

Energiewende

cernoch@mail.muni.cz

Socio-technical transitions

System disruption and replacement difficult due to resistance of

- actors,
 - infrastructure,
 - and (social) institutions.
-
- Spontaneous change vs. orchestrated policy.

Why Energiewende

- „Laboratory“ of the energy transition.
- Technological and ideological leadership.
- Largest energy sector, with direct and indirect impact on the neighbouring countries.
- Germany as an economic and political (not military) leader of Europe and the EU.
- Energiewende has some serious geopolitical consequences (RES + natural gas from Russia).

Origins of EW

1st pillar: nuclear phase-out

- Long and successful tradition of nuclear industry in Germany – in 1970s 17 000MW.
- German anti-nuclear movement – Ausserparlamentarische Opposition in 1960s (leftist students), environmental movements, local opposition.
- Three Mile Island in 1979, Chernobyl in 1986.
- 1998 Greens in federal government (with SPD) – Germany's plan (2002) to gradually withdraw from nuclear.
- In 2010 the Atomic Energy Act amended – NPP's lifespan extended, production limits on nuclear electricity increased.
- 2011 Fukushima – phase-out by 2022.

Origins of EW

2nd pillar: climate and environment protection measures.

- In 70s anti-nuclear sentiment, environmental consciousness and oil crisis raised the issue of RES.
- 1974 first RES subsidy program – PV parks. Strengthened in 1977 – 25% of investment costs reimbursed.
- 1990 – Act on the Supply of Electricity from RES into the Grid (StrEG).
- 2005 – Merkel's great coalition (CDU/CSU + SPD) – ambitious climate plans, incl. RES and energy efficiency.
- 2010 – Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply -> Energiewende.

Germany's renewable energy targets and status 2020

Data: BMWi, 8th Monitoring Report on the Energy Transition (2021) / BMWi, AGEE-Stat (2021).

	Status		Targets			
	2019	2020	2020	2030	2040	2050
Share of renewable energies						
Share in gross final energy consumption	17.7 %	19.6 %	18 %	30 %	45 %	60 %
Share in gross power consumption	42.0 %	45.4 %	min 35 %	65 %*		**
Share in heat consumption	15 %	15.2 %	14 %			
Share in transport sector	5.6 %	7.3 %	10 % (EU goal)			

*Target from Climate Action Programme 2030, EEG 2021

**The EEG 2021 stipulates that before 2050 all electricity generated or consumed in Germany is generated in a greenhouse gas-neutral manner

Germany's 2030 sector targets for greenhouse gas emission reduction and 2020 status

Data: UBA (2021) / Climate Action Law.

Sector	2020 status (cut from 1990 levels)	2030 target (cut from 1990 levels)
Energy	52.7 %	76.8 %
Buildings	42.8 %	68.1 %
Transport	11.1 %	48.1 %
Industry	37.2 %	58.4 %
Agriculture	23.7 %	35.6 %
Other	76.7 %	89.5 %
Total	40.8 %	65 %

Note: Without emissions from land use, land use change and forestry (LULUCF), 2020 data preliminary.

Germany's energy efficiency and consumption targets, status 2020

Data: BMWi, 8th Monitoring Report on the Energy Transition (2021) / AGEB (2021).



	Status		Targets			
	2019	2020	2020	2030	2040	2050
Energy efficiency and consumption						
Primary energy consumption (compared to 2008)	-11 %	-18.1 %	-20 %	-30 %		-50 %
Final energy productivity	1.4 % per year (2008-2050)	ND*	2.1 % per year (2008-2050)			
Gross electricity consumption (compared to 2008)	-7.1 %	-11.1 %	-10 %			-25 %
Primary energy demand buildings (compared to 2008)	-23.6 %	ND*		-55 %		
Heat demand buildings (compared to 2008)	-10.9 %	ND*	-20 %			
Final energy consumption transport (compared to 2005)	7.2 %	ND*	-10 %			-40 %

