

The German energy transition

Status, trends and challenges

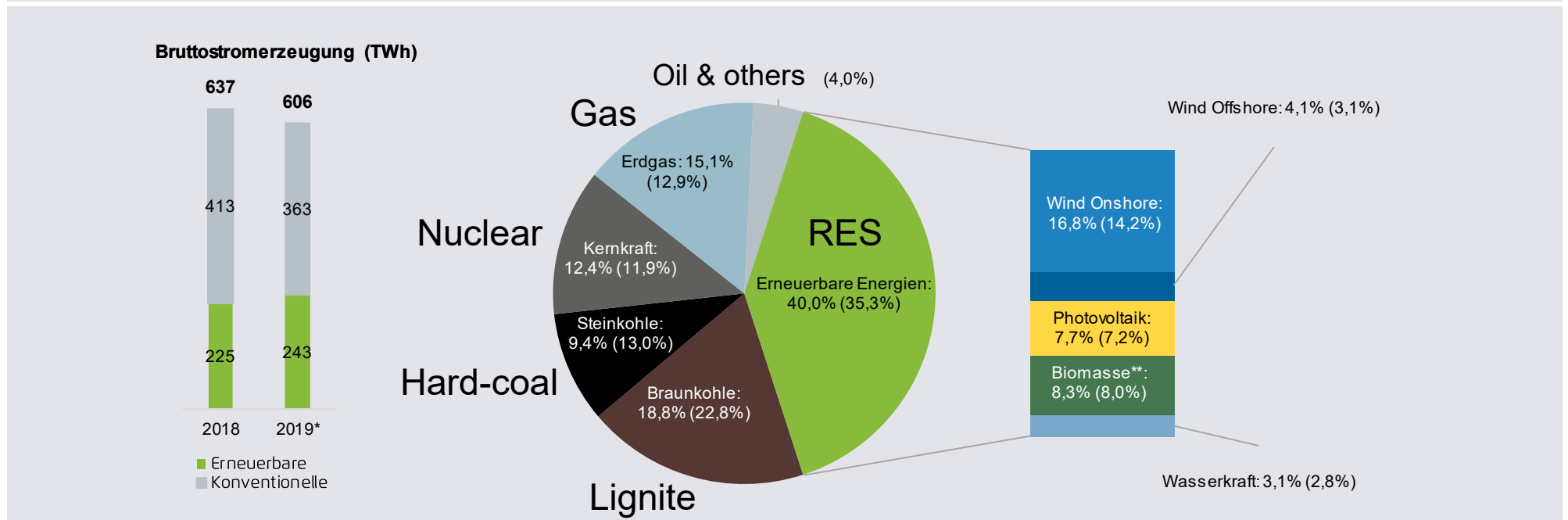
Christian Redl

BERLIN / KYIV, 23 SEPTEMBER 2020



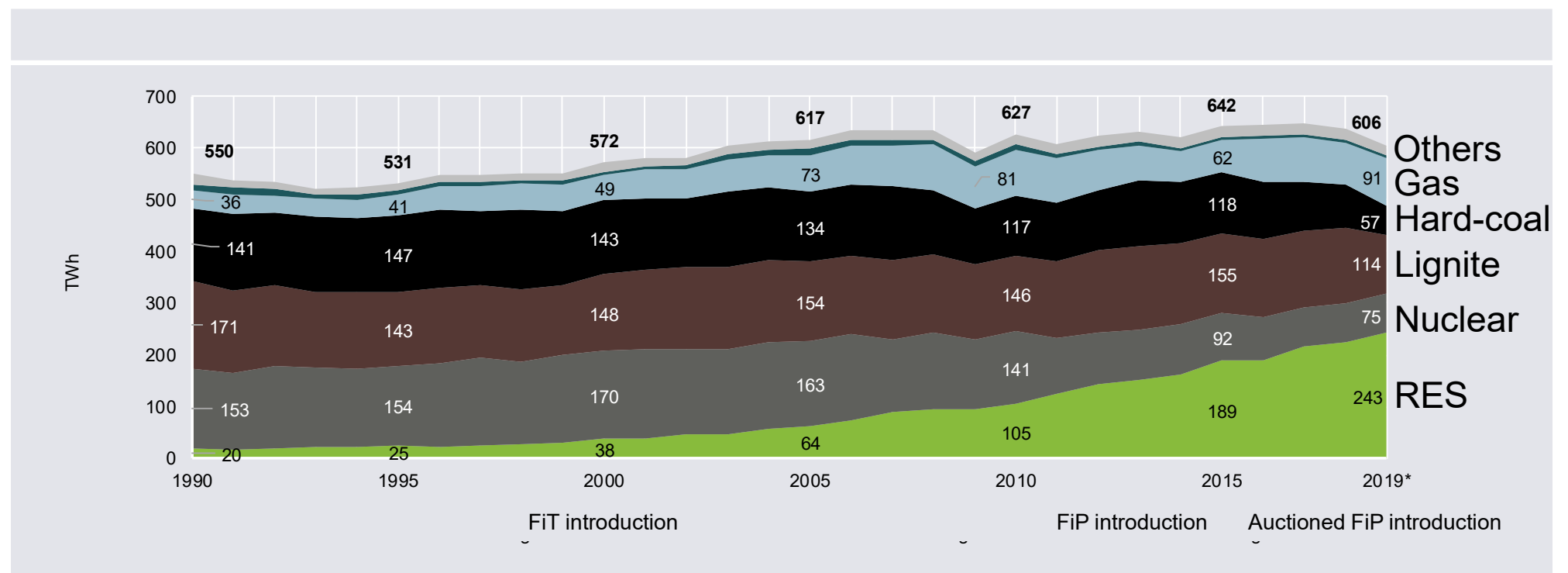
The power generation mix in Germany: Renewables generate as much as coal and nuclear together

Power generation mix 2019 (2018 values in brackets)



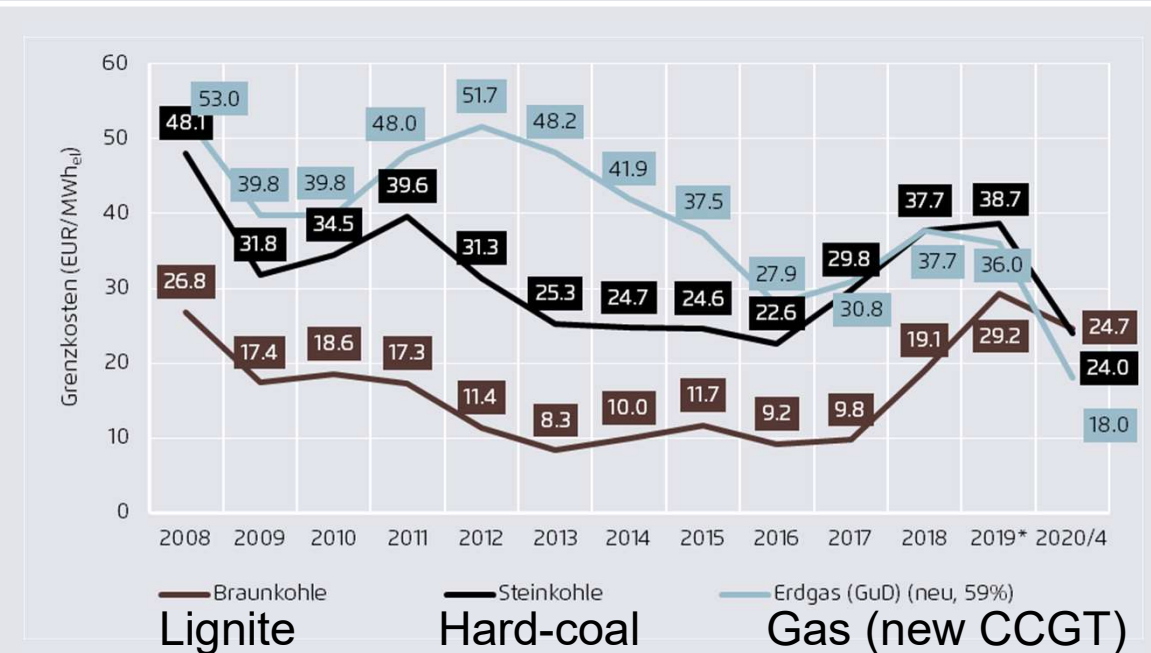
AG Energiebilanzen (2019)

Evolution of gross electricity generation



Coal-fired generation is more expensive than gas generation

Generation cost of fossil power plants in Germany

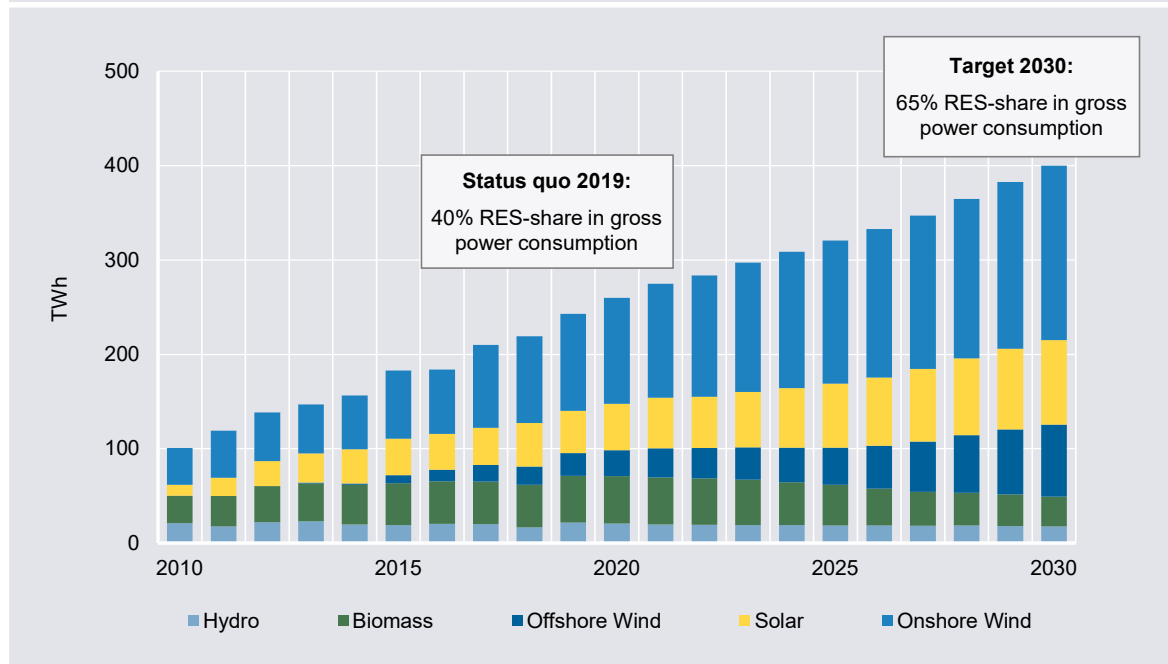


Own calculations. Electrical efficiencies: Lignite 39%, Hard-coal 44%, Gas 59%

- Given rising CO2 prices in the EU's Emission Trading System, the competitiveness of hard-coal and lignite power plants is deteriorating
- As of 2018, hard-coal plants are more expensive than gas-fired plants
- As of 2020, lignite plants are more expensive than gas-fired plants
- Note: This comparison concerns the generation cost ("short-run marginal costs") of power plants, comprising fuel, CO2 and variable operation & maintenance costs

