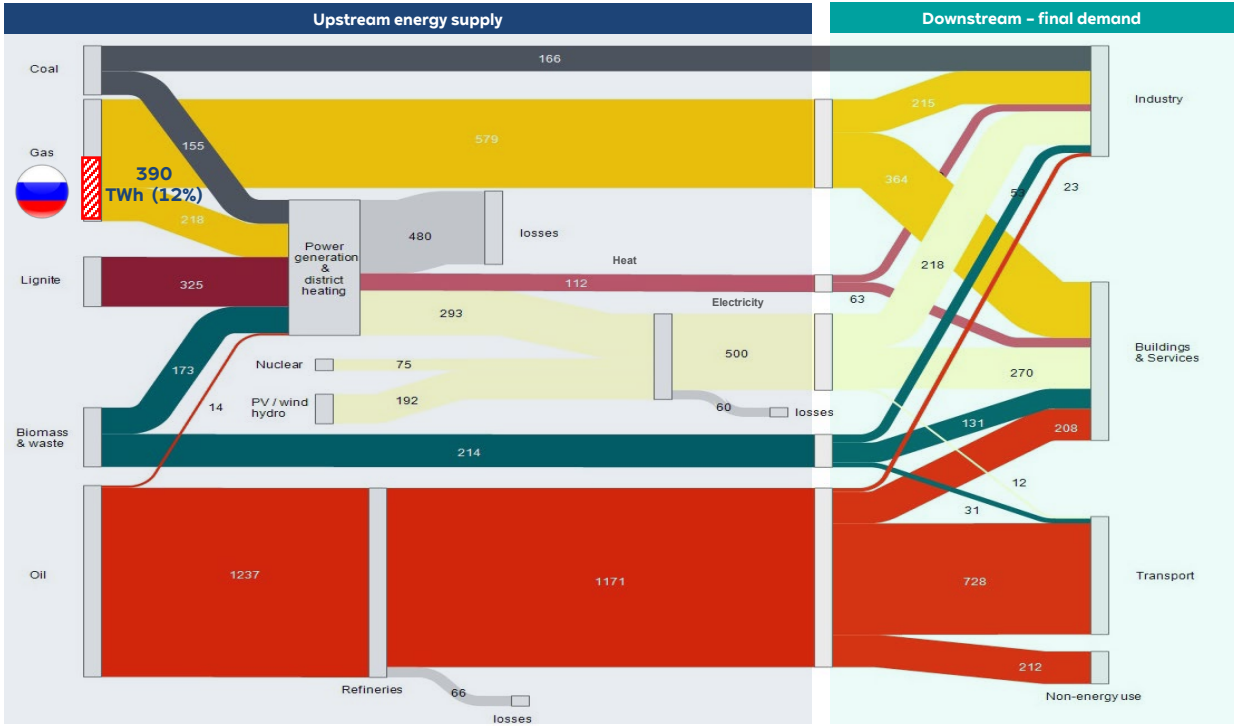
Energiemärkte:
Rück- und Ausblick.

Dr. Tobias Zimmermann

Russian gas supplied 12% (390 TWh) of Germanys primary energy consumption in 2019 – German energy Balance



Key Parameters 2019

Primary energy consumption: 3,350 TWh

- whereof from natural gas: 797 TWh (24%)

Final energy demand: 2,740 Twh

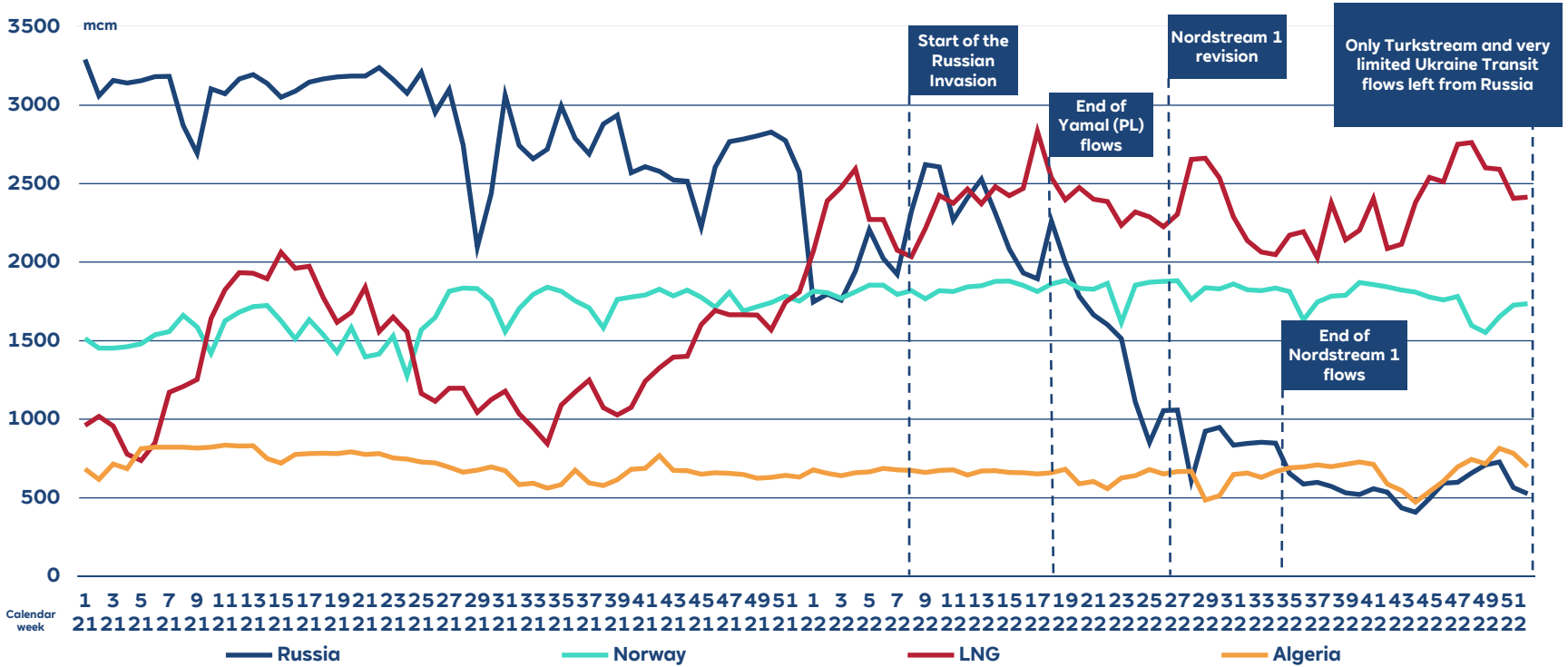
- whereof direct natural gas usage: 579 TWh (22%)