*No data

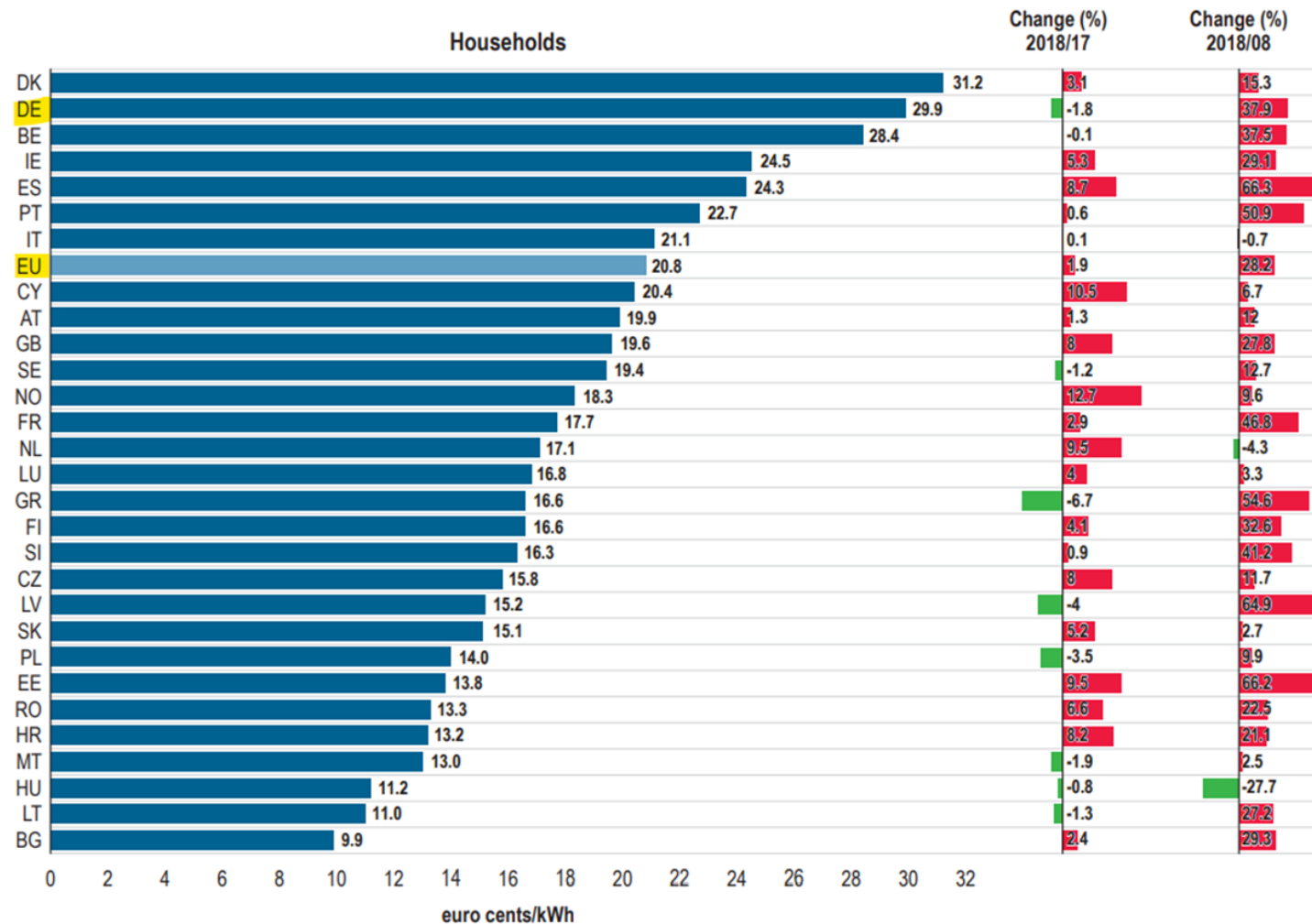
1) Costs of EW

- Impossible to be measured properly. Investments in hundreds of billions of euros by the end of 2030s.
 - Costs of Atomausstieg.
 - RES surcharges.
 - Grid investments and management.
 - Activities in heat and transportation.

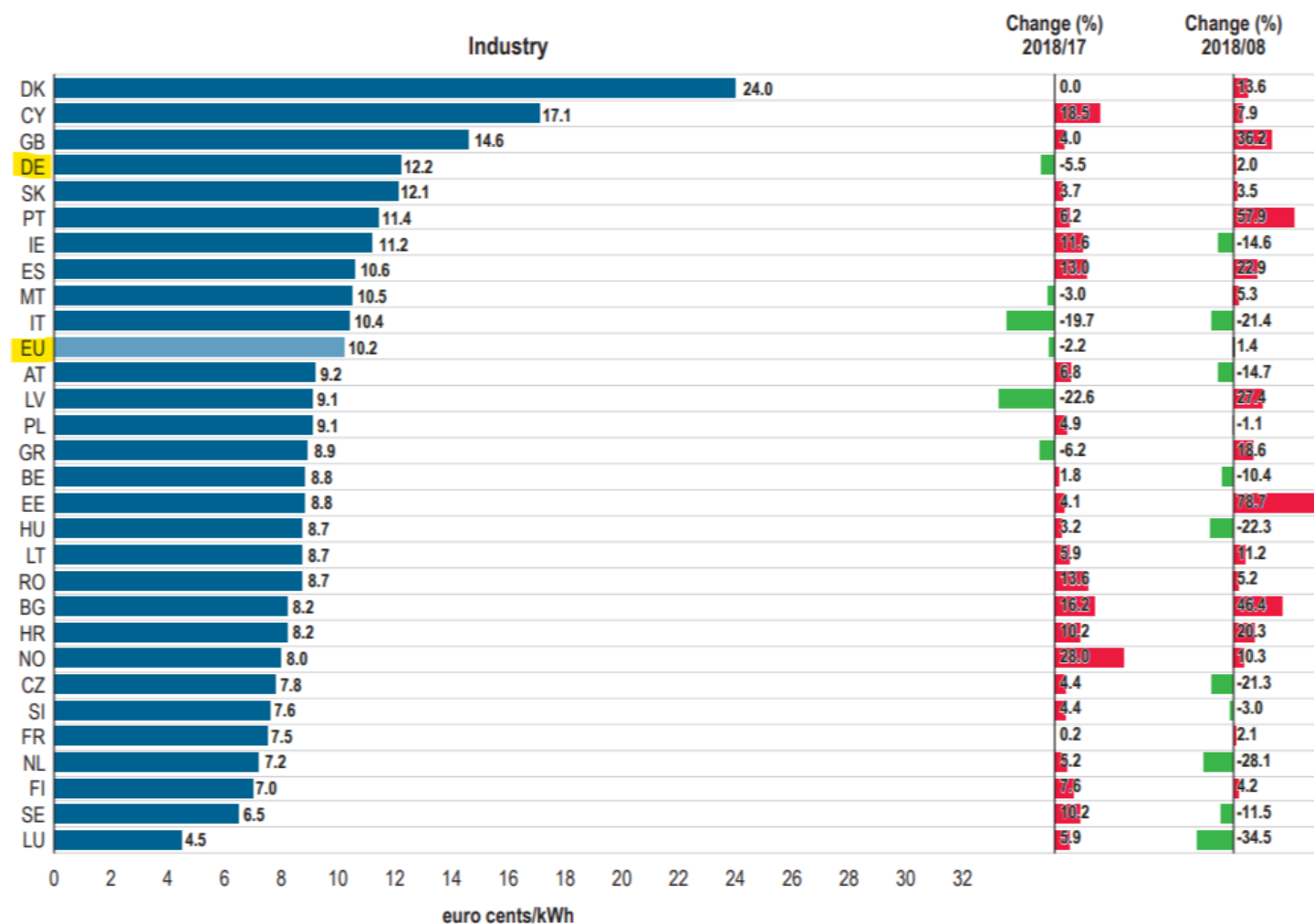
vs.