Renewable energy: *Wind and solar* to increase renewables to at least 65% of the power sector and 30% of primary energy consumption by 2030

Gross power generation from renewables

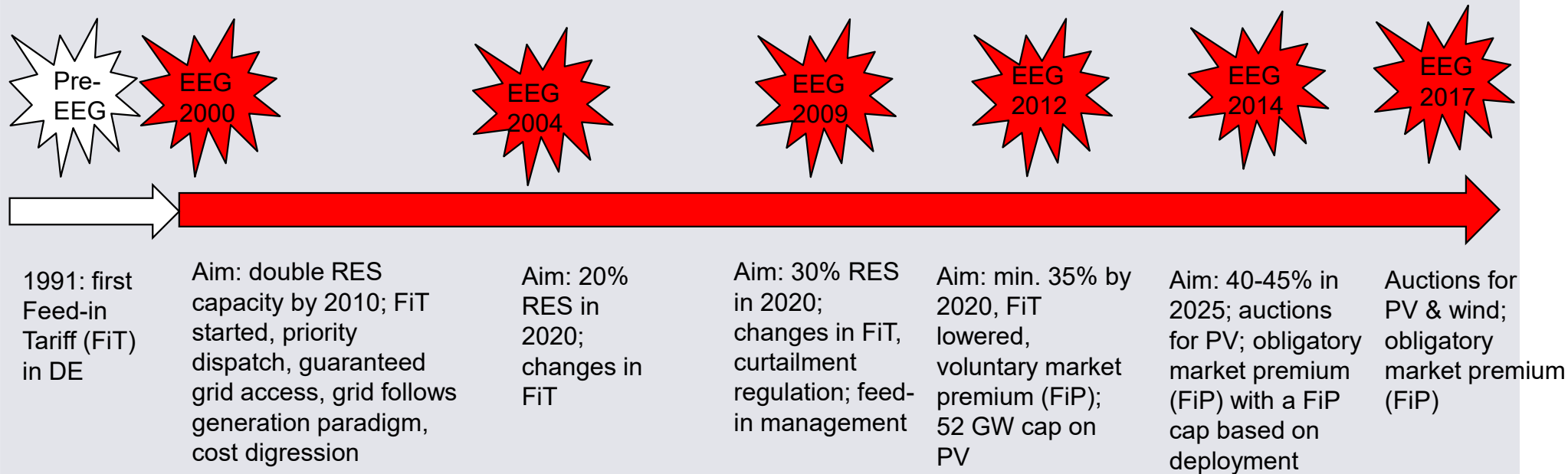


AGEB, own calculations based on Öko-Institut

- According to the coalition treaty, the share of RES in the gross power consumption shall increase to 65% till 2030.
- Primarily wind and PV shall be expanded, because they are the least-cost option in Germany.
- The potential for other RES is constrained:
 - Biomass is relatively expensive, is subject to land-use constraints and involves disadvantages with respect to sustainability concerns.
 - Hydro power cannot be expanded massively due to topographical circumstances.

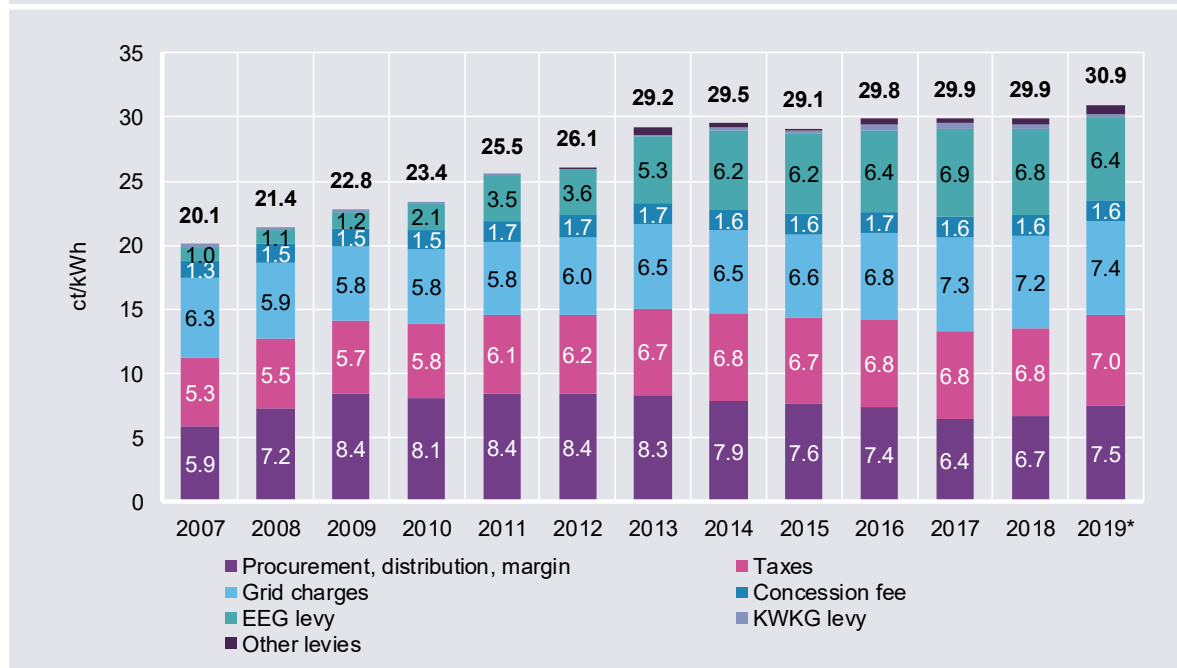
Nimble RES support policies adjusted along the way considering investment risks to trigger deployment. New version of “EEG” to be adopted by end of this year.

Renewable Energy Law (EEG) – reform steps 2000 to 2014



After significant increases in previous years, household electricity prices are relatively stable since 2013

Average household electricity prices in a 2500-5000 kWh/year household

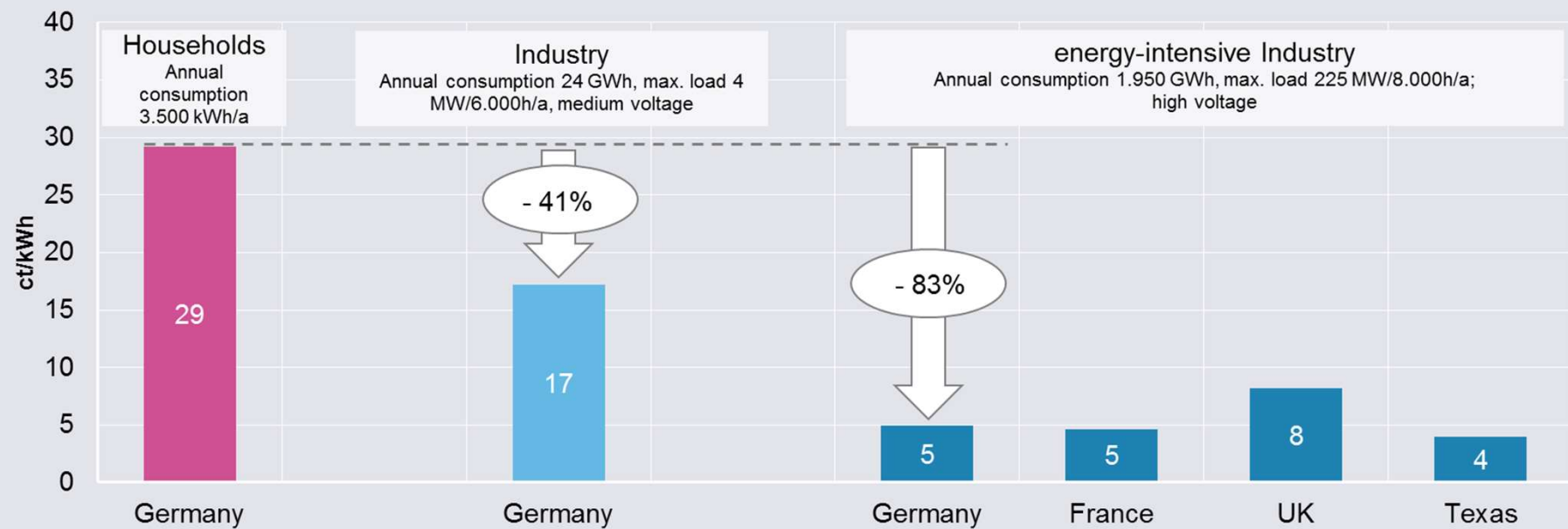


BNetzA, *own estimates

- In contrast to whole sale prices, household prices have increased almost every year since 2007. However the increase has flattened since 2013.
- Besides increasing procurement costs, during the last 10 years, the grid charges have also risen due to grid expansion and the integration of RES (redispatch and curtailment measures).
- The grid connection-costs for offshore wind power plants will be included in the offshore wind levy, which will therefore increase, too.
- The other price elements have remained stable.