Electricity produced with natural gas: 90 TWh

Heat (district heating) produced with natural gas: 61 TWh

in TWh_{th} - includes international aviation and shipping
Source: AG Energiebilanzen, Umweltbundesamt

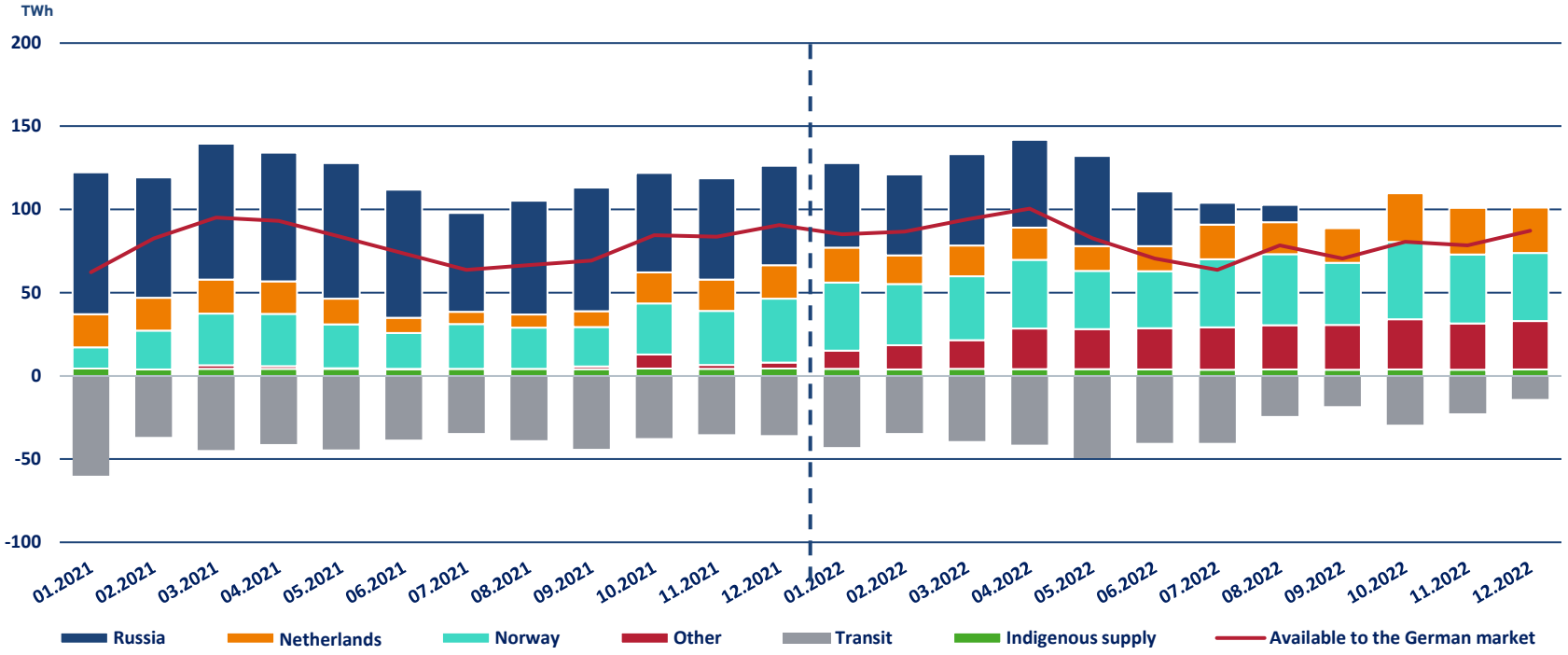
Weekly EU 27 gas import via main import routes from 2021 – 2022



Source: ENTSO-G

Gas import origin of German flows 2021 - 2022

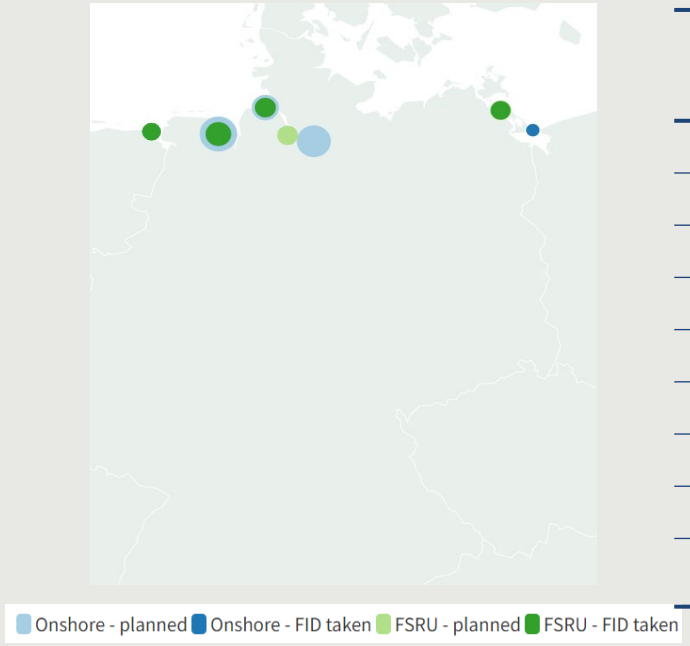
Germany has lost its status as gas transit country



