Energy Transition in Germany

Where do we stand and what happens next?

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Overview

What I like to cover today

- Germany‘s power system at a glance
- Energy transition goals and targets
- Progress to date
- Remaining challenges and uncertainties
  - Market design
  - Grid development

Germany‘s power system at a glance

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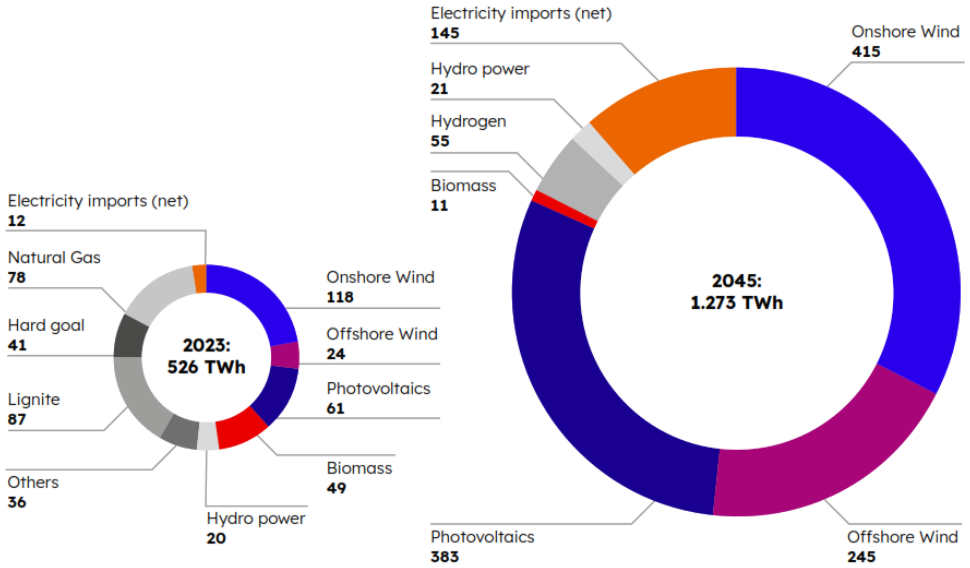
Germany‘s energy system

Roughly half of Germany‘s power generation stems from renewables

- In 2023, renewable energies provided more than half of Germany’s power generation for the first time (53%)
- For 2045, scenarios that reach climate neutrality expect the power system to more than double due to electrification in buildings, transport and industry



Source: dena based on data by BMWE Long-Term Scenarios

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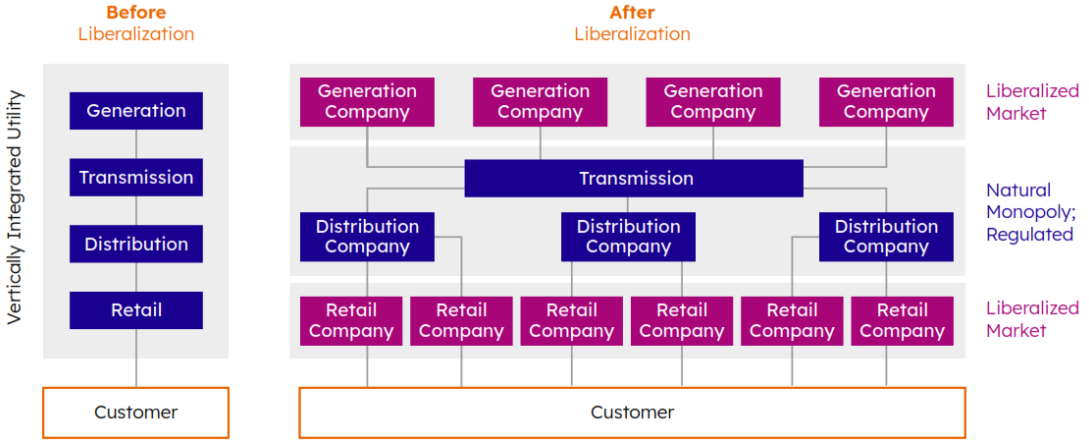
Germany‘s power system

Since 1998, Germany‘ power system is liberalised based on EU law….

- The key feature of liberalization is “unbundling” of vertically integrated utilities
- Transmission remains a natural monopoly – with operators being regulated by the Federal Network Agency
- All other areas are subject to competition