Energy intensive industries are largely exempt from taxes and levies to safeguard their competitiveness

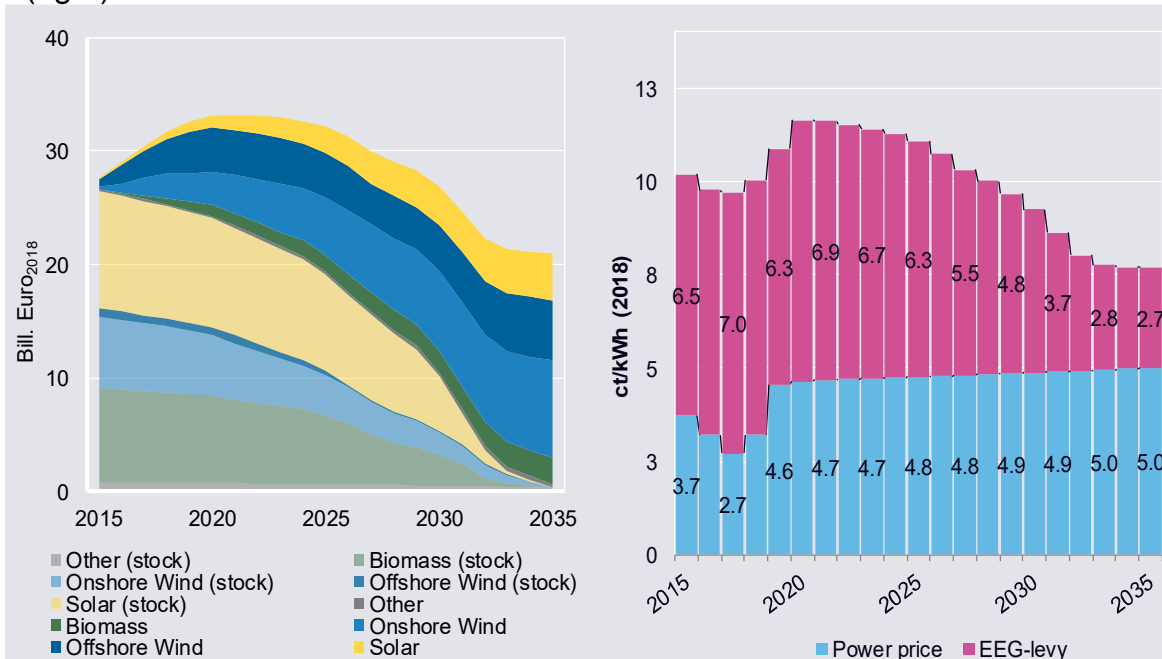
Average end consumer prices for different consumer groups, 2013



BMWi (2014)

Cost challenge in the power sector: Overcoming the "cost hill" between 2018 to 2025

Remuneration for RES-operators (left), wholesale prices and EEG surcharge (right) 2010 - 2035

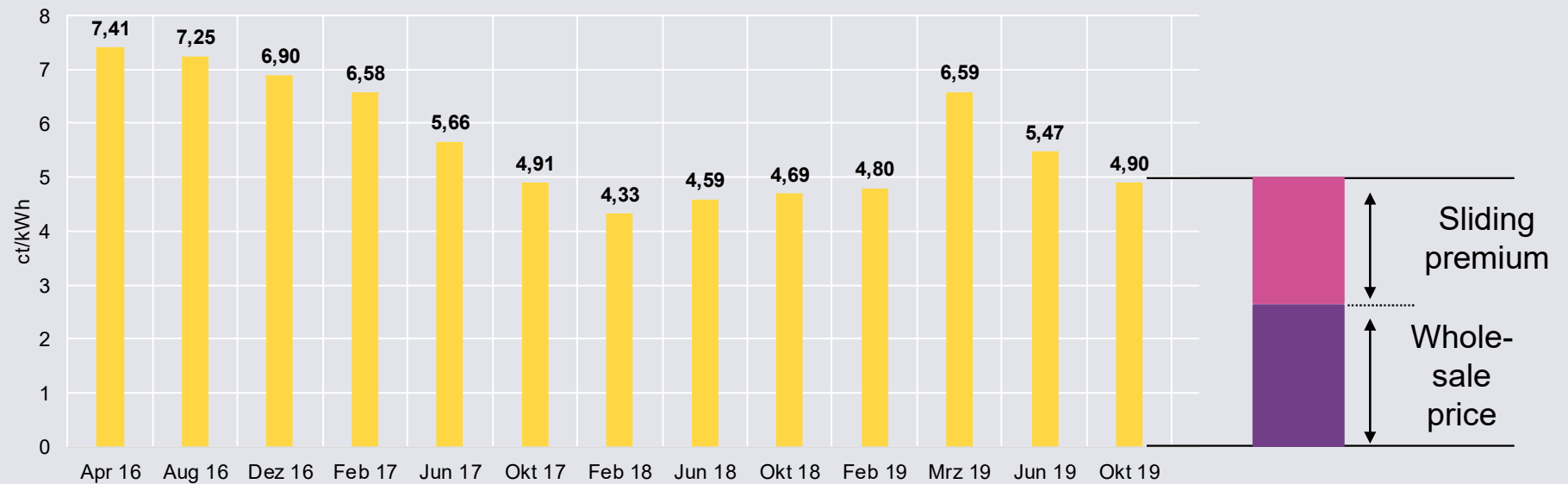


Calculations by Agora, based on Öko-Institut

- In the middle of the 2020s, the costs of RES will decline, while simultaneously, the RES share in gross power consumption will increase.
- Reasons:
 - RES power plants become cheaper.
 - In 2021 a high number of old plants will exit the support scheme, because they will have reached the maximum support period of 20 years.
 - A stronger effect of the emissions trading system makes power generation from fossil fuels more expensive.

Auctions for large-scale PV

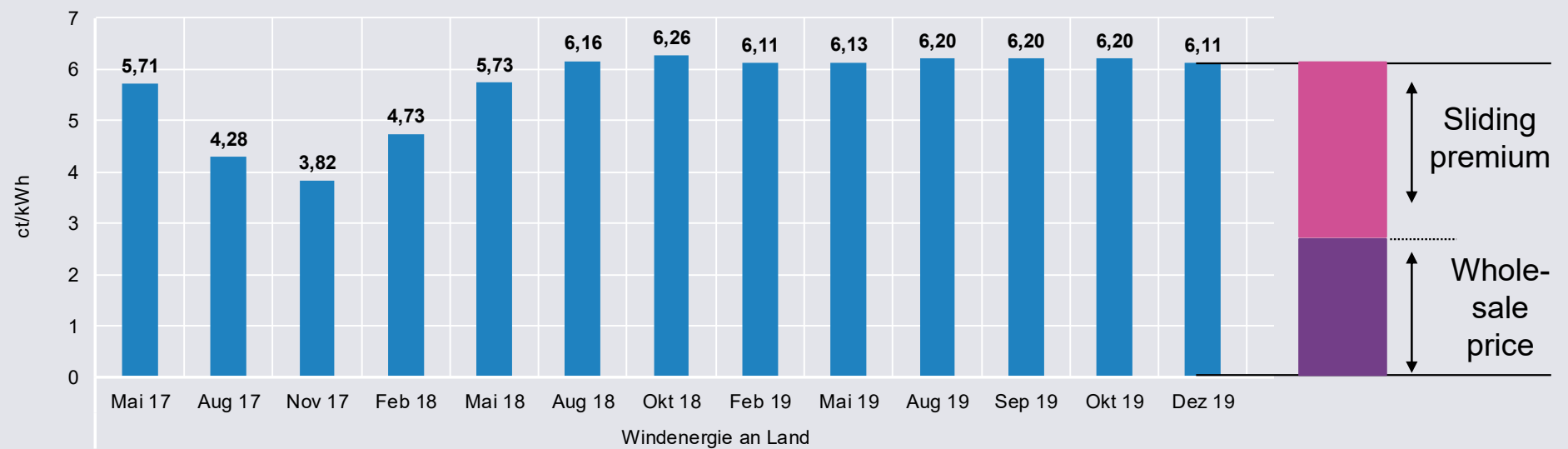
Average remuneration for large-scale PV in Germany (PV receives the difference between the tender remuneration and the wholesale price as a sliding premium)



Bundesnetzagentur (2019)

Auctions for onshore wind

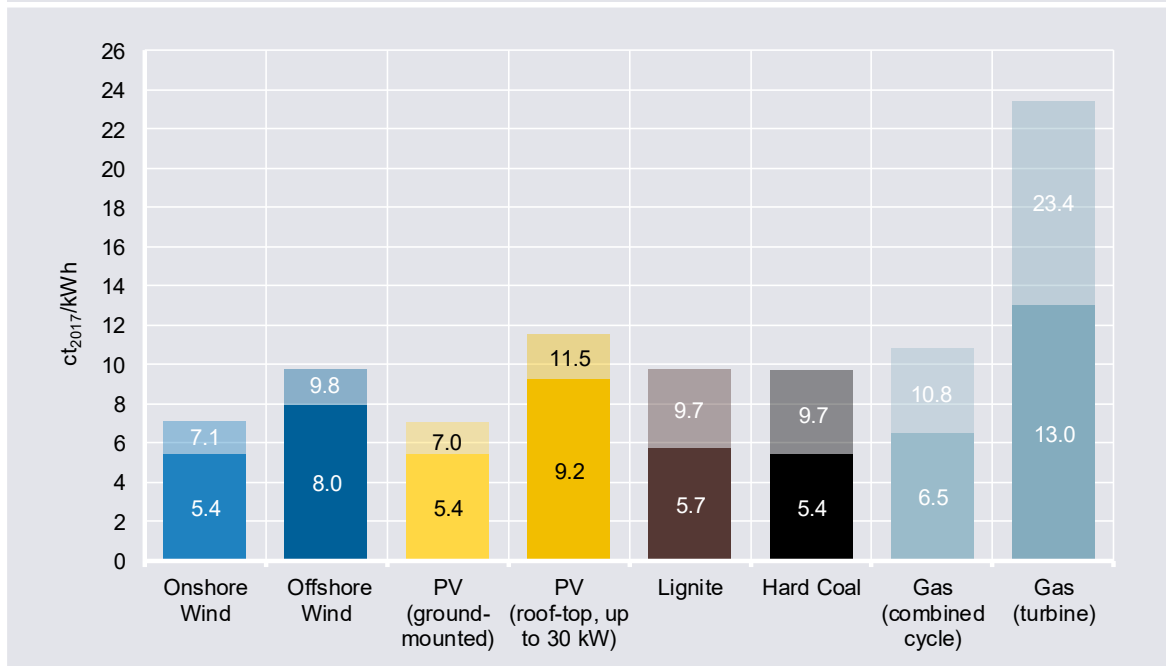
Average remuneration for onshore wind in Germany (wind receives the difference between the tender remuneration and the wholesale price as a sliding premium)