Source: BDEW

Gas crisis – German government measures focused on new LNG terminals

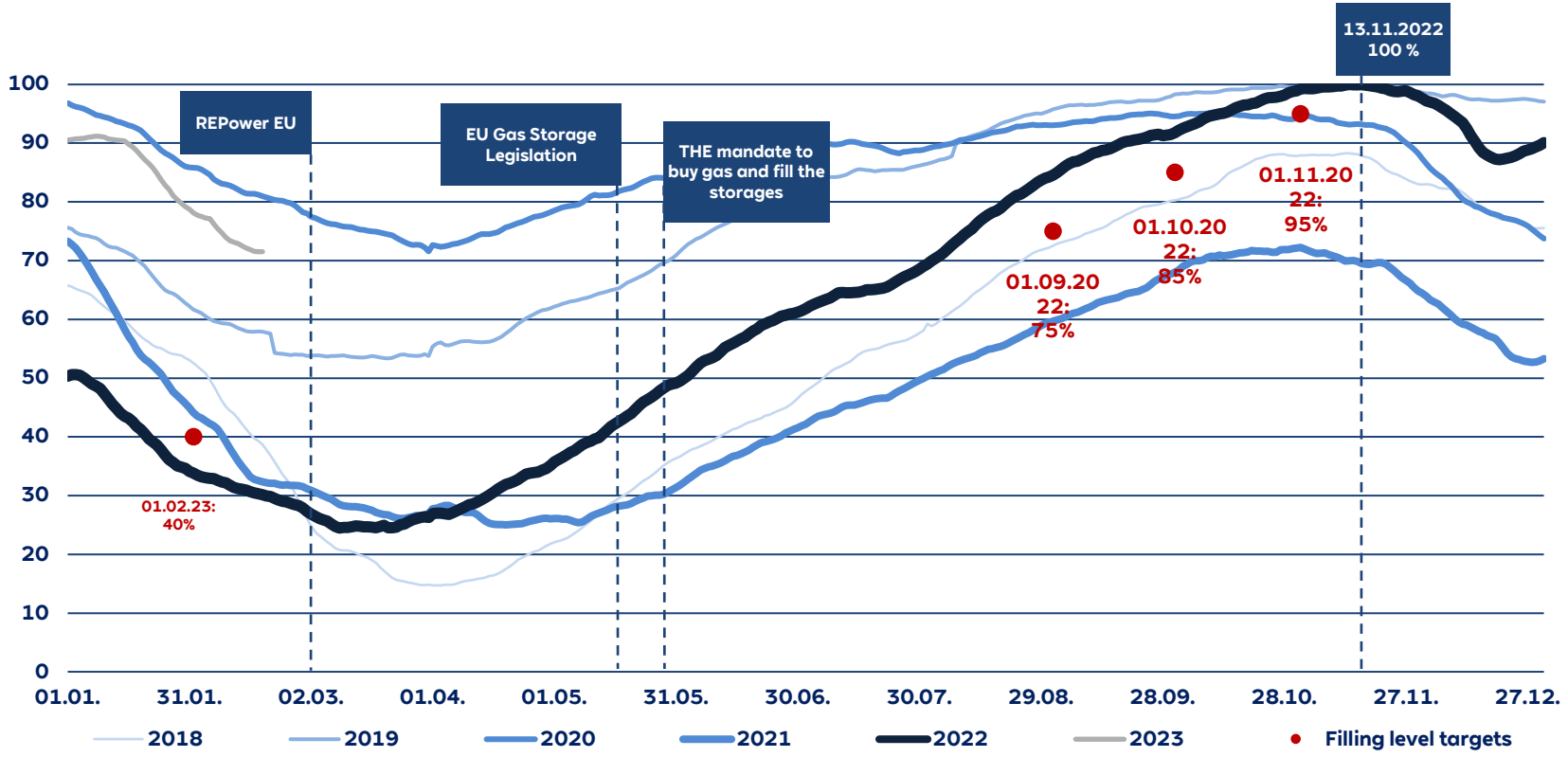
Gas infrastructure diversification – Planned German LNG regasification terminals



Type	Terminal	Volume capacity (bcm/y)	Planned start MM-YY	Status
FSRU	Wilhelmshaven	7,5	12-22	Operational
FSRU	Brunsbüttel	5	01-23	Operational
FSRU	Lubmin	4,5	01-23	Operational
FSRU	NWO Wilhelmshaven	5	02-23	FID taken
FSRU	Lubmin II	5	12-23	Announced
FSRU	Stade	5	01-24	FID taken
Onshore	TES Wilhelmshaven	16	01-25	Announced
Onshore	Brunsbüttel LNG	8,4	01-25	Announced
Onshore	Hanseatic Energy Hub	13,1	01-26	Announced