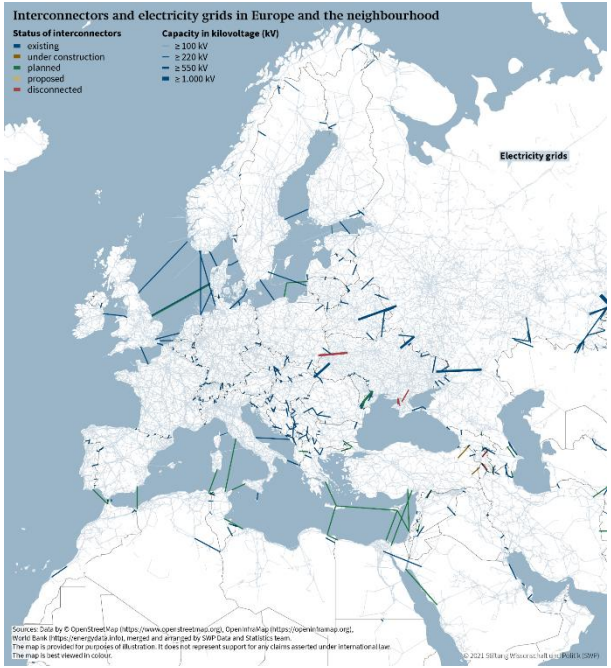


Source: dena based on an illustration by Next Kraftwerke

Germany‘s power system

…and increasingly interconnected with the rest of Europe.

- The European power grid is one of the largest synchronous electrical grids in the world – reaching from Spain to Ukraine
- Interconnection allows for increasingly liquid cross-border trading – day-ahead and increasingly also intra-day
- Common EU market rules provide the basis



Source: Stiftung für Wissenschaft und Politik (SWP).

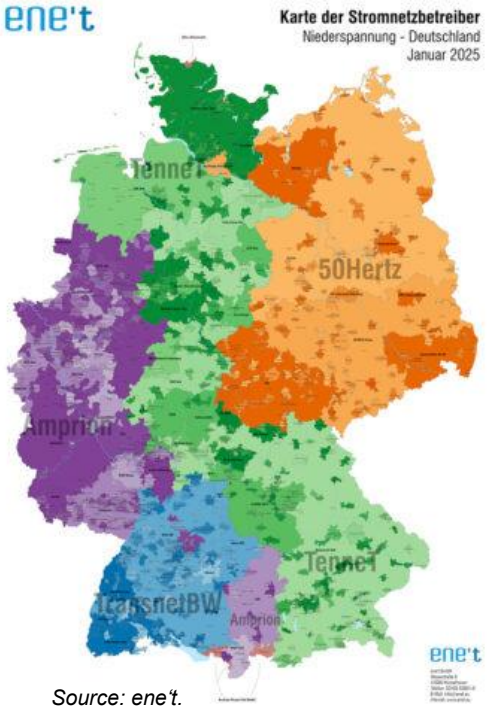
Germany‘s transmission grid is operated by four transmission system operators (TSOs)

- The four TSOs jointly ensure system stability and jointly plan the transmission grid‘s expansion.
- They are governed by the Energy Industry Act (EnWG)
- They are regulated by the Federal Network Agency (*Bundesnetzagentur*).

Source: Francis McLloyd

A speciality of our system: At the distribution level we have 866 grid operators

- Germany has a very high number of very diverse distribution grid operators
- While e.on and its subsidiaries serve about a third of the country, 662 small grid operators (<30.000 customers) serve towns and villages
- Many smaller grid operators are owned by municipalities



Source: ene‘t.

Energy transition goals and targets

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Energy transition goals and targets

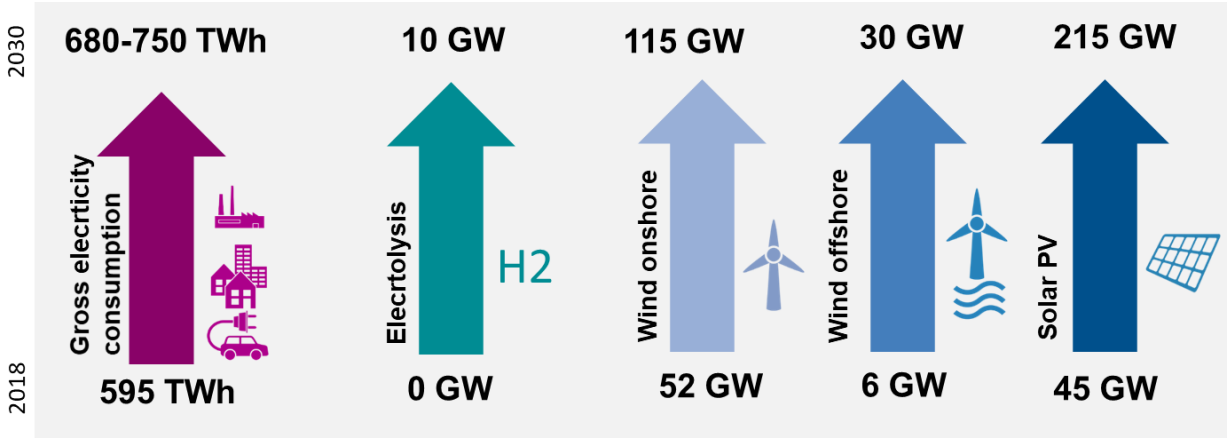
Germany‘s aim is to reach climate neutrality by 2045

Dies

	Germany				EU	
Targets	2030	2040	2045	2050	2030	2050
Climate						
Greenhouse gas emissions reduction (compared to 1990 levels, including all sectors)	65%	88%	GHG neutral	GHG net sink	55%	GHG neutral
Renewable energy sources (RES)						
RES share final energy (gross consumption)	30%	45%		60%	>42.5%	
Energy efficiency						
Increase in energy efficiency (Primary energy consumption reduction)	39.3%			50%	11.7%	
	compared to 2008				Reduction in energy consumption compared to PRIMES 2020 Business-as-usual scenario	

Energy transition goals and targets

For the power system, targets address renewable energy expansion and hydrogen



Germany pursues climate neutrality by 2045.