Bundesnetzagentur (2019)

Wind and solar are cost competitive with other newly built power plants

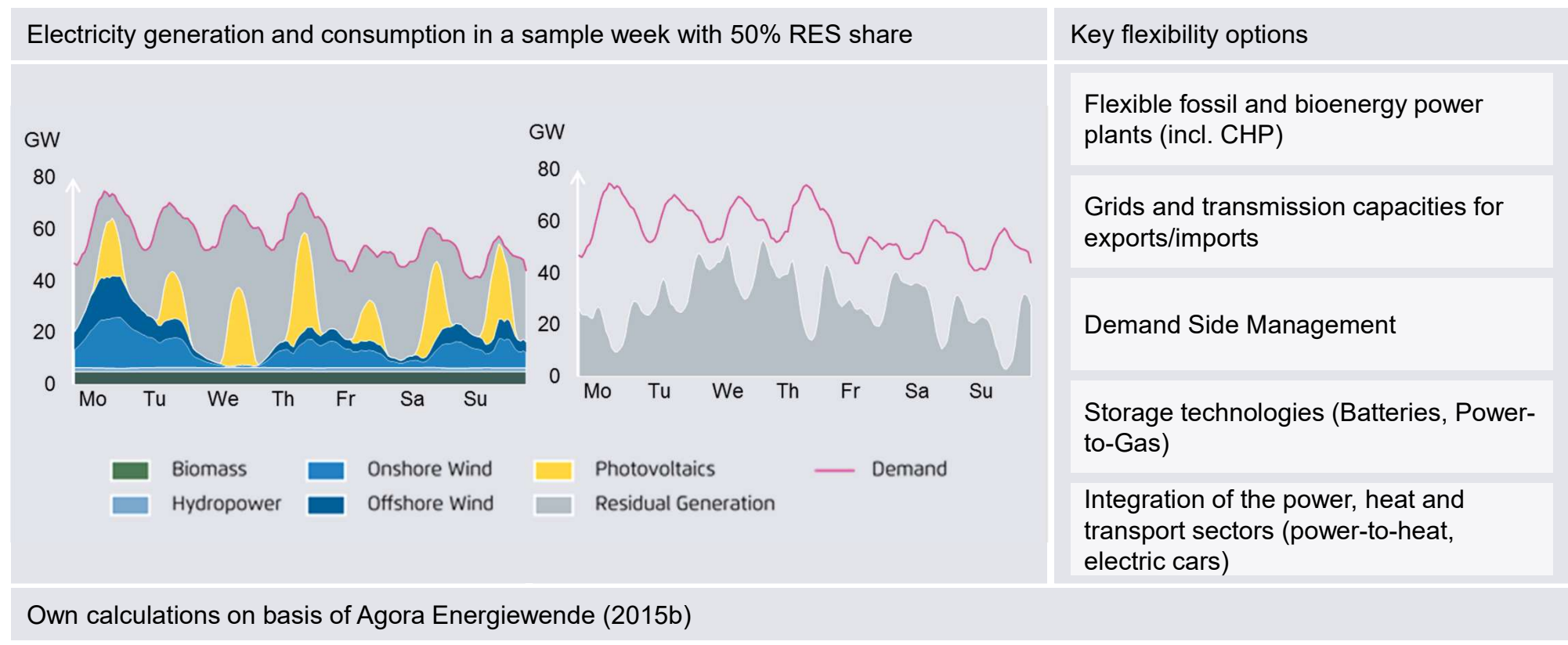
Range* of levelized cost of electricity (LCOE) 2017



Own calculations, *based on variable utilization, CO₂-price and investment cost, Offshore wind excluding grid connection cost

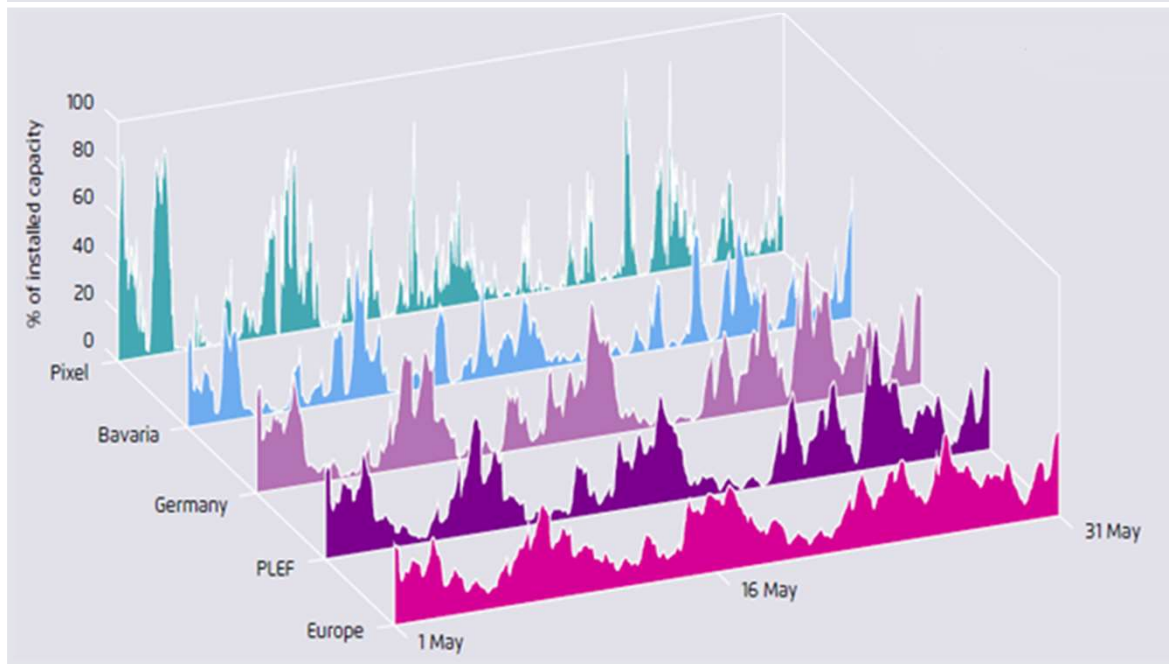
- Levelized costs indicate that RES generation costs decrease, also below the generation costs of coal plants.
- Ground-mounted PV and onshore wind power plants are the two cheapest technologies for power generation in Germany.
- While RES-plants imply high investment costs, the production costs for power from fossil fuels depend on variable costs (CO₂-Price and fuel costs).
- Gas power plants have the highest fuel costs.

Flexibility is the paradigm of the new power system – baseload capacities are not needed any more



Minimising flexibility requirements through market coupling: Cross-border power flows enable smoothing effects

Wind onshore generation, May 2030, for different levels of aggregation



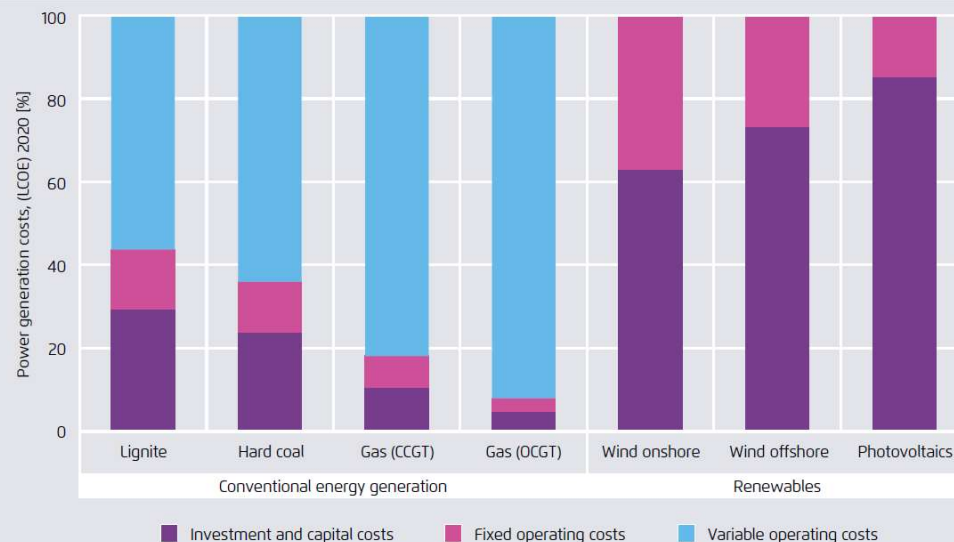
Fraunhofer IWES (2015), 1 pixel corresponds to an area of 2.8 x 2.8 km, PLEF summarize the countries AT, BE, CH, DE, FR, LU, NL

EU wide aggregation:

- Instantaneous wind output is less volatile and has fewer very high and low values
- Fluctuations of wind power are then “softer” and slower. Thus, flexibility requirements decrease
- Example:
- Largest EU-wide hourly wind ramp is -10% of installed capacity
- For comparison, largest hourly wind ramp in France is 21% of installed capacity