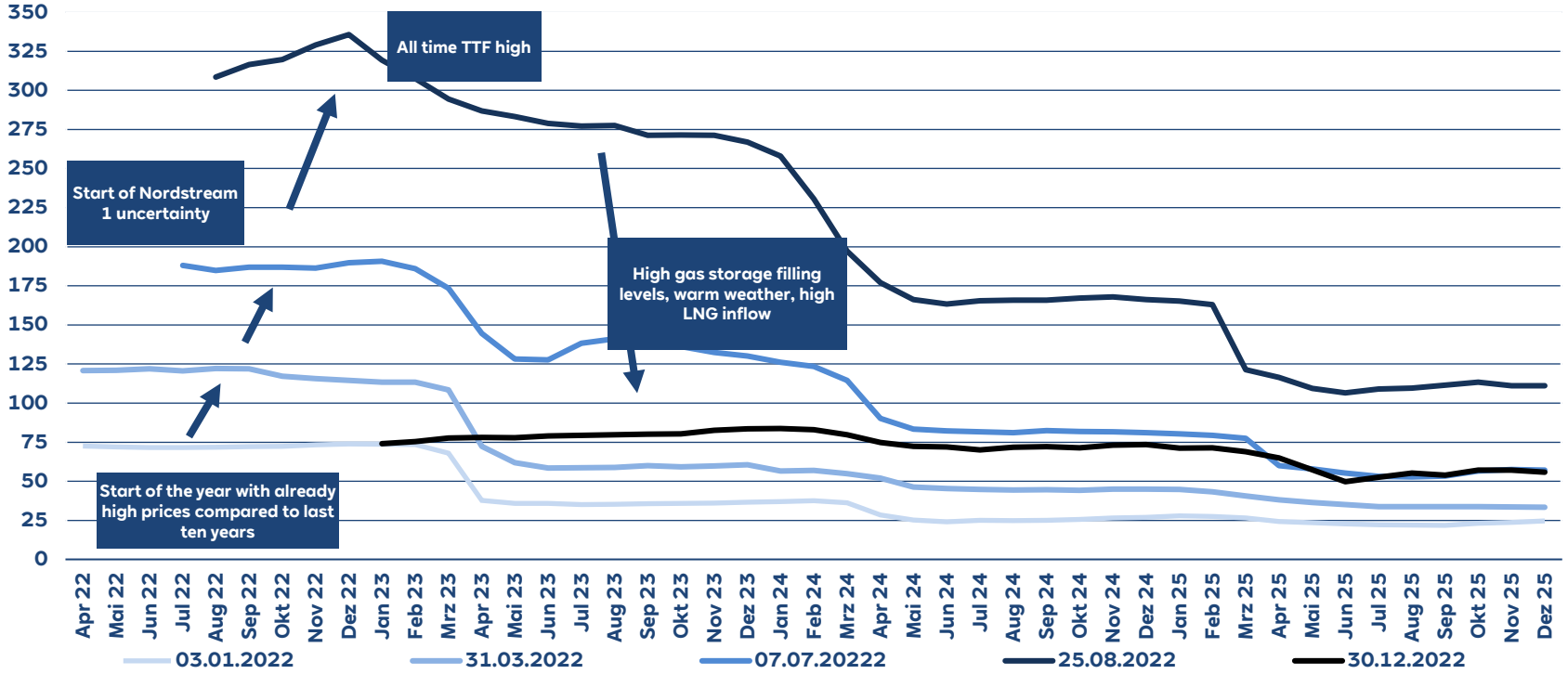
Source: Bruegel

German gas storage filling level development



Source: Gas Infrastructure Europe

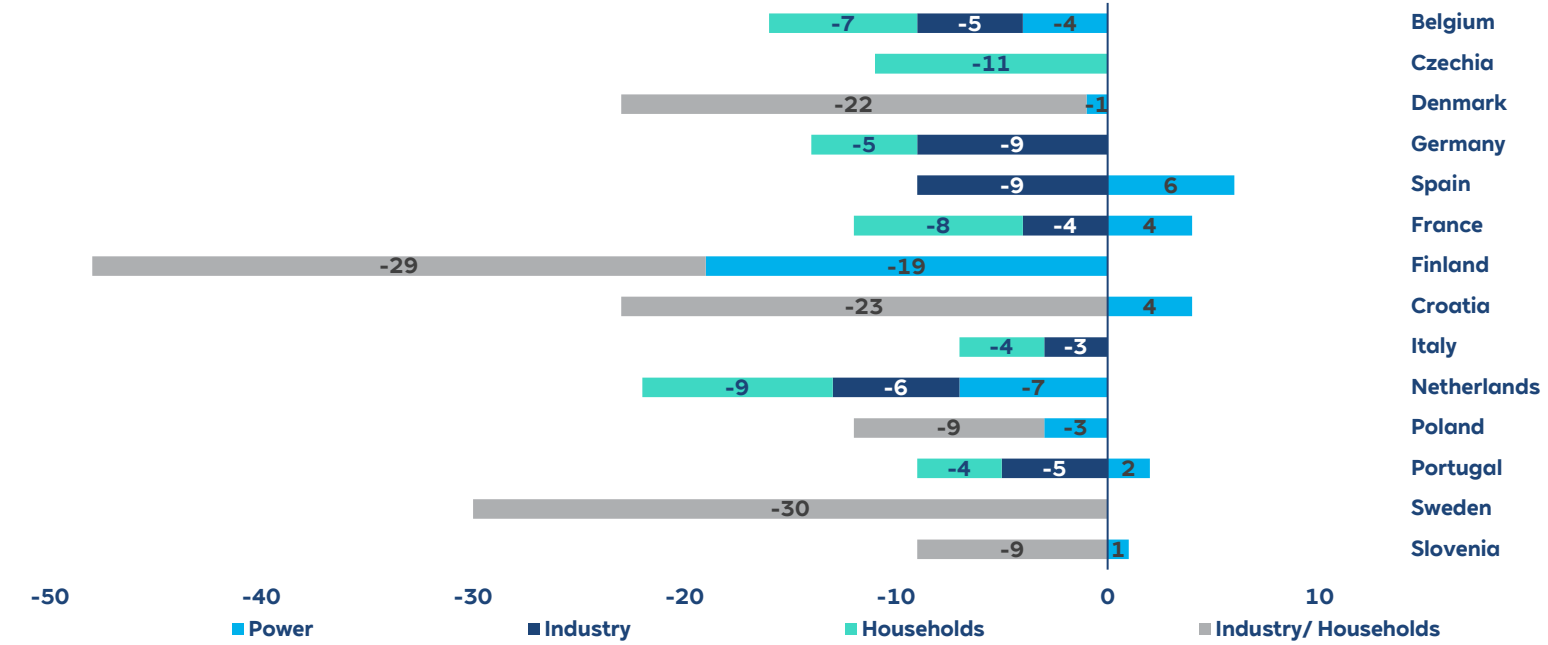
TTF forward curve evolution in 2022 – from 75 EUR/MWh to 330 and back again to 75 in one year