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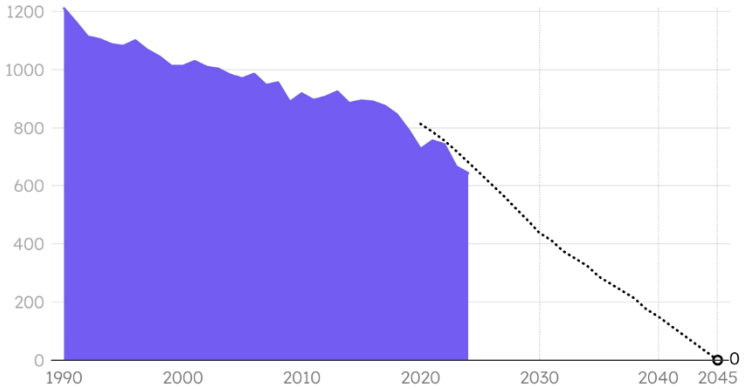
Progress to date

Progress to date

Greenhouse gas emissions

- In 2024, 643 m tons of CO2-e emitted, a decrease of 48% compared to 1990.
- Mitigation has ben most successful in the power and industry sectors.
- By contrast, reduction are slower in the transport and building sectors.
- If the current annual GHG reduction is maintained, Germany can achieve its 2030 target of -65%

GHG emissions in Germany in m tons of CO_{2-e}



Source: dena based on data by Umweltbundesamt (UBA).

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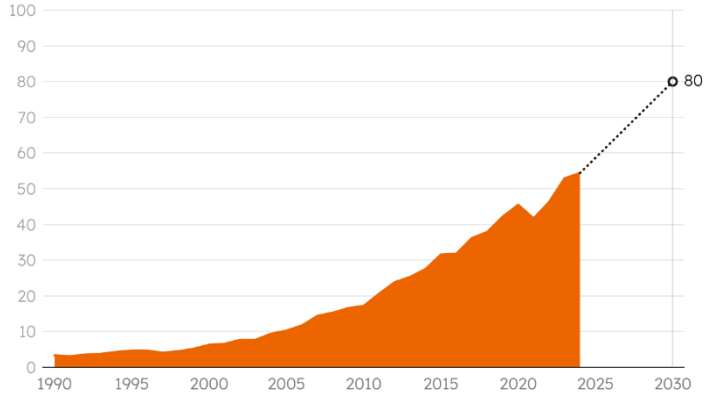
Progress to date

Share of renewables in electricity consumption

- In 2024, renewables provided more than half of all gross electricity consumption in Germany (54%).
- Germany aims to reach 80% by 2030, requiring an increase of 4 percentage points per year.
- Currently, Germany is on track to reach its 2030 goal.

Share of renewables in total gross electricity consumption (in %)



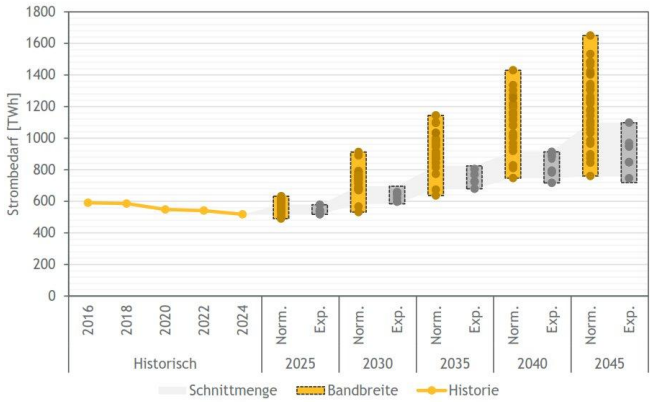
Source: dena based on data by AGEE-Stat.

Progress to date

Power consumptions does not grow as expected

- Current targets on renewable capacity expansion are based on the assumption that power demand would rise to 750 TWh by 2030.
- However, power demand is stagnating since 2016 due to lower demand in industry and slower-than-expected electrification in buildings and transport.
- The current government therefore expects demand to reach appr. 600 TWh by 2030 – up from 531 TWh in 2024. .