RES are changing the cost structure of the energy system

Renewables feature high fixed and no variable operating costs



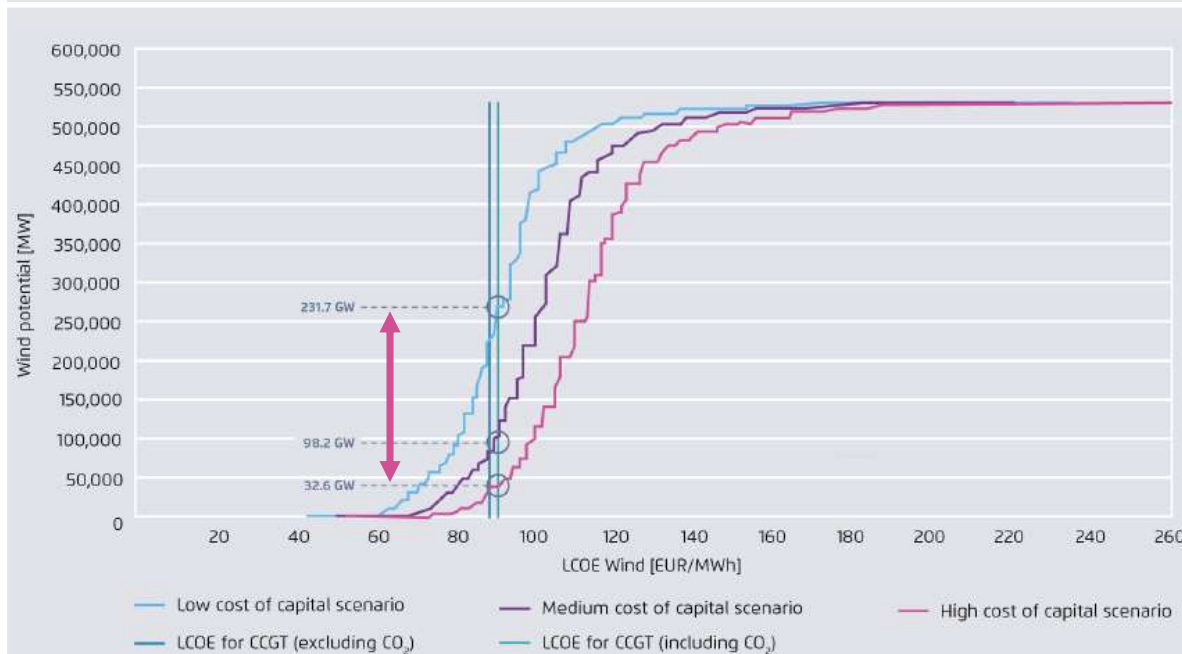
Variable operating costs consist mostly of costs for fuels and CO₂ emissions; fixed operating costs consist mostly of costs for personnel and maintenance.
Calculations by Agora, based on IEA/NEA (2015).

Own calculations based on IEA 2015

- Financing structures and electricity markets have been based on the assumption that power generation has comparably low fixed and high operating costs.
- Wind and Solar PV have high fixed and low operating cost – the same is true for storage, efficiency technologies and power grids.
- Financing structure determines whether investors are willing to hedge risk.

Preconditions for a clean energy transition

Cost-competitive wind potential in SEE as a function of cost of capital



IRENA (2017)

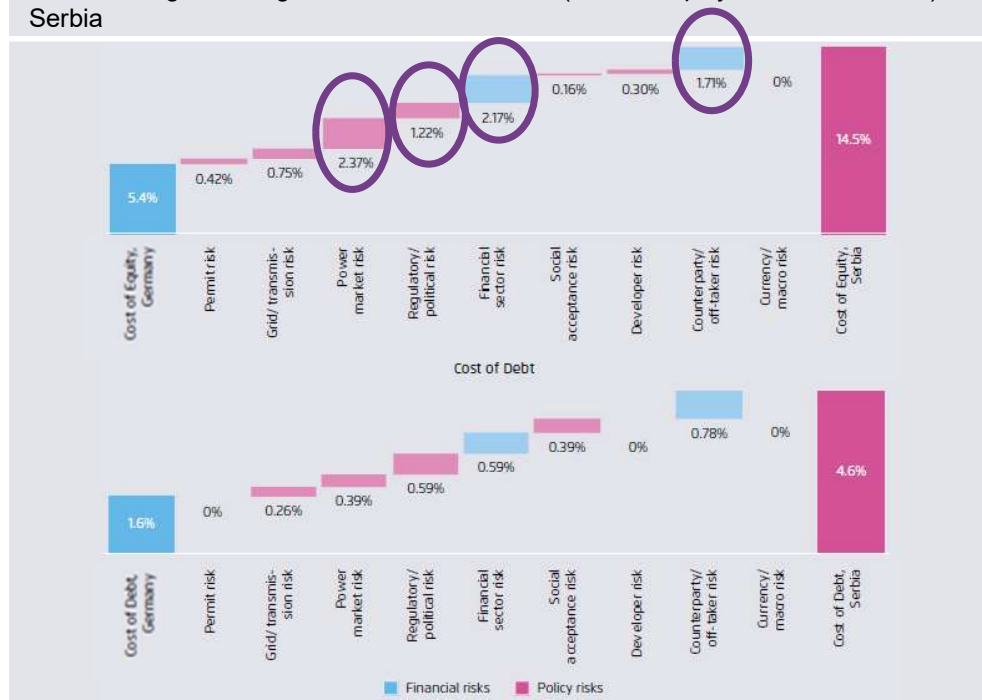
Very high renewable energy potential

To unlock deep RES deployment, RES-related opportunities (economic, health, climate, security etc), maximise security of supply and minimize consumer cost, policy should:

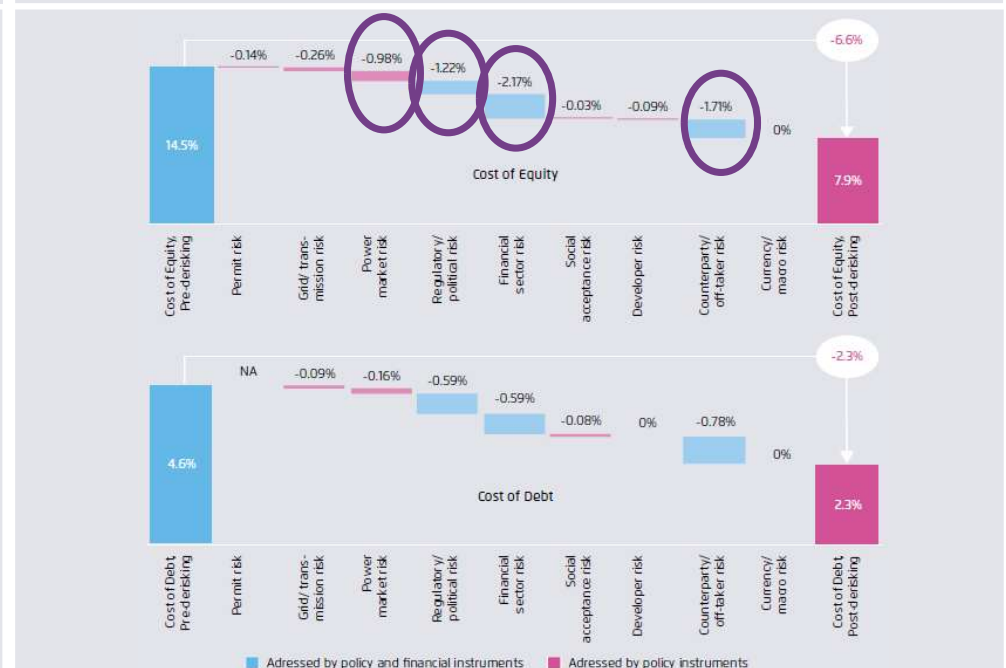
- Remove regulatory barriers and lower financing risks for RES (for large and small-scale RES)
- Gradually phase-out coal & lignite
- Plan robustly regarding climate & energy
- Cooperate regionally, reform power markets and pursue market integration

Financial and policy derisking can strongly lower cost of capital: Case study Serbia

Pre-derisking financing costs for onshore wind (Cost of Equity and Cost of Debt) in Serbia



Post-derisking financing costs for onshore wind (Cost of Equity and Cost of Debt) in Serbia



NewClimate Institute (2019)

Key derisking policies for RES in Serbia

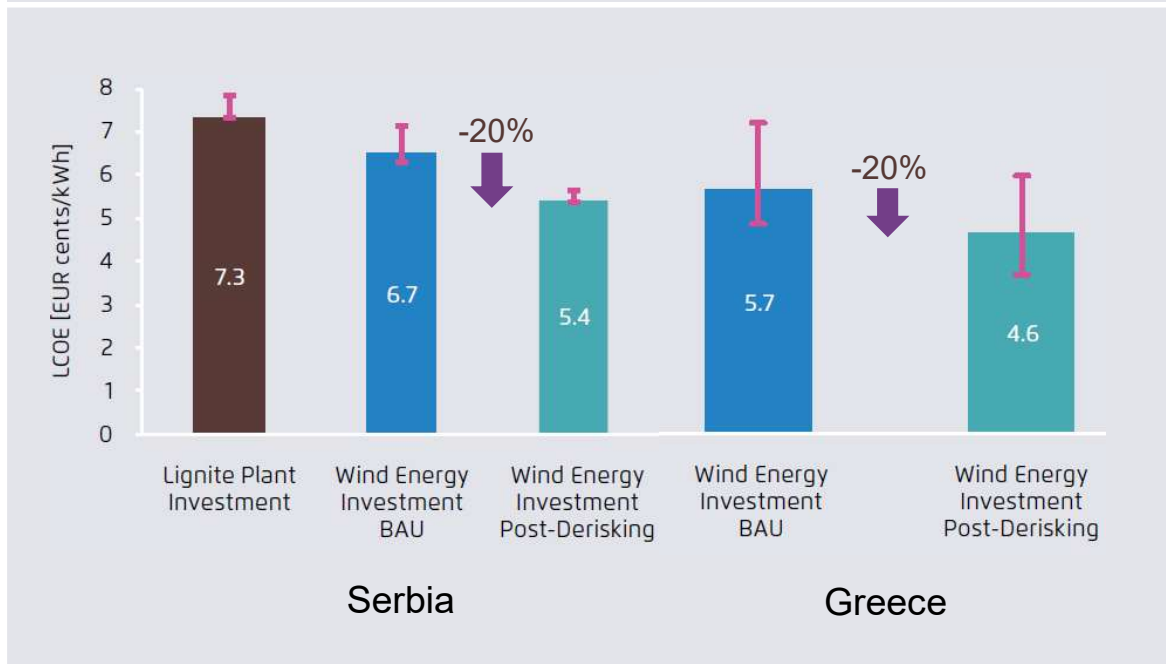
RES investment risks and derisking instruments – Serbia

