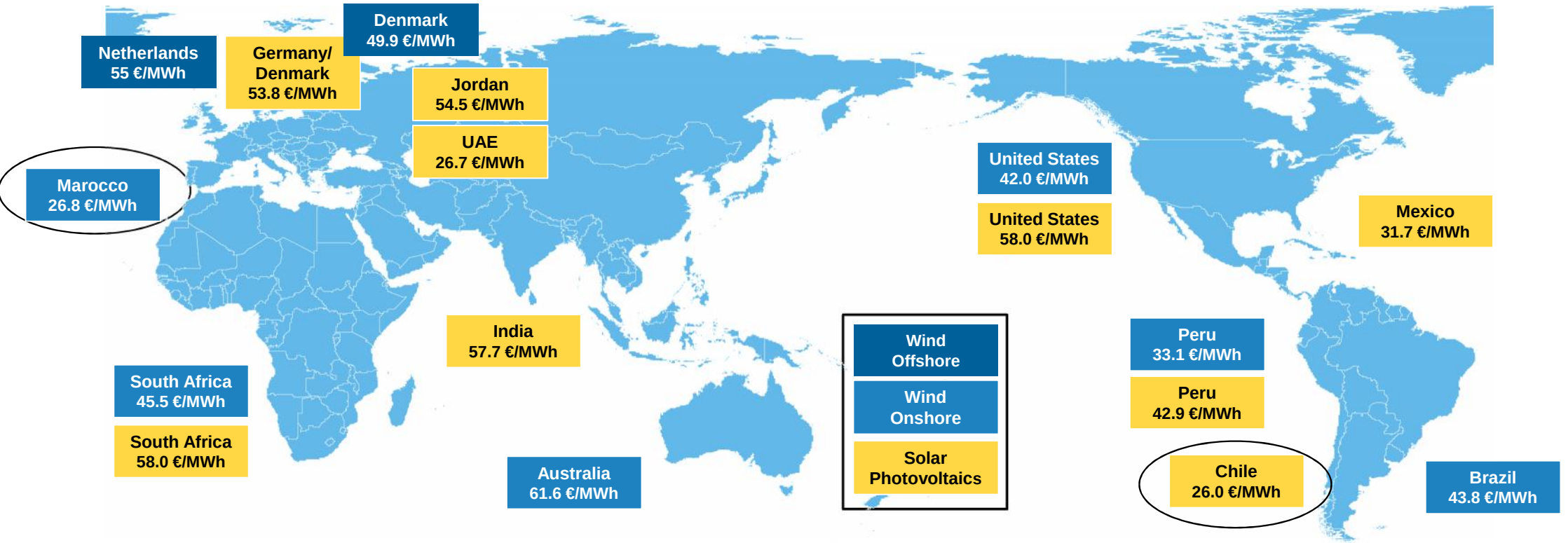
The energy sector is undergoing a transition across the globe

Share in global capacity additions 2001- 2013



IRENA (2014, 2015), FS UNEP (2017)

The reason: Wind offshore, wind onshore and solar energy get constantly cheaper



Fortum 2016; Sources: announcements by the investing companies and IEA report "Renewable Energy Medium-Term Market Report 2015" for US, Brazil, South Africa, Australia and Jordan. Values reported in nominal EUR, 1 EUR = 1,12 USD, 1 EUR = 75,3 INR, 1 EUR = 9.48 SEK. United States values calculated excluding tax credits. Typical contract lengths are 15-25 years. The prices indicate levels with which investors have been willing to invest, however, they may not describe the actual comparable costs as the bid prices may be reduced by preferential land prices, site exploration cost, targeted low-cost loans etc. The price level at which investors can hedge their renewable production for the next 4 years: average of 2017-2020 electricity (LUL) + elcertificate futures with 29.8.2016 closing prices. This low price levels still result in continuation of investments in onshore wind in Sweden.