- Benefits and avoided costs of investments in the stranded assets, less energy imports (in the long term, incl. geopolitics), less carbon payments.
- Wholesale prices of electricity among the lowest in the EU.
- Households pay one of the highest prices in the EU (regulated component of prices).
- Cost unevenly distributed in favor of companies.

Electricity prices: Households (Eurocents/kWh)



Electricity prices: Industry (Eurocents/kWh)



2) Nuclear phase-out

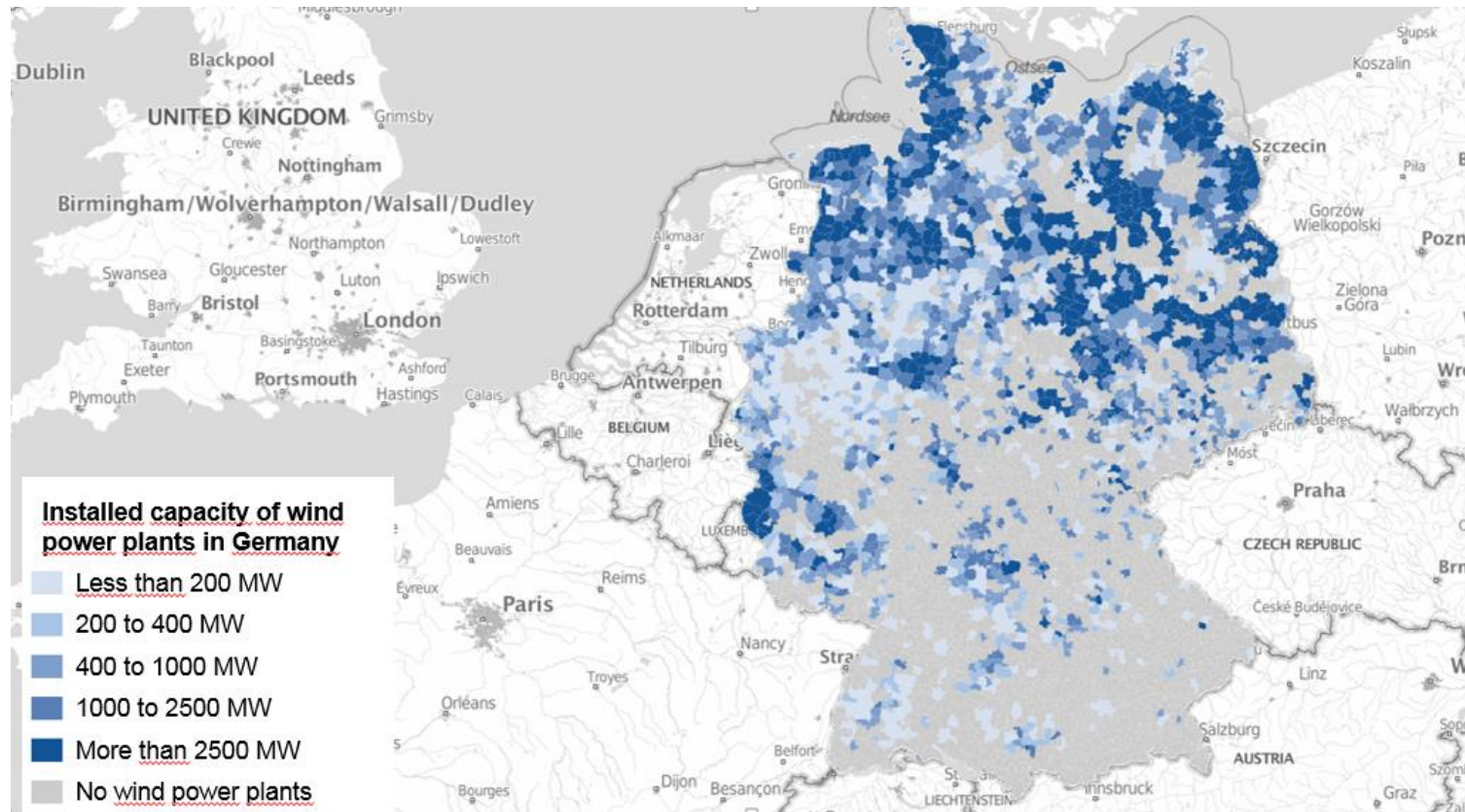
- 81% of Germans support the phase-out (2015 poll).
- Costs of decommissioning (EUR 38 billion earmarked for this purpose – may not be enough). Stability of the companies compromised.
- Nuclear waste.
- Operators (E.ON, RWE, EnBW, Vattenfall) claimed compensation – more than 30 lawsuits and constitutional complains -> settled in 2021 for about EUR 2,5bn.