	RISK CATEGORIES	LIST OF DERISKING INSTRUMENTS	
		Policy instrument(s)	Financial instrument(s)
1	Permit Risk	Streamlined permitting	
2	Grid/Transmission Risk	Grid development; up-to-date grid connection code implementation; continuation of shallow-charging approach	
3	Power Market Risk	Stable RES remuneration scheme; abolishment/reform of fossil fuel subsidies; opening up balancing markets across borders; implementing intraday markets	
4	Regulatory/ Political Risk	Stable RES remuneration scheme; 2030 targets adopted	Curtailed rules with financial compensation
5	Financial Sector Risk	Implementation of RED II	RES Cost Reduction Facility
6	Social Acceptance Risk	Public campaigns	
7	Developer Risk	Streamlined processes and good RES framework	
8	Counterparty/ Off-taker Risk	Revised PPA/CfD structure, including provisions of self-consumption; stable RES remuneration scheme implemented; enabling of corporate PPAs	RES Cost Reduction Facility
9	Currency/Macro Risk	Indexing/inflation adjustments, also for new auctions	RES Cost Reduction Facility

NewClimate Institute (2019)

Derisking measures are key tools for enhancing RES. They lower LCOE of RES by 20% and allow benefitting from dropping technology cost

LCOE comparison, lignite* vis-a-vis onshore wind in Serbia and Greece



NewClimate Institute (2019)

* At current ETS prices of 25 EUR/t CO₂, LCOE of new lignite in Serbia would equal 150 EUR/MWh

Derisking measures with the highest projected impact include:

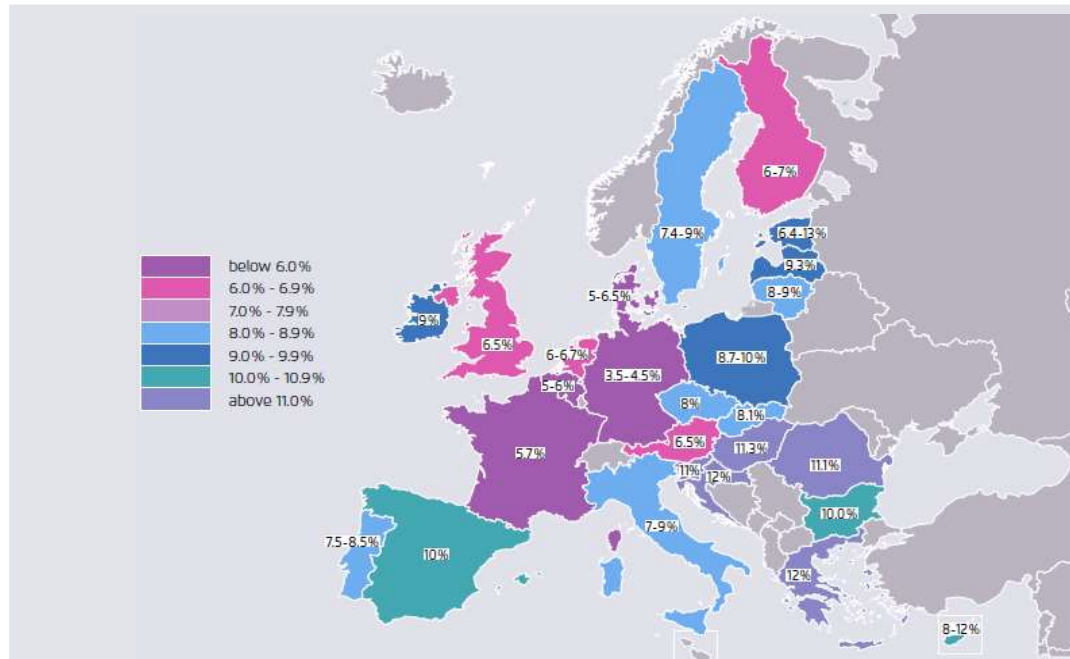
- the proposed EU budget guarantee mechanism under Invest.EU
- reliable, long-term RES remuneration regimes, including long-term RES targets
- provisions to allow corporate PPAs
- Open, well-functioning and regionally integrated balancing & intraday markets

An EU budget guarantee alone accounts for some 40 % of the estimated financing cost decline in Serbia and Greece

A guarantee scheme in the WBIF is already implemented

The challenge: Getting robust frameworks and smart financing instruments for scaling up renewable energy

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



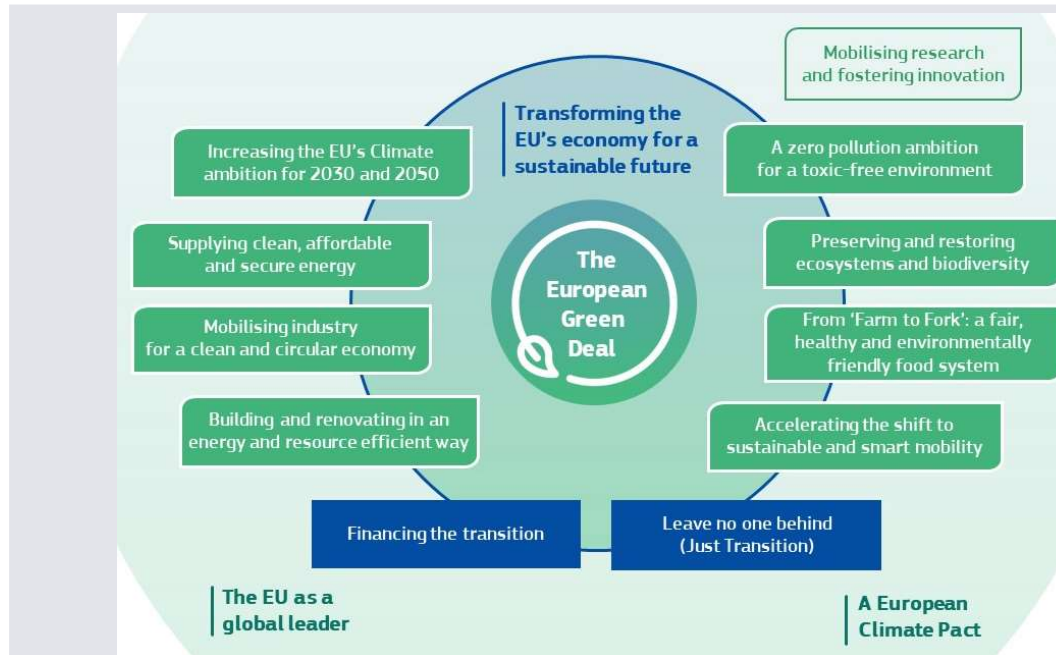
DiaCore (2016)

Renewable energy is now cheaper than coal when investing in new power capacity – if there is a robust regulatory framework and smart financing helps to reduce risks and costs

- Robust implementation of the EU RES Directive and related best practices
- Use of new financing opportunities under the Multiannual EU Budget 2021-2027
 - “De-risking” renewable energy investments under InvestEU / WBIF
 - Renewable energy projects of European interest
 - EU renewable energy financing mechanism

The European Green Deal shall enable a robust, just and deep energy transition of the EU

Main elements of the European Green Deal



European Commission

- Comprehensive plan to increase the EU 2030 climate target to at least -55%
- Enshrining the 2050 climate neutrality objective into EU law
- Sectoral measures for reduction of emissions & resource consumption (buildings, agriculture, traffic, industry, energy)
- Public and private investments oriented towards climate protection & sustainability
- Just Transition
- Mainstreaming climate policies in international trade

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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.



Backup



Agora Energiewende – Who are we?



Think Tank with more than 40 Experts
Independent and non-partisan

Founded in 2012

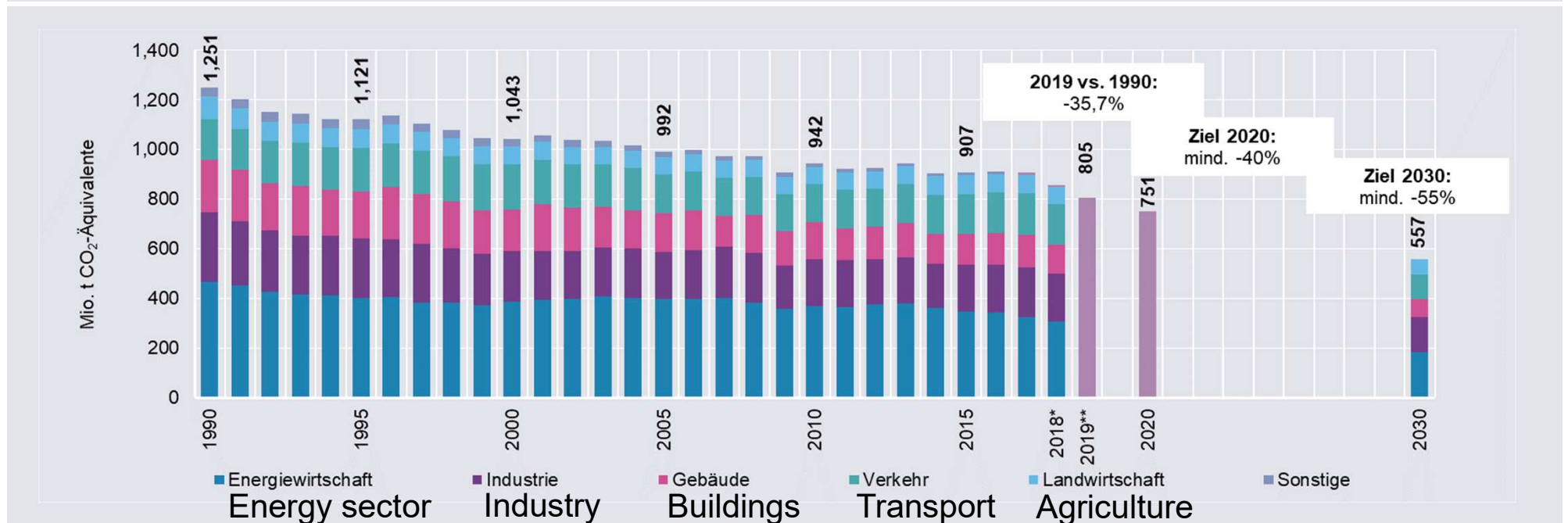
Shareholders: Mercator Foundation &
European Climate Foundation