Source: Bloomberg, monthly forward curve on the respectiv trading date

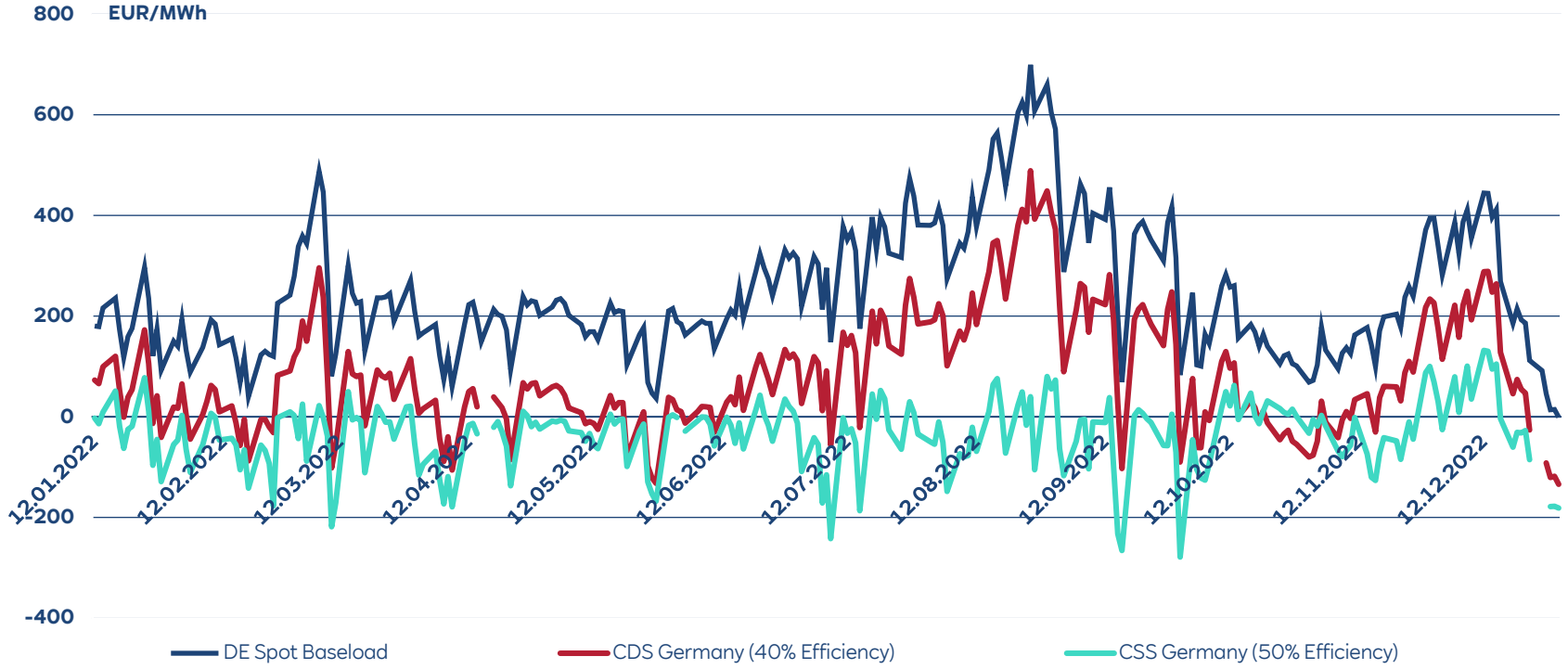
Gas demand destruction due to high prices and voluntary reduction efforts took place in almost every EU country in 2022

Relative changes in sectoral demand in 2022 compared to the average demand 2019-2022 in % per country



Source: ENTSO-G transparency platform

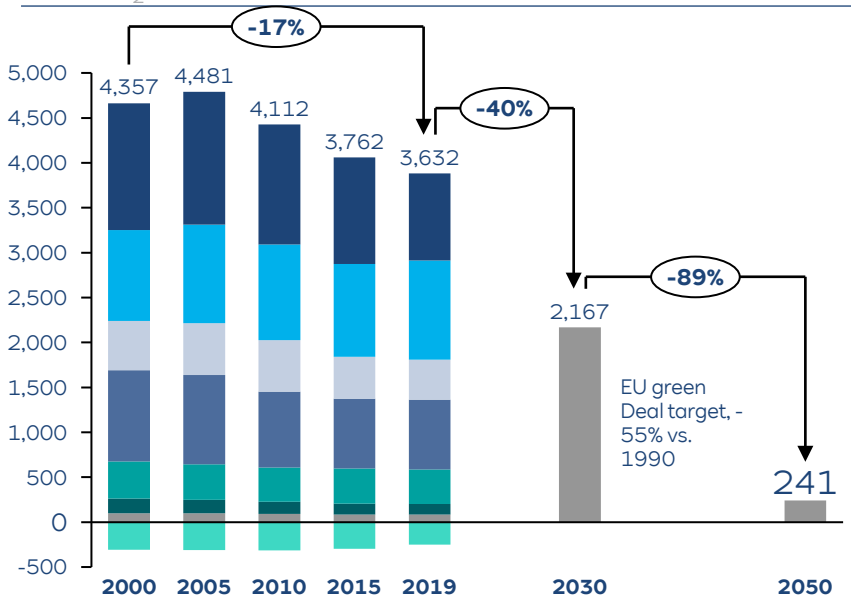
Rolling into (spot) power prices – CSS and CDS



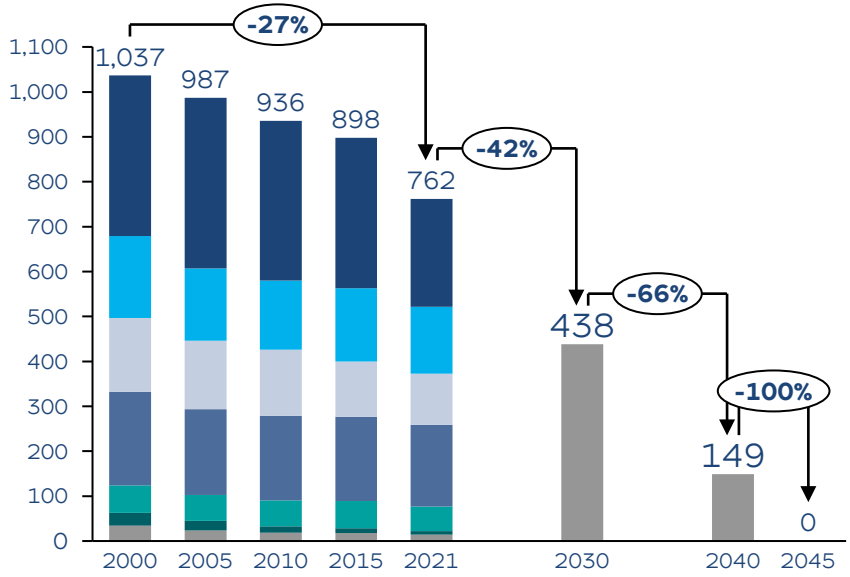
Source: Bloomberg, CDS = Clean Dark Spread, CSS = Clean Spark Spread

All sectors have to contribute to reach intermediate decarbonisation targets and net zero by mid of century

European CO_2 emissions & targets
in mt CO_2



German CO_2 emissions & targets[1]
in mt CO_2



Energy Industry | Residential & Commercial | Agriculture | Land use, land-use change and forestery
Transport | Industry | Waste and Waste Water | Other Emissions, Total

Source: BMU, UBA, EEA - [1] Excludes international aviation and shipping, German targets correspond to Klimaschutzgesetz as of May 12th , 2021