3) The future of coal

- In 2018, 22.5% of electricity from lignite, 12.8% from hard coal. Last hard-coal mine closed in 2018, but Germany still largest producer of lignite in the world.
- Multi-stakeholder coal commission – roadmap (1/2020) for shutting down the lignite-fired plants and on compensations (about EUR 4.35 billion + up to EUR 5 billion of social benefits by 2030).
- Auctions to shut-down hard-coal power plants by 2026, then forced closures. Ban on new coal plants with exception of Datteln plant (Uniper).
- No coal after 2038 (aiming at 2030).

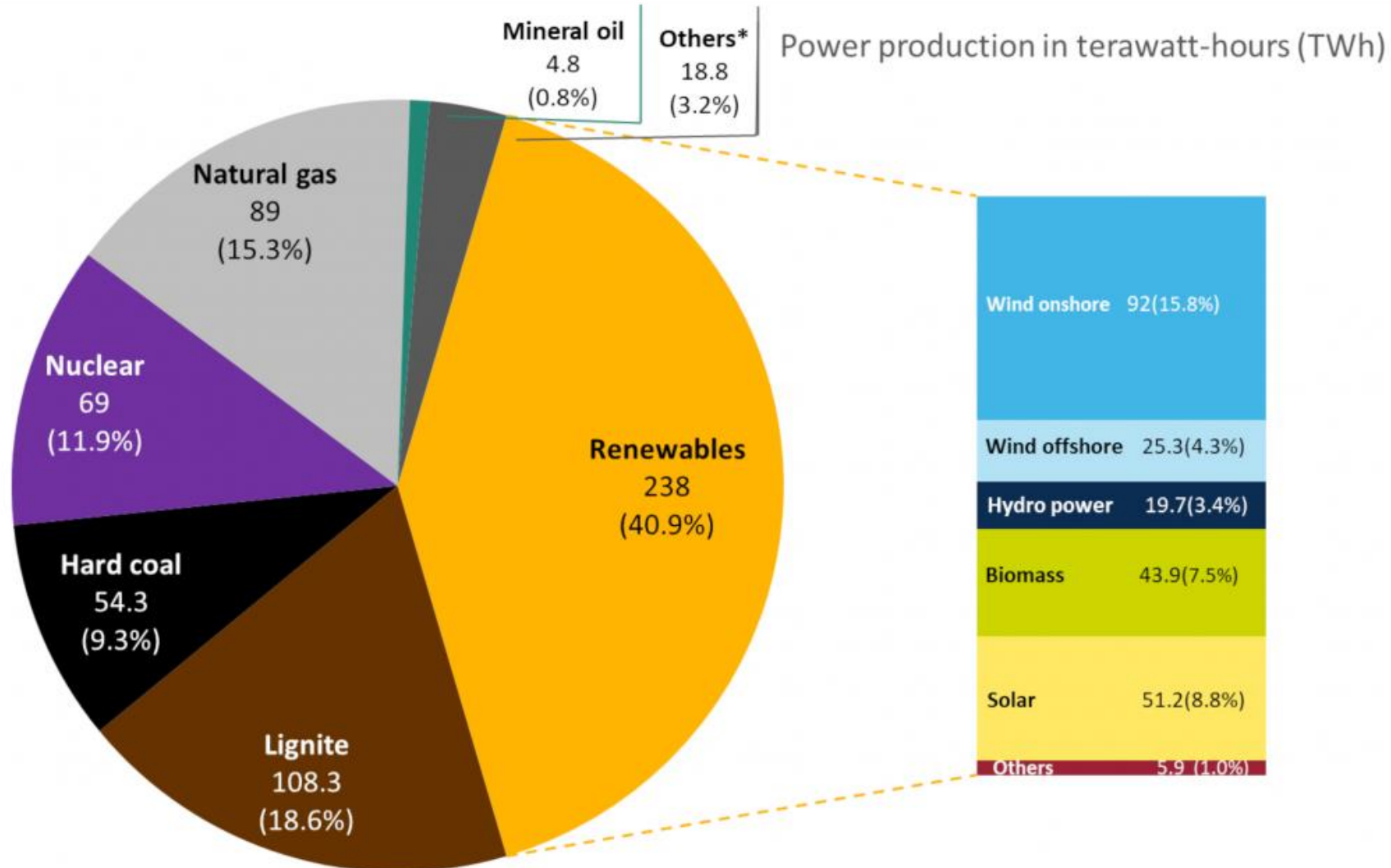
4) Grid capacity

Grid is unable to accommodate 1 500 000 PV units and 23 000 wind turbines.