Historical and projected growth of gross electricity demand in Germany in different scenarios (in TWh)



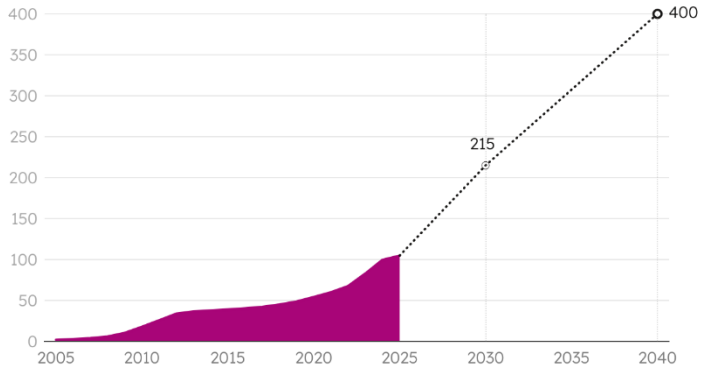
Source: EWI and BET 2025. Energiewende. Effizient. Machen.

Progress to date

Expansion of photovotaics (PV)

- Germany aims to quadruple PV capacity by 2040. However, the target might be lowered later this year.
- Currently, the expansion is on track: In 2024, Germany added 16.7 GW of PV capacity.
- To achieve the 2030 interim target of 215 GW, annual development must be increased to an average of 19 GW per year and continue at this speed up to 2040.

Expansion of PV capacity (in GW)



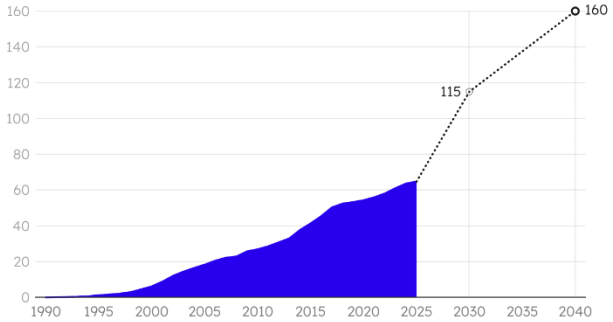
Source: dena based on data by Bundesnetzagentur (BNetzA).

Progress to date

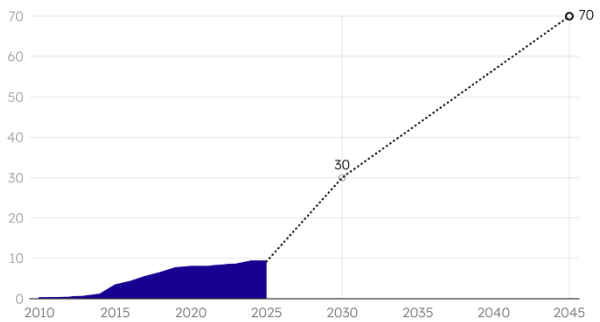
Expansion of onshore and offshore wind

- Expansion of wind energy is currently below target path.
- Onshore wind expansion needs to triple from 2.6 GW in 2024 to 8.4 GW per year.
- Offshore wind expansion must also speed up, from 0.7 GW in 2024 to 3.5 GW.
- Adaption of both targets are likely to take place this year.

Expansion onshore wind (in GW)



Expansion offshore wind (in GW)



Source: dena based on data by Bundesnetzagentur (BNetzA).

Remaining challenges and uncertainties

Challenges and uncertainties

A cost-efficient and secure system transformation remains a challenge

The German power system needs:

- New mechanisms to ensure security of supply and system stability.
- Substantive grid expansion on the distribution and the high-voltage level.
- Grid digitalisation as a key for facilitating efficient co-ordination of high number of energy producing and consuming assets.
- Flexibilisation on the demand side to efficiently integrate variable renewable energies
- Increased cost-efficiency to safeguard competitiveness and social acceptability.