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

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

By end of 2019, greenhouse gas emissions were 35% below 1990 levels. The energy sector is the largest emitter, followed by industry and transport

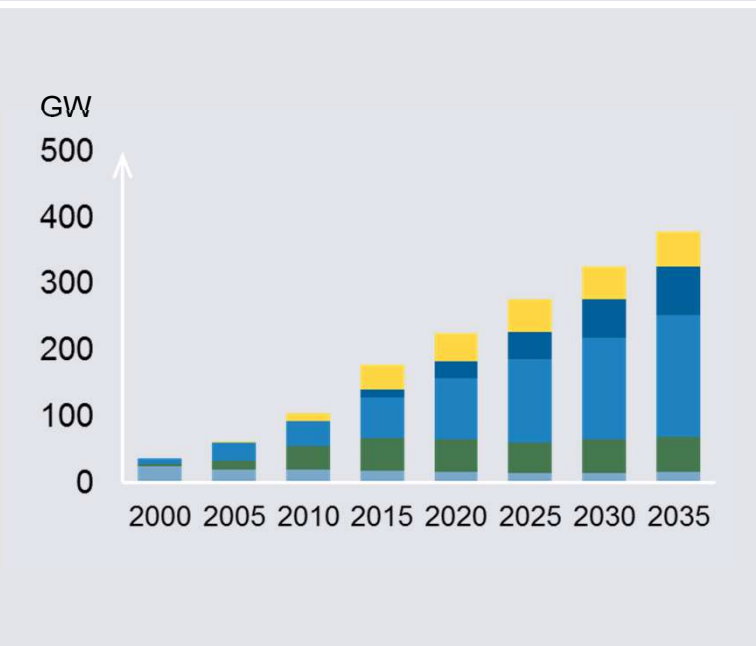
Greenhouse gas emissions by sectors



Umweltbundesamt, own calculations, *preliminary

With wind and solar, the new power system will be based on two technologies that completely change the picture

Gross electricity generation of renewable energies 2000 - 2035

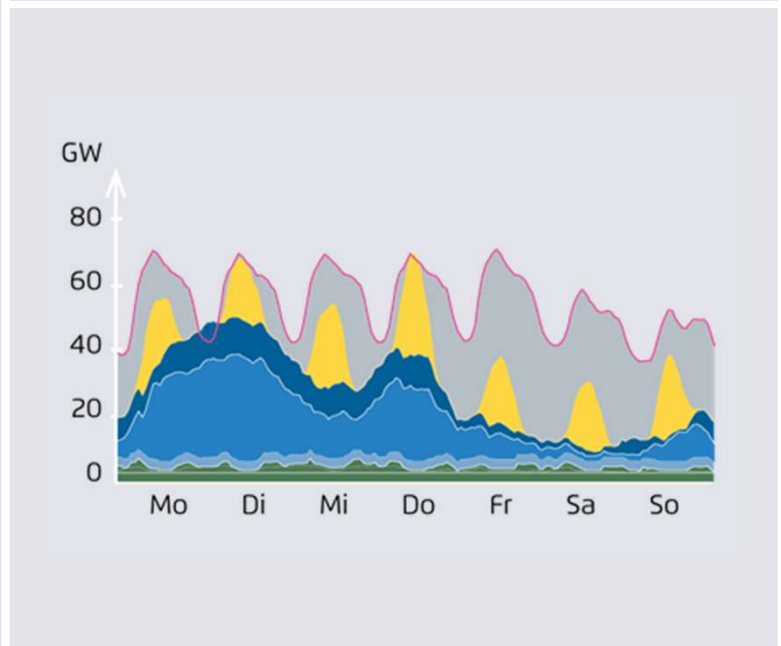


AGEB (2015a), BNetzA (2014), BNetzA (2015b), own calculations

Specific characteristics of Wind and Solar PV

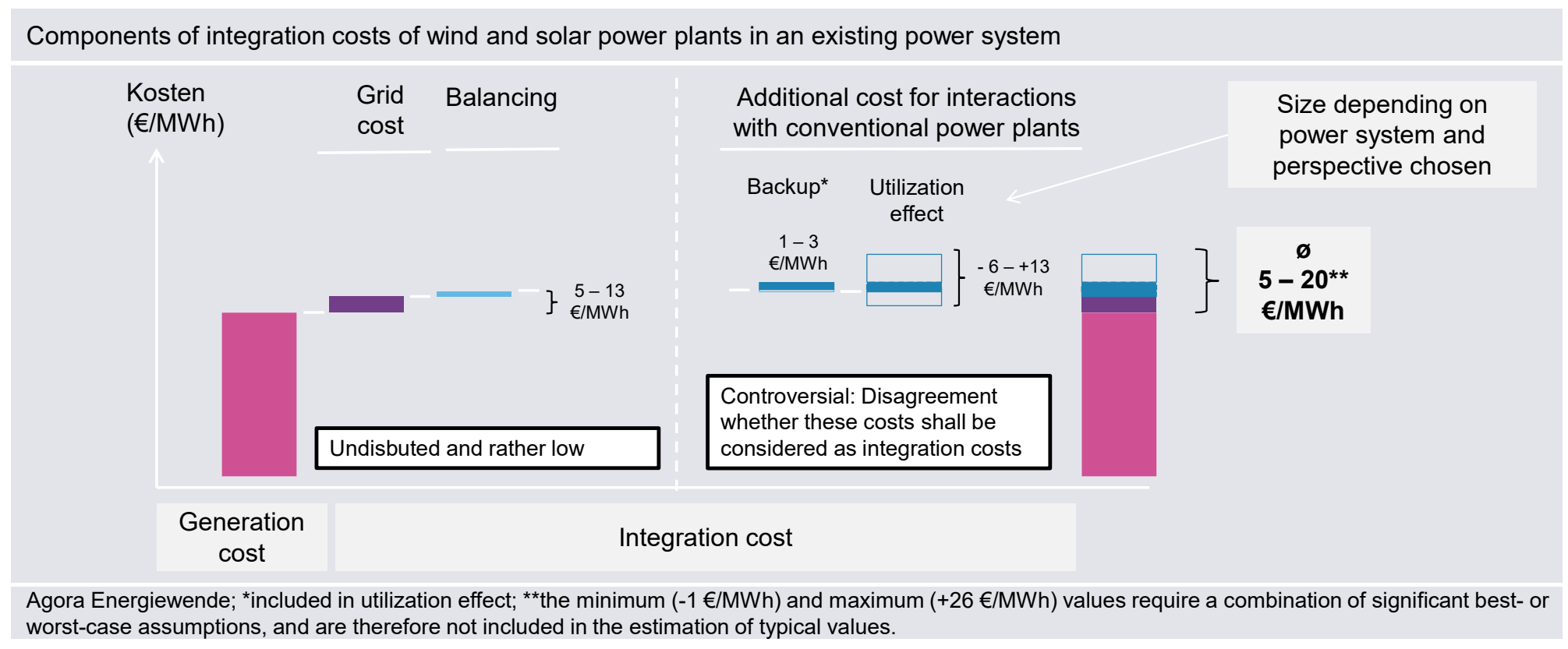
- 1 Intermittent
- 2 High capital costs
- 3 Very low variable cost

Electricity generation and consumption in a sample week 2023



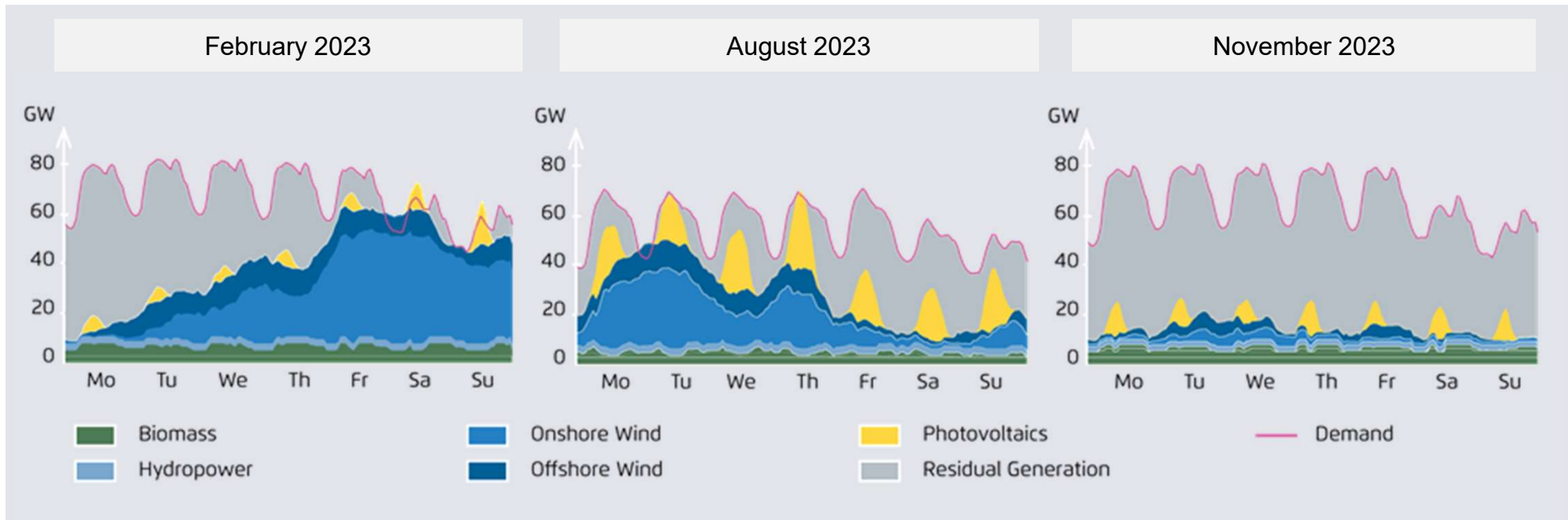
Fraunhofer IWES (2013)