Share of energy sources in gross German power production in 2021.

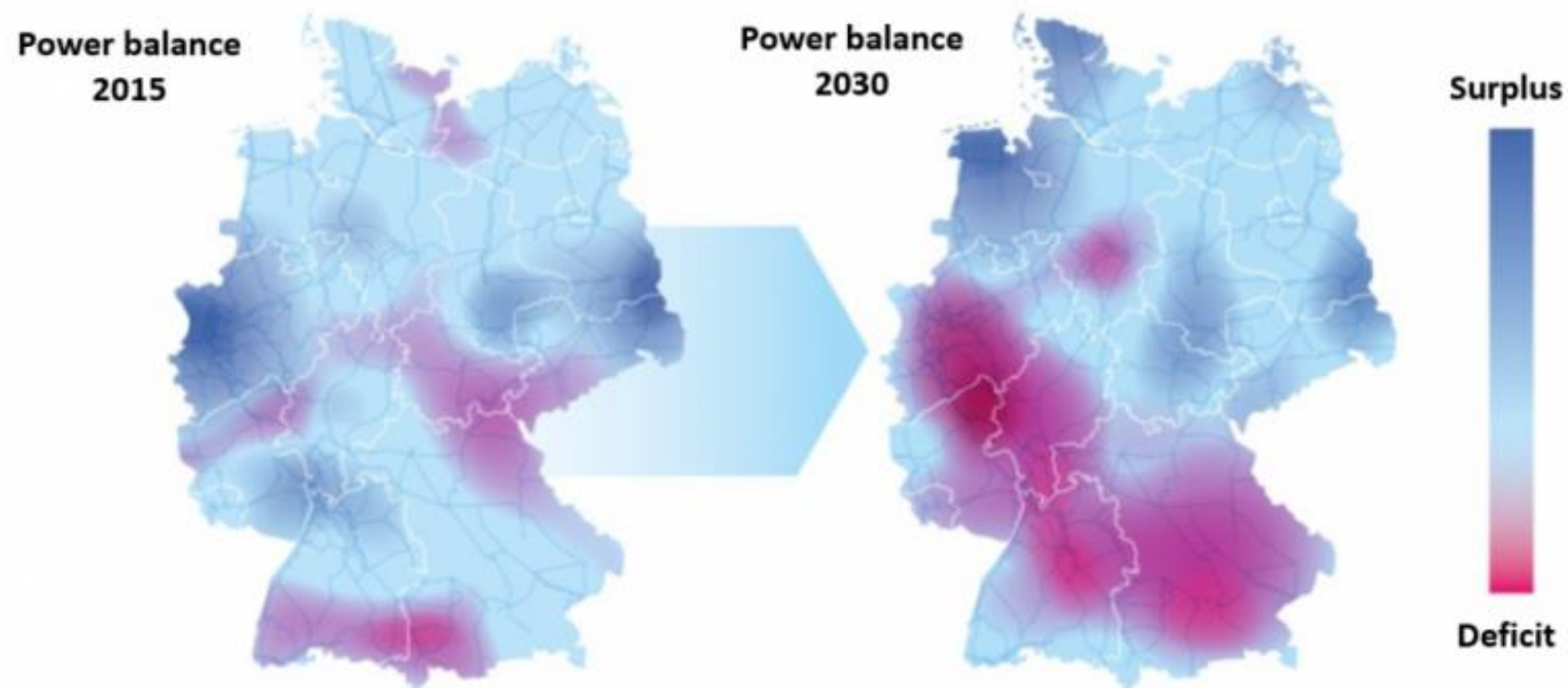
Data: BDEW 2021, preliminary.