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Market design

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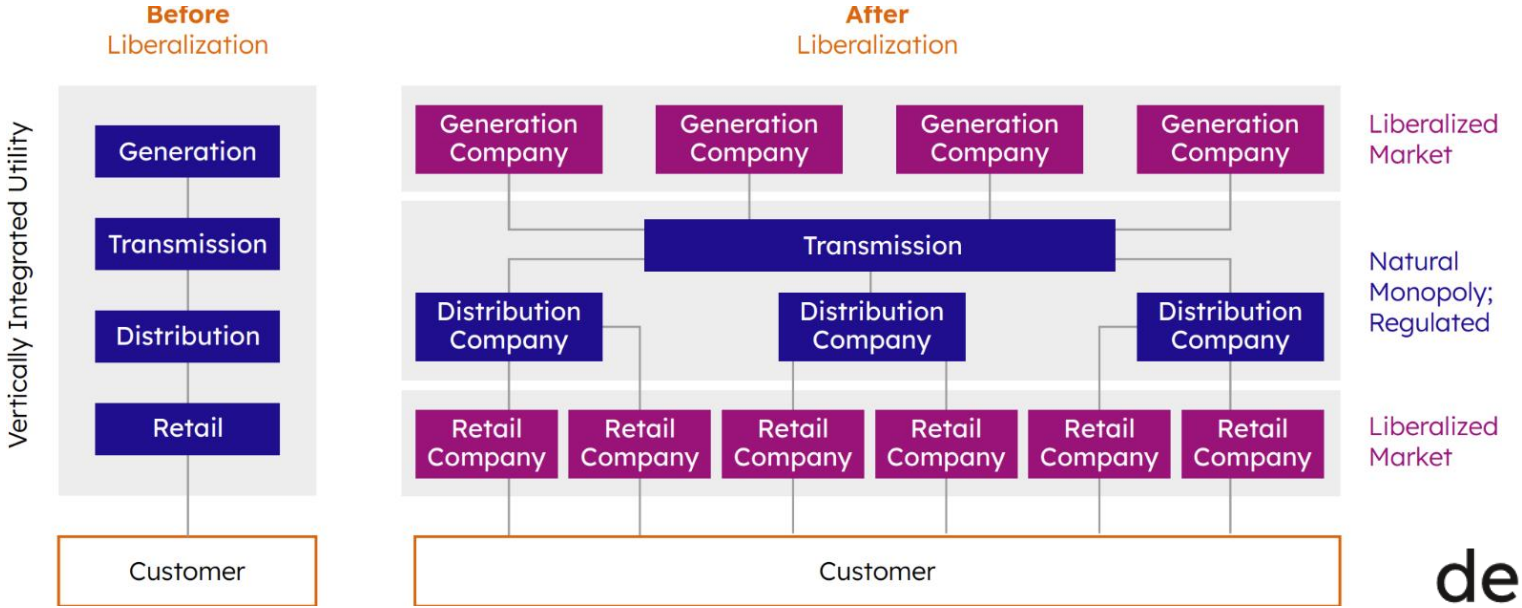
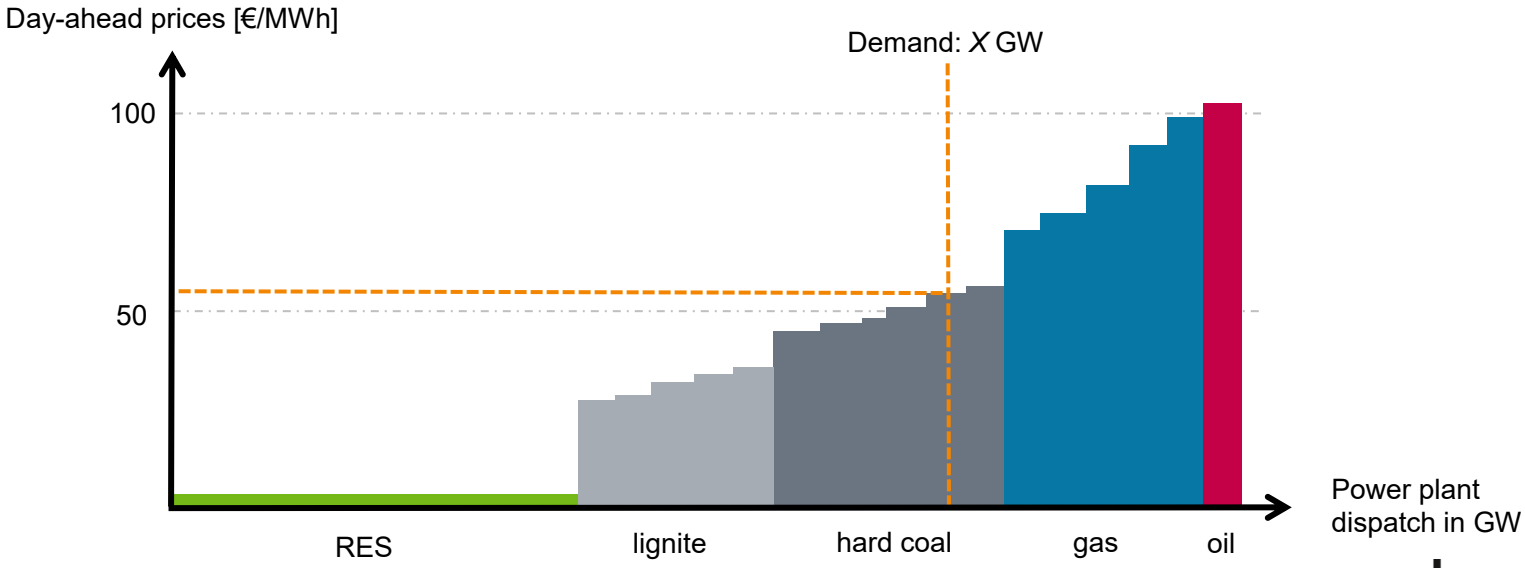
Market design

Electricity markets in the EU have been steadily liberalized starting in the mid 1990s