The integration cost of wind and solar (5 to 20 EUR/MWh) do not change the picture – wind and solar remain the cheapest technologies



The power system and power markets will need to cope with a highly fluctuating power production from wind and solar

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

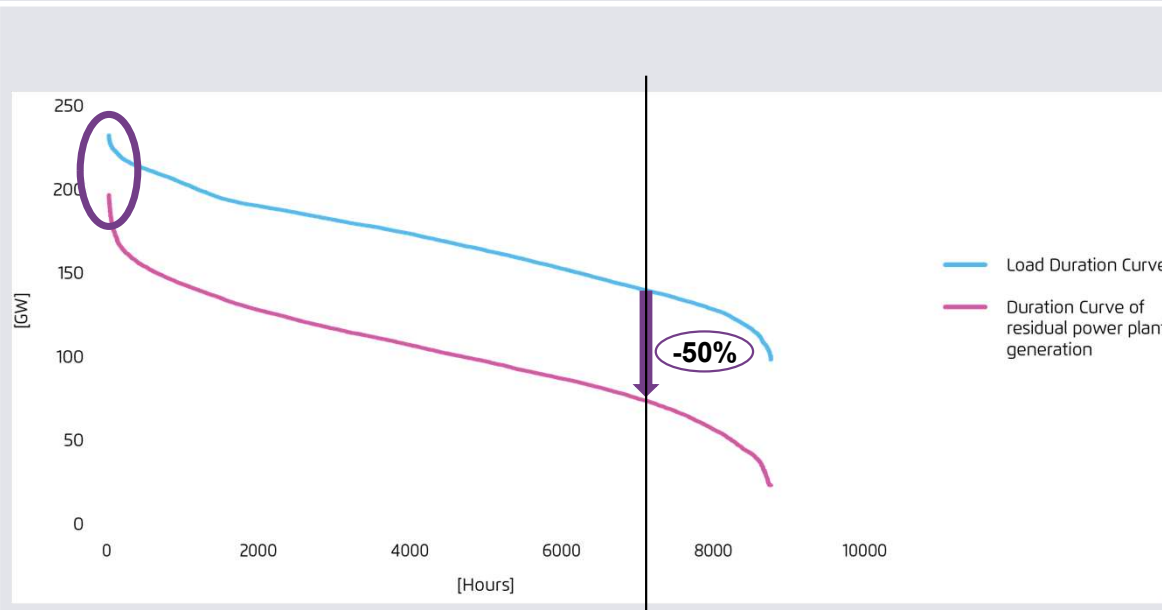


Fraunhofer IWES (2013)

* Modelling based on 2011 weather and load data

In a 50% RES system, the need for baseload capacities halves. The need for peak capacities does not

Load duration curve, duration curve of generation of residual power plant park for PLEF/CWE* 2030



50% RES-E (~30% wind and PV) reduce capacity needs for power plants running more than 7000hrs per year by 50%

Peak load needs are reduced less strongly

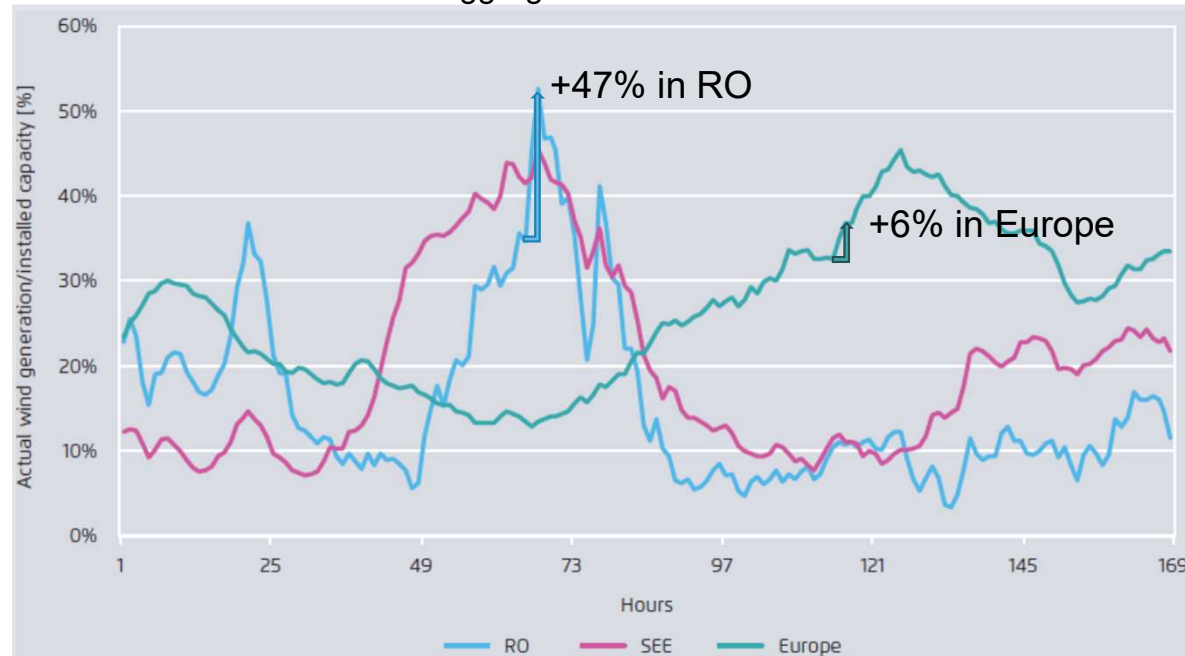
Adequacy not only about “*how much*” but “*what kind*” of capacities

Cross-border adequacy assessments to meaningfully inform domestic SoS debates

Agora Energiewende based on Fraunhofer IWES (2015) *AT, BE, CH, DE, FR, LU, NL; Weather year 2011

Regional integration allows geographical smoothing of wind feed-in, minimises flexibility needs, maximises security of supply

Time series of onshore wind power generation in a simulation for the first week of 2030 at different levels of aggregation

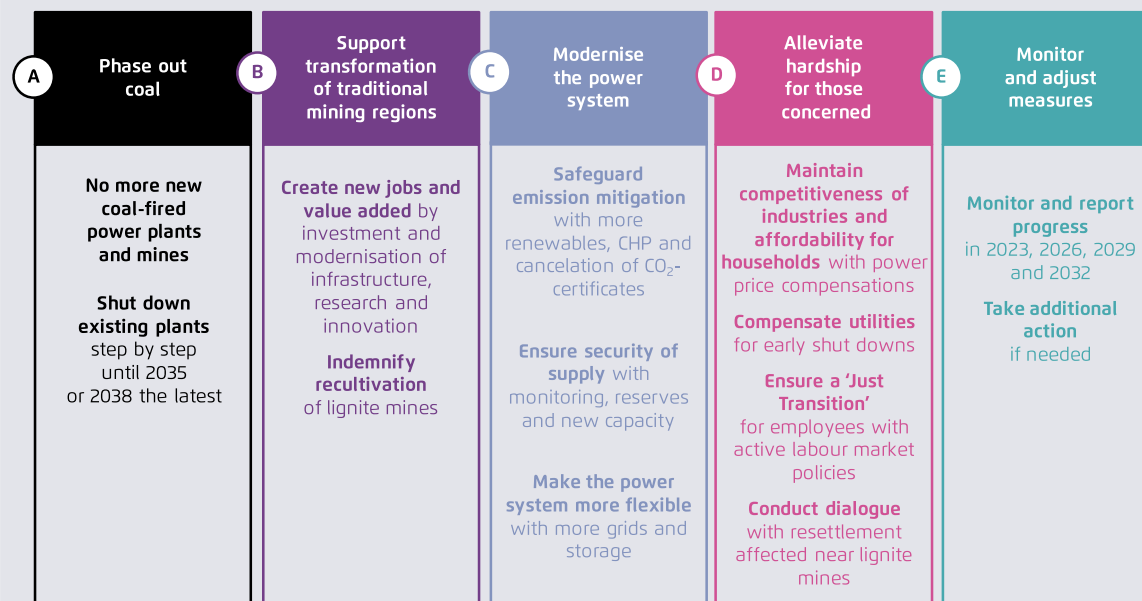


REKK (2019)

- Wind generation can fluctuate from one hour to the next by up to 47% in Romania, whereas the comparable figure for Europe is just 6%
- In the SEE region, wind speeds show weak correlation, ranging from 11% to 46% between countries
- SEE follows a different wind generation pattern from northern European countries, which means wind production would not peak at the same time
- Conventional power plants will need to operate in a flexible manner. For economic reasons, hard coal and lignite will provide less than 25% of SEE power demand by 2030

Country strategies are needed for smart and managed retirement of coal and lignite generation capacity

Overview of the recommendations of the German Coal Commission



Authors' figure based on "Kommission WSB" (2019)

- The recommendations of the Coal Commission are an important milestone in the German energy policy debate
- Germany has now resolved to phase out both nuclear energy and coal, and is fully committed to developing renewable energy
- The Coal Compromise will ensure a just transition for coal regions and employees
- While the Coal Compromise envisions full phase-out by 2038, earlier achievement of this goal is likely