*Without power generation from pumped storage

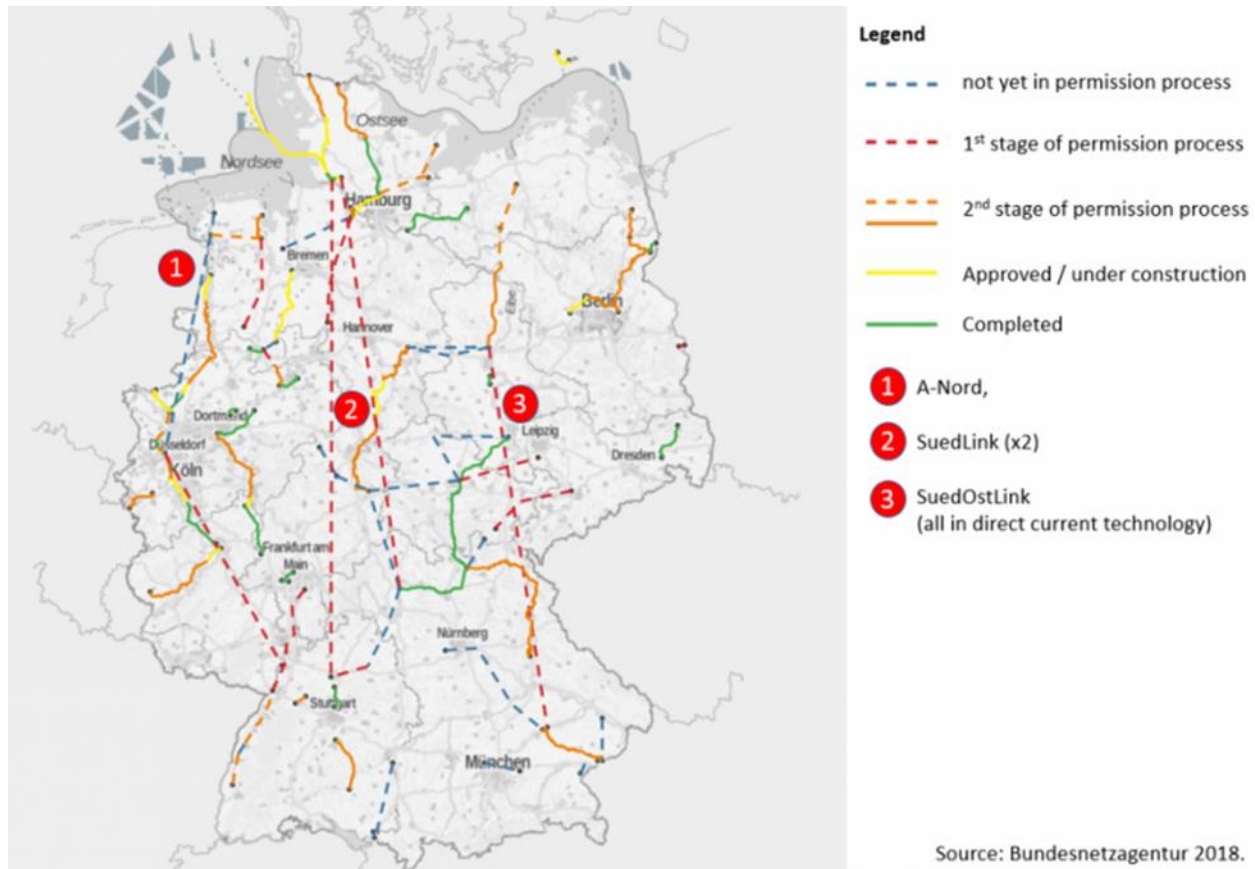
Note: Government renewables targets are in relation to total power consumption (561.8 TWh in 2021), not production. Renewables share in gross German power consumption 2021 (without pumped storage): 42.4%.

Building of the grid



Schematical overview

Source: Amprion.



Suedlink – in 2028, instead of 2026.

SuedOstLink – 2027, instead of 2025.

Ultranet – 2027, instead of 2024.

A-Nord – 2027, instead of 2025.

3Q 2021 – only 1435km of about 11500km planned finished,
 another 1114 in construction.

5) Restructuralization of power production

Extensive development of RES at the expense of traditional sources =>

- New technologies needed to store electricity, manage fluctuations of RES, back-up them, integrate them in the system.
- New companies and actors to emerge, traditional companies loosing their ground.
- New regulation, trading mechanisms and financing mechanisms to be developed.

= the same for other energy-related sectors (heat/cooling, transportation).

Is the EW successful story of policy-driven transition?