Clean electricity and Hydrogen are the key energy carriers to replace fossil fuels, biomass and CCS also play a role

Fuel switching options

- **Electrification** or **switch to Hydrogen (H_2)** will be the **dominant decarbonisation methods**
- For many applications **switching to electricity has significant efficiency advantages compared to H_2**
- **H_2 has the advantage of being easier to store and transport** than electricity, **H_2 imports are scalable**
- Following **table summarises the efficiency effects** on final energy consumption **when switching from the current fossil energy carriers to clean alternatives**

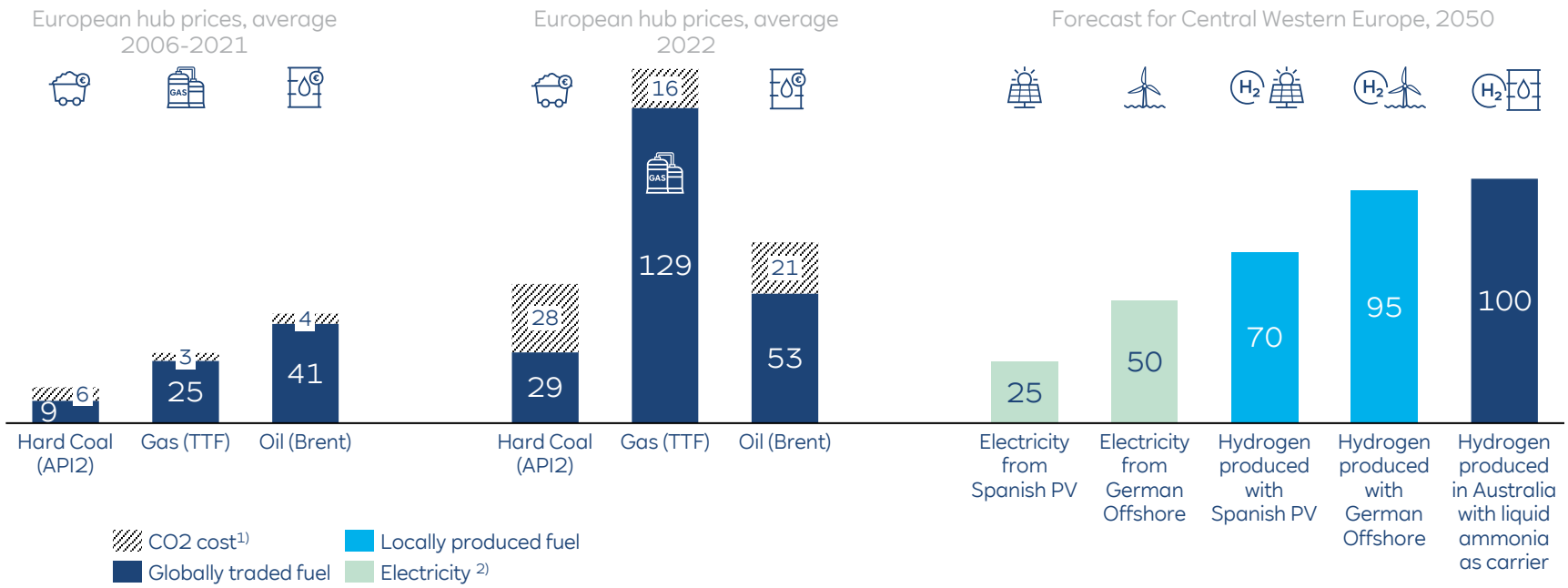
Assumptions

Application	Effects on final energy demand by Option A: Electricity		Effects on final energy demand by Option B: Hydrogen	
Low temperature heat <160°C	Heat pump	-75%	H_2 boiler	0%
Medium and high temperature heat >160°C	Electrification e.g. electric resistance	0%	H_2 boiler or burner	0%
Internal combustion engine in road transport	Battery electric vehicles	-65% -60%[1]	Fuel cell vehicles	-35% -30%[1]
Primary steel production			H_2 based DRI steel production	-20%[2]
Aviation			Synthetic jet fuels	+40%[3]
Shipping	Battery electric shipping	-60%	Ammonia engine	+35%[3]

[1] Efficiency improvement of heavy road transport slight lower than for light road transport | [2] Based on hydrogen and electricity input vs. current fossil fuel input | [3] Conversion process from hydrogen to green fuel increases energy demand

To get in the range of historic low cost for energy, direct use of renewable electricity is the only zero-emission option – globally imported Hydrogen is much more expensive

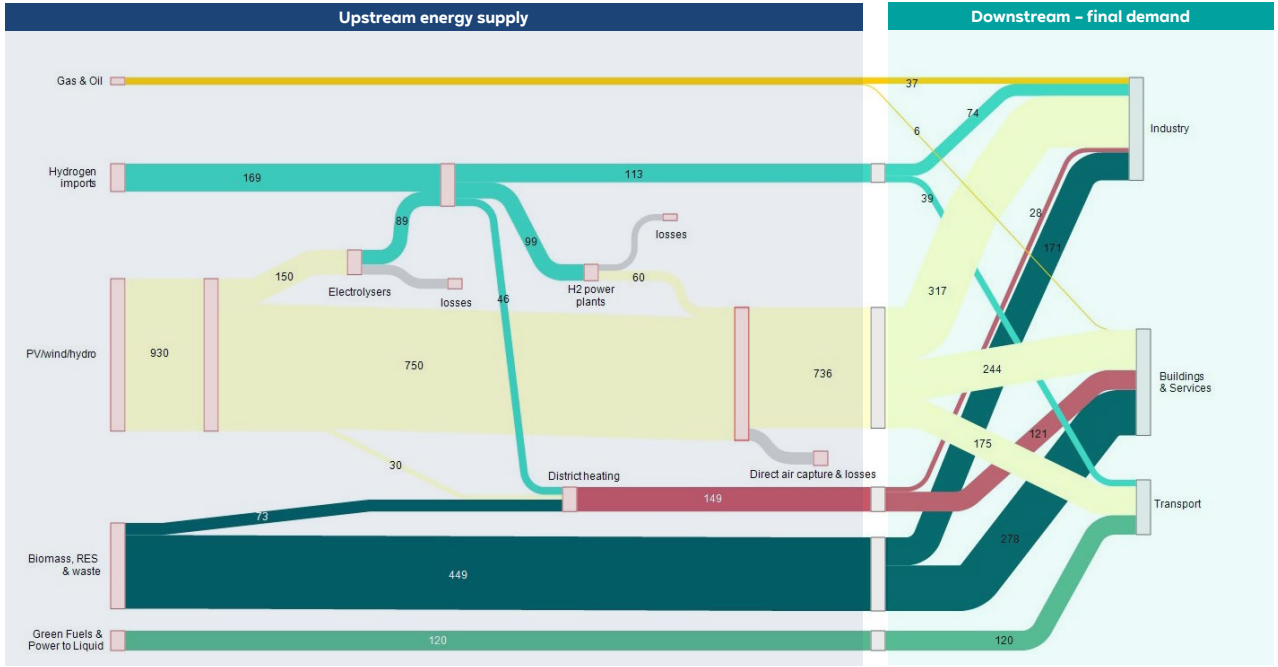
Prices and cost for different energy sources (EUR_{2021}/MWh_{th})