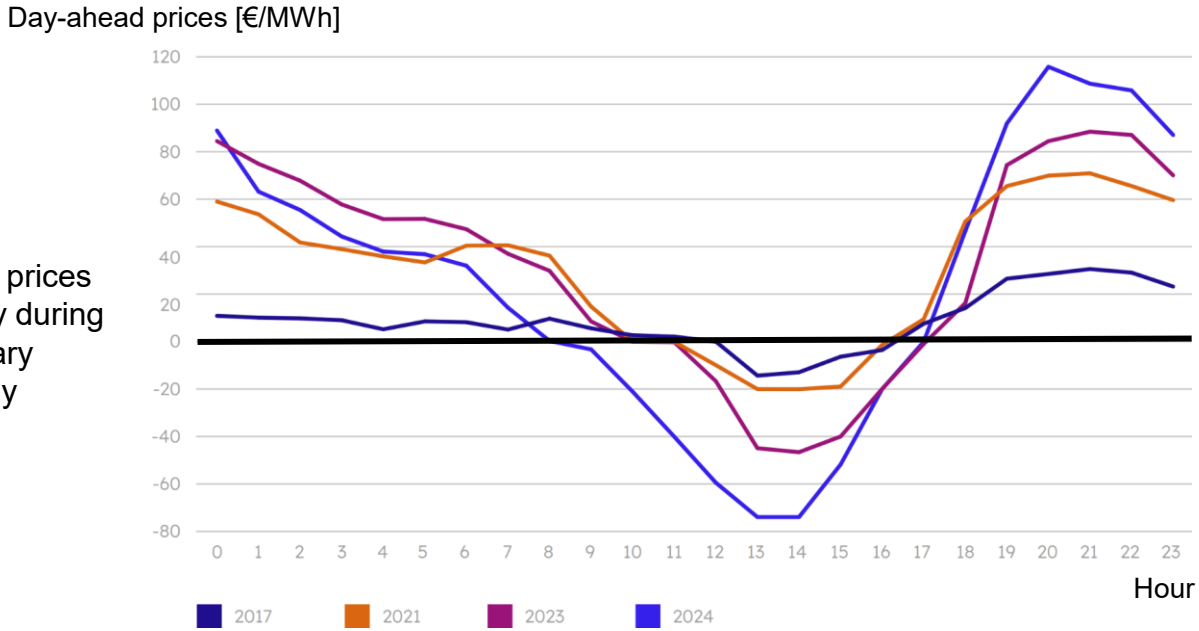
Market design

RES with marginal costs close to zero push conventional generation out of the market



Higher RES-share leads to price fluctuations

Day-ahead prices in Germany during an exemplary summer day



Source: dena 2026 adapted from Cunico and Copac 2024 using data from EPEX Spot.

BNetzA and ENTSO-E see resource adequacy gap by 2035

- Grid regulator BNetzA assesses resource adequacy every two years. Most recent report from September sees capacity gap of 22 - 35 GW by 2035. The scenario already assumes incentives for additional gas plants of 7 - 10 GW foreseen by the last government.
- The European Ressource Adequacy Assessment that is preapared annually by ENTSO-E sees a gap of 15 - 18 GW by 2035.
- The difference in the result reflect uncertainties, particularly on: speed of coal exit, growth of power demand, and development of demand side flexibility and batteries.

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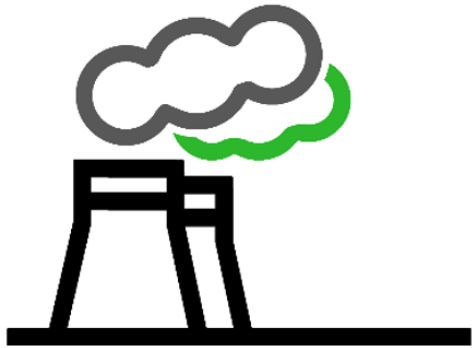
Market design

New power plant strategy to cover generation gap due to coal phase out in the short term

Challenge

- Energy-only market does not incentivise bankable investments in gas power plants, as competition in the merit order reduces load hours



Latest proposal from November 2024

- 13 GW of gas power plants should be tendered
- Plants need to be H2-ready, time horizon unclear

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New capacity market to guarantee sufficient dispatchable capacity in the long term

Challenge

- 13 GW will not be enough in the long term

Latest proposal from November 2024

- Capacity market to be introduced by 2027
- Various design options exist: cenral, decentral, combined, mandatory peak price hedging
- According to EU law, mechanisms need to be technology-neural + compatible with climate goals