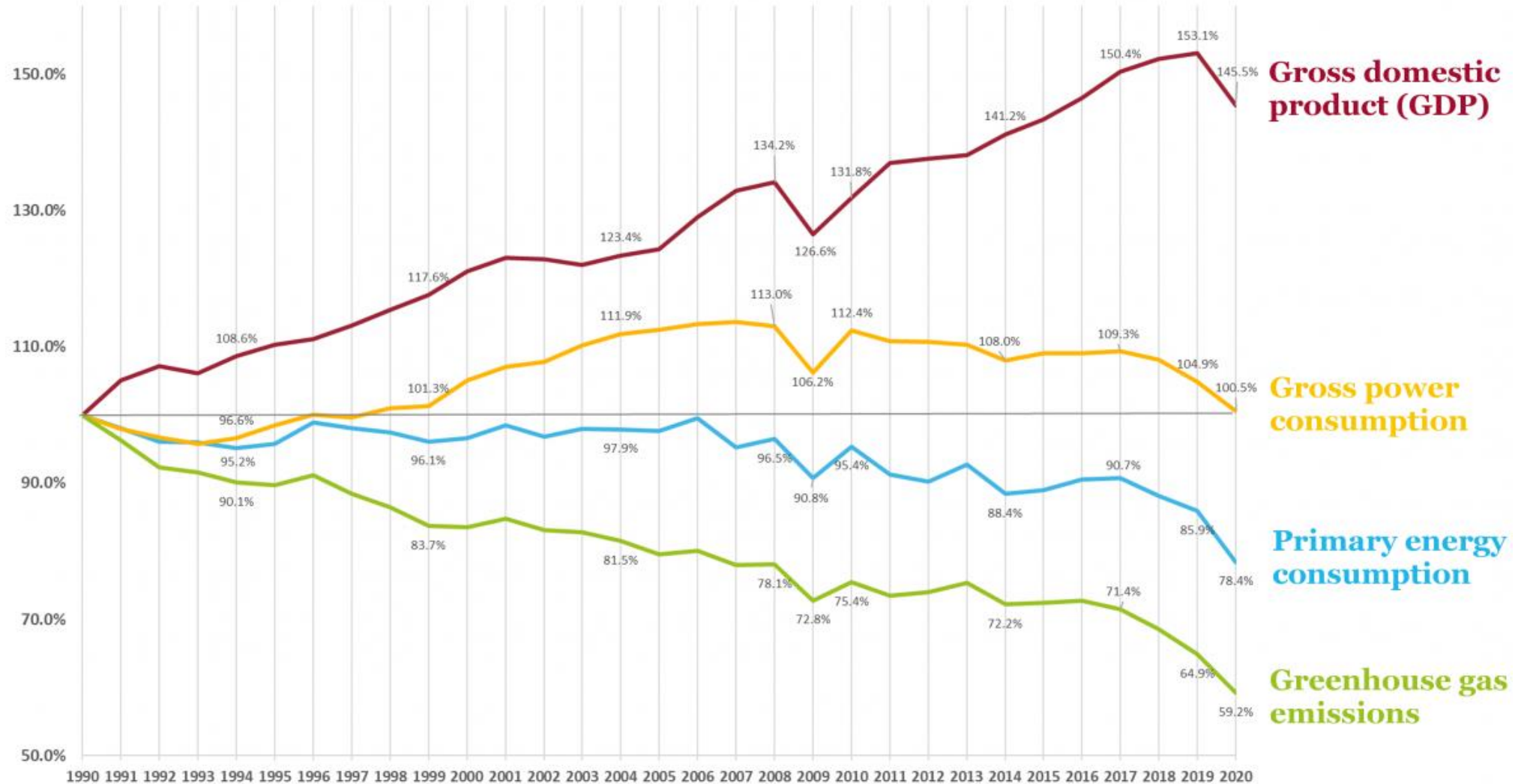
- Increasing share of RES in energy (electricity) mix + decrease in their costs.
- Decoupling of energy consumption from economic growth.
- Stable and reliable supplies of electricity despite original concerns.
- High but manageable costs.

VS

- Over-emphasis on Russian natural gas.
- Untimely shutdown of nuclear power plants.
- Limited climate contribution (at least in Germany – vs. decreasing the prices of RES globally).
- Increasing dependency on neighbouring countries for stabilizing the grid.

Economic growth, power & energy consumption, GHG emissions 1990 - 2020.

Data: BMWi 2021, UBA 2021.

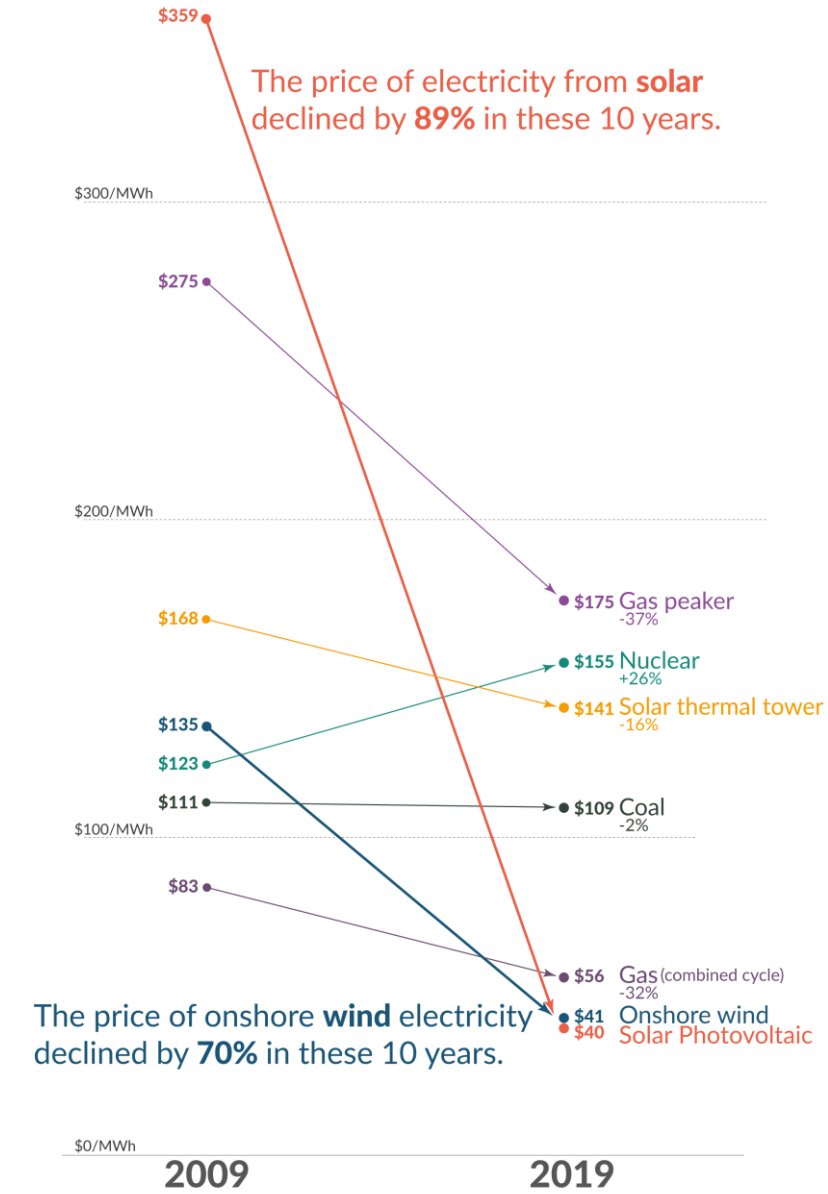


Note: As a general rule, emissions data for the last year shown can expected to be preliminary.

The price of electricity from new power plants



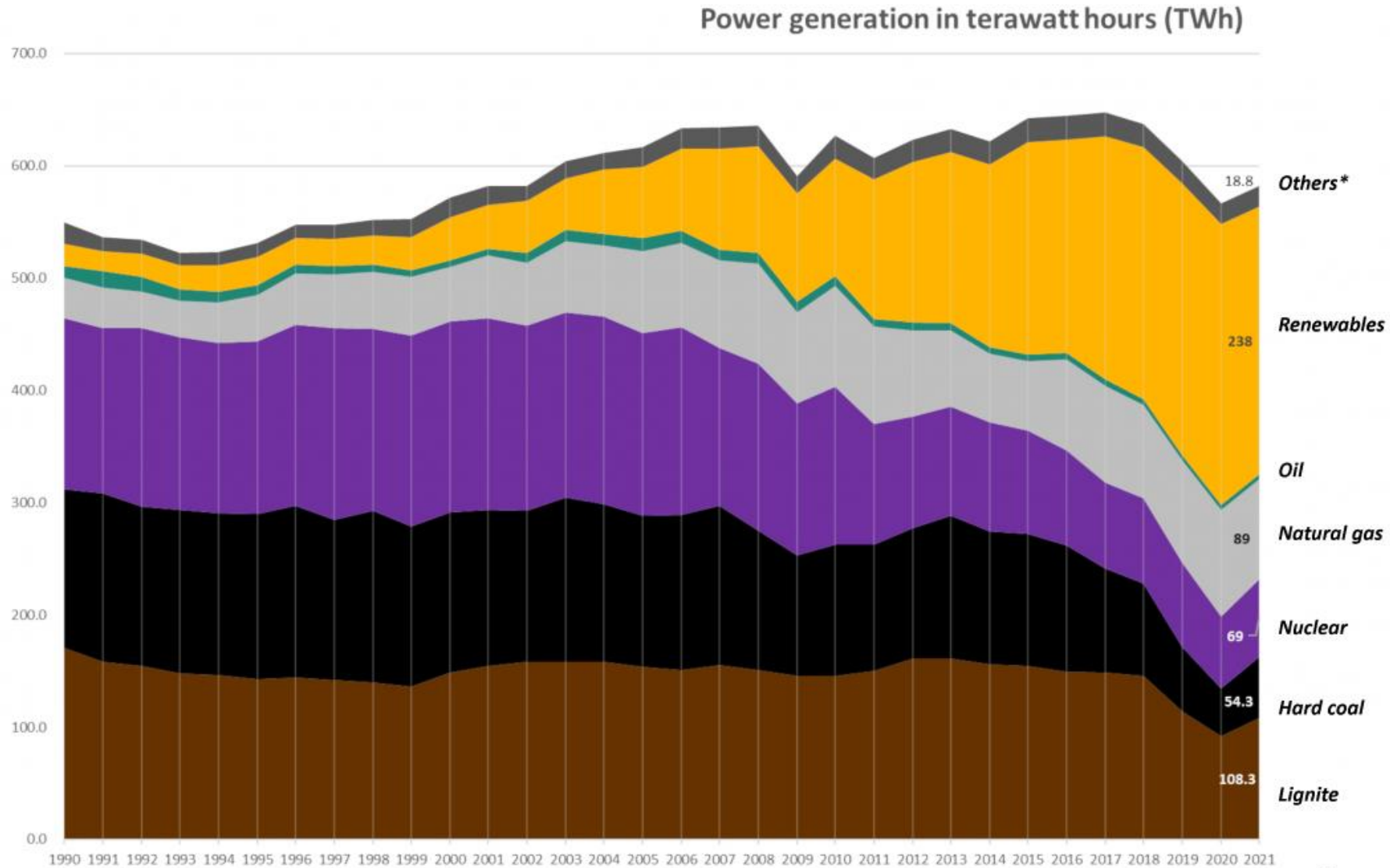
Electricity prices are expressed in 'levelized costs of energy' (LCOE). LCOE captures the cost of building the power plant itself as well as the ongoing costs for fuel and operating the power plant over its lifetime.



Data: Lazard Levelized Cost of Energy Analysis, Version 13.0

Gross power production in Germany 1990 - 2021, by source.