Source: Bloomberg [1] Only relevant when fuel consumed within the ETS; [2] MWh_{el}; Needed additional cost for storage not considered here

Direct use of electricity remains the main decarbonisation method in most downstream sectors and applications

DE net zero energy balance in 2045



Source: Agora Energiewende, Klimaneutrales Deutschland 2045 (2021)

Key parameters

Final energy demand: 1567 TWh

Final electricity demand: 736 TWh

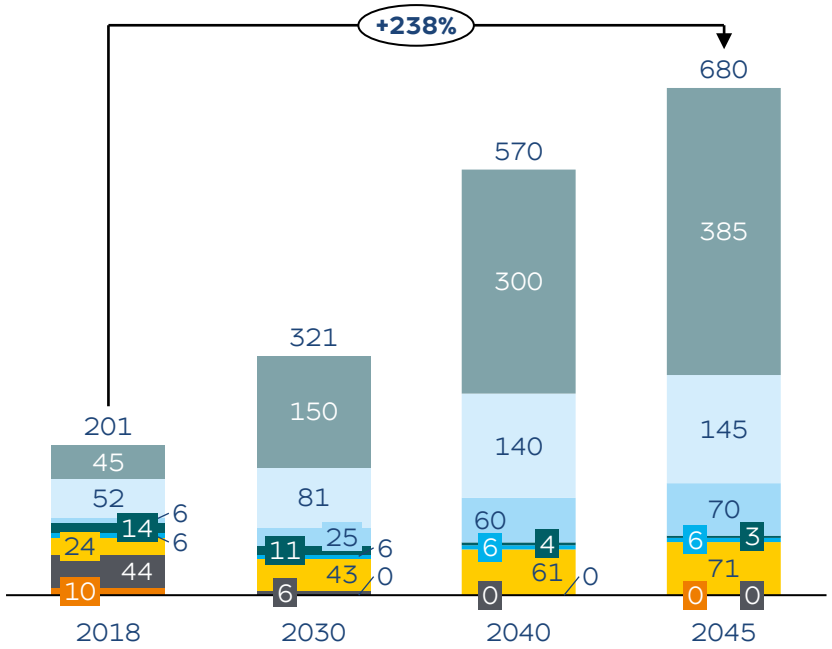
Electricity share in final demand: 47 %

Final Hydrogen demand: 113 TWh

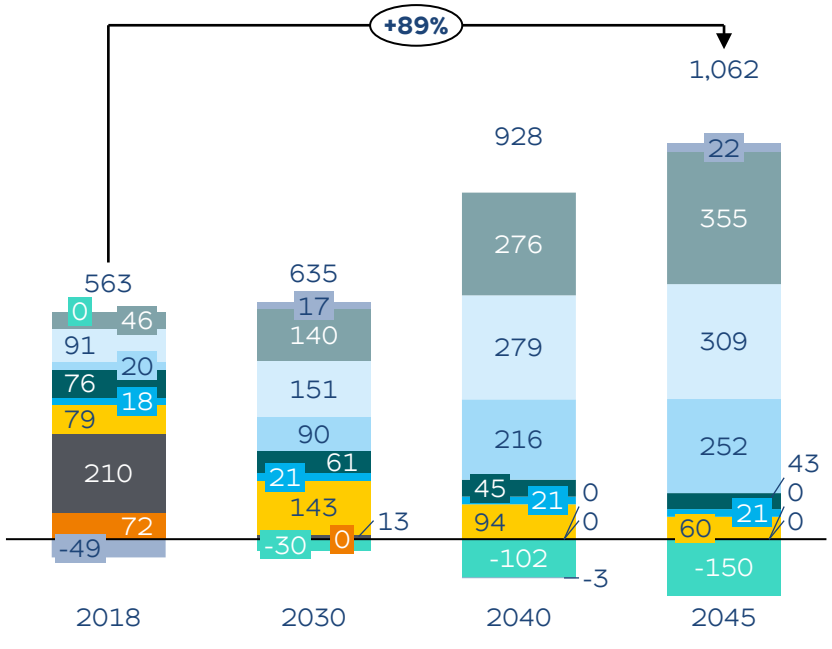
Hydrogen share in final demand: 7 %

The future electricity system needs all types of technologies. Renewables dominate nameplate capacity growth to deliver most of required energy volumes. An stable amount of controllable capacity is additionally needed to deliver security of supply

Installed capacity [GW][1)]



Production [TWh][1)]