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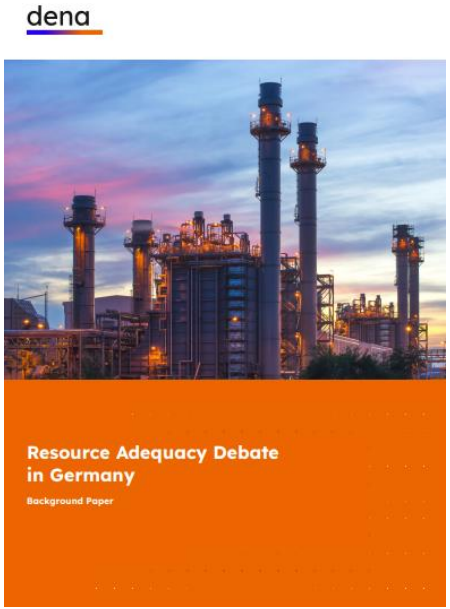
Market design was key for integrating RES, continuous adoption for new challenges

- Market design has played a key role in successfully integrating large shares of RE
- Integrated EU electricity markets have also contributed to efficiently integrating RE
- The key challenge for the next 10 years is to ensure sufficient investment in dispatchable capacity to safeguard security of supply in times of low RES

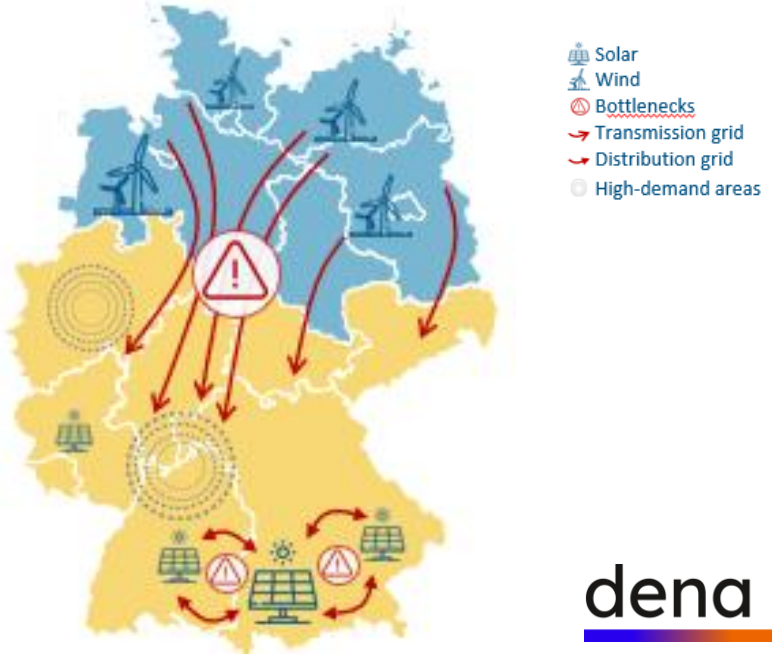


Link

Grid development

Expansion of grid connections from North to South needed to relieve bottlenecks

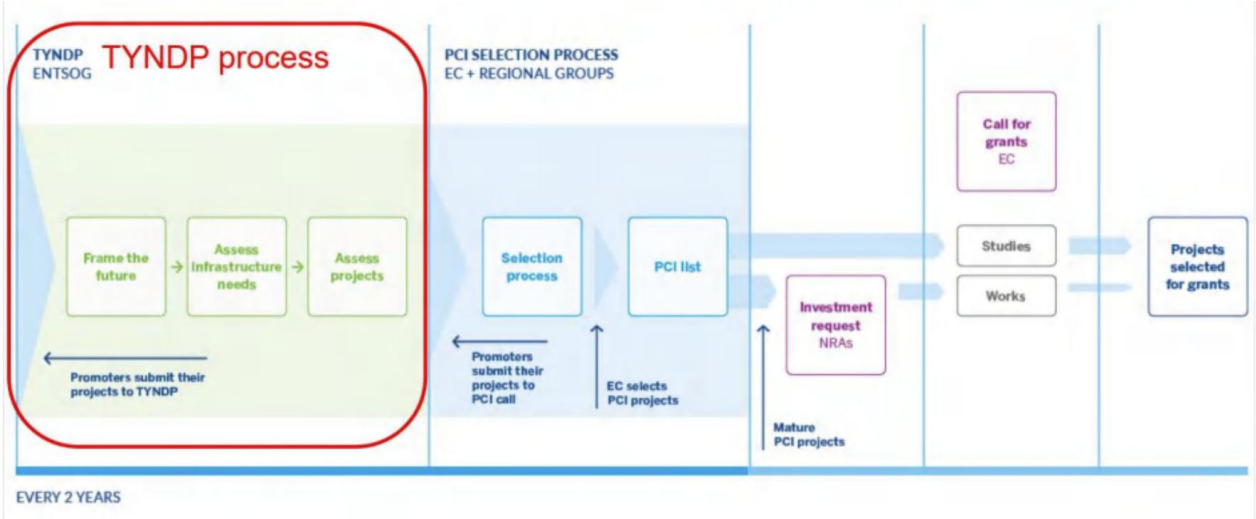
- Wind power mostly installed in North Germany, but load centres are located in the West and South
- PV generation is centred in the South and creates challenges for the distribution grid
- TSOs are in the process of commissioning and building HVDC power highways to bridge gap: SuedLink, SuedOstLink and Ultranet



Source: Guidehouse based on BMWK 2024; Icons: Flaticon.com

At EU level, the grid development process focuses on cross-border connections

- EU Ten-Year-Network Development Plan is managed by EU grid operators (ENTSO-E) and regional groups
- Iterative and transparent process
  - every 2 years
  - build on stakeholder input



Source: Watine 2018.

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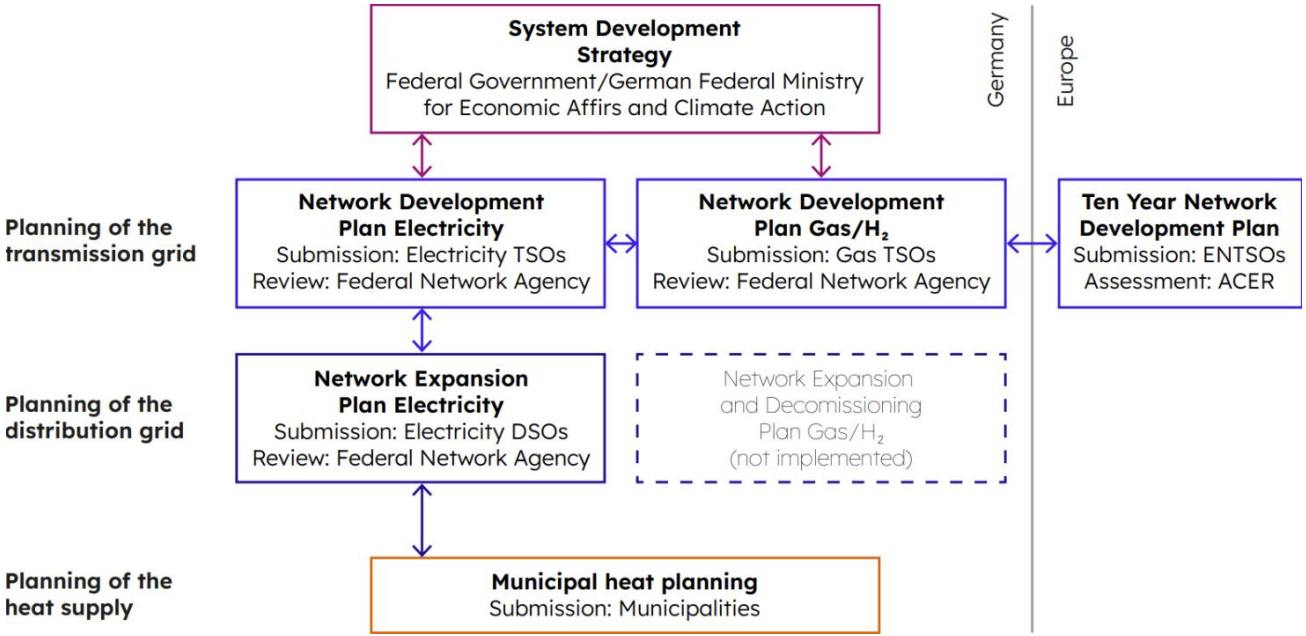
Grid development

Germany has developed a sophisticated power grid planning process



Source: dena 2025.

Thank you.

Katharina Umpfenbach, Director Electricity

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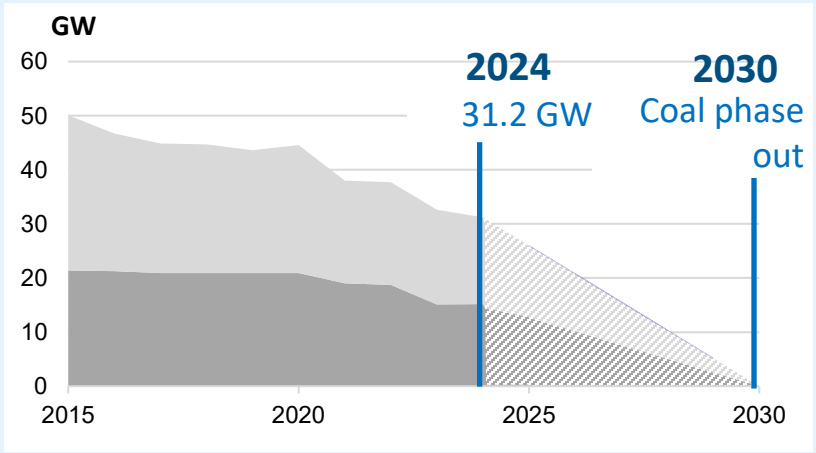
Germany has phased out nuclear since 2023 and will phase out coal ideally by 2030



Source: Guidehouse based on Fraunhofer ISE 2025 & BMU 2020

Federal Ministry for Economic Affairs and Climate Action