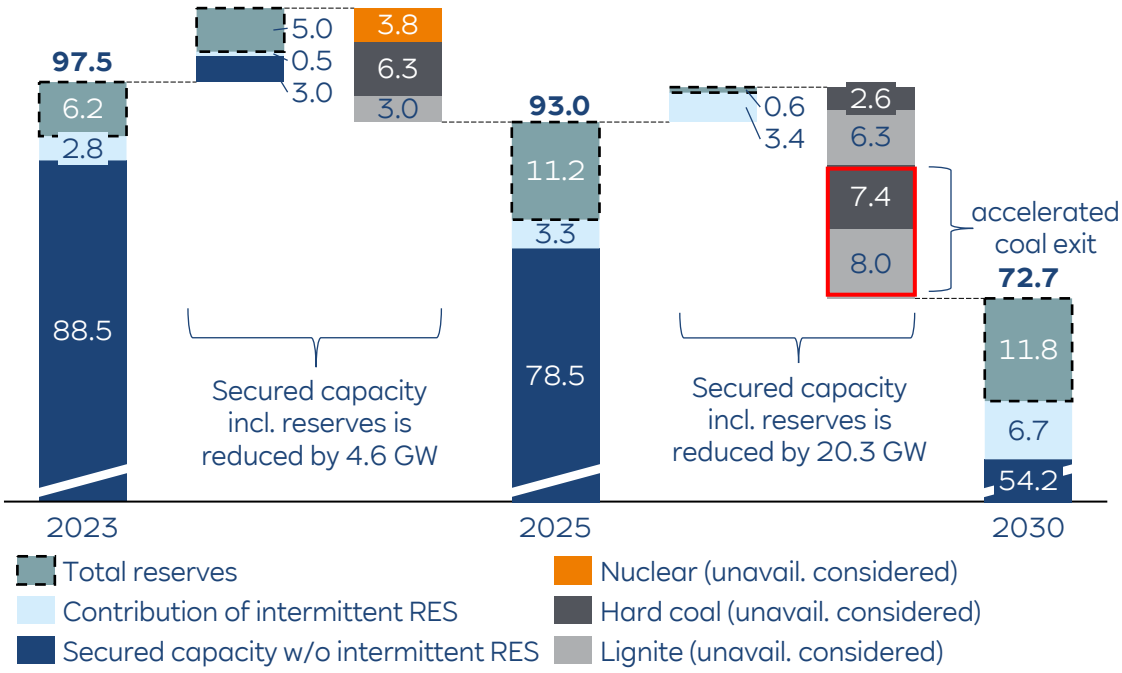


Nuclear | Coal & Lignite | Gas & Oil (CCS), H2 | Hydro | Biomass & Other | Offshore | Onshore | PV | Net import | Electrolyser

[1)] **Source:** Agora Energiewende, Klimaneutrales Deutschland 2045 (2021)

When coal-based power production terminates before 2030 secured capacity incl. reserves reduces by even approx. 25 GW

Total secured capacity development[1], (2023-2030), [GW]



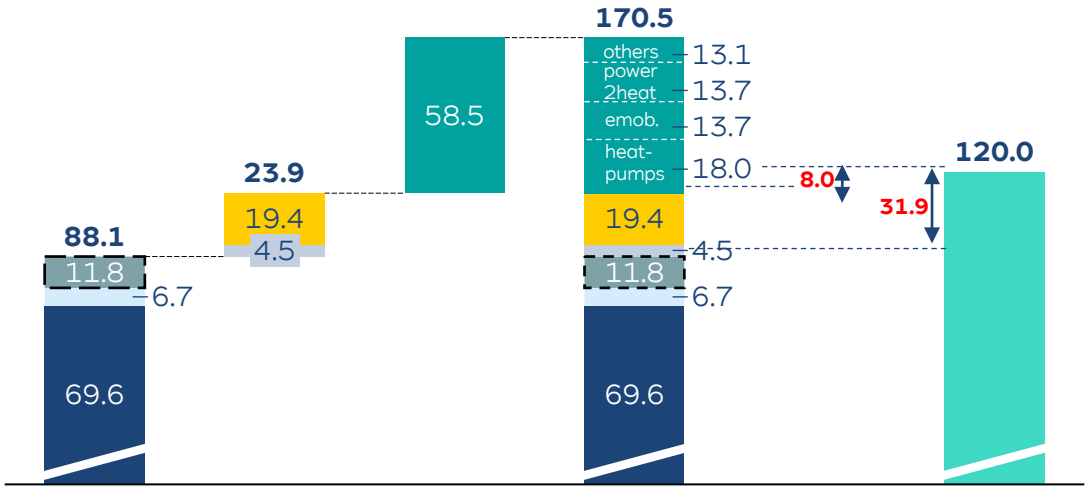
Comments

- The new German government intends to **"ideally" finalize the coal exit until 2030** and assumes that it could happen market driven even before
- Compared to KVBG, this **accelerated coal exit reduces the installed capacity** by another 16.7 GW until 2030 (8 GW hard coal and 8.7 GW lignite)
- As consequence, **Secured capacity reduces by additional 15.4 GW** if coal exit terminates before 2030
- **In total, up to 26.3 GW installed capacity is decommissioned between 2025 and 2030** which translates into 24.3 GW secured capacity
- In total, **Secured capacity incl. reserves** in 2030 will only be 72.7 GW which is 24.8 GW less than in 2023 and 20.3 GW less than in 2025

[1] Calculation based on BNetzA power plant list as of 22.11.2022

Coverage of relatively high peak demand in BNetzA SoS report is strongly dependent on ability to use FlexOptions when needed

Total secured capacity vs. peak load, BNetzA SoS report, 2030, [GW]



1) BNetzA SoS report (January 2023) 2) own calculation 3) after deduction of unavailability 4) BNetzA publications + power plant list (Nov. 2022)

Comments

- **Recent BNetzA report** on SoS **starts with current legislation** and total secured capacity of 88.1 GW in 2030
- **This will** by far **not be sufficient to cover the assumed peak load** of 120 GW
- **Even if** the maximum **gas new build** of 21 GW (= 19.4 GW sec. capacity) **and emergency power systems** (4.5 GW) from the BNetzA SoS report are **considered, a gap** of 8 GW **remains**
- According to BNetzA this **gap can be easily filled with new FlexOptions** (58.5 GW)
- In fact, these FlexOptions are (short-term) electricity storages. Their contribution to security of supply
  - can only be assessed with simulations over longer-period, ideally across weather years
  - depends on the amount of other secured capacity they interact with
  - depends on the willingness & ability of consumers to behave system-friendly
- Anyhow approx. 14% of the FlexOptions (mainly power2heat, emob. and heatpumps) have to be used
- **Total secured capacity** based on BNetzA list **contains coal exit according to KVBG**. If a full coal exit applies, additional secured capacity (e.g. from FlexOptions) is needed
- In the BNetzA SoS report **total secured capacity is much higher than peak demand**. This can be interpreted as indicator that FlexOptions can only be used partially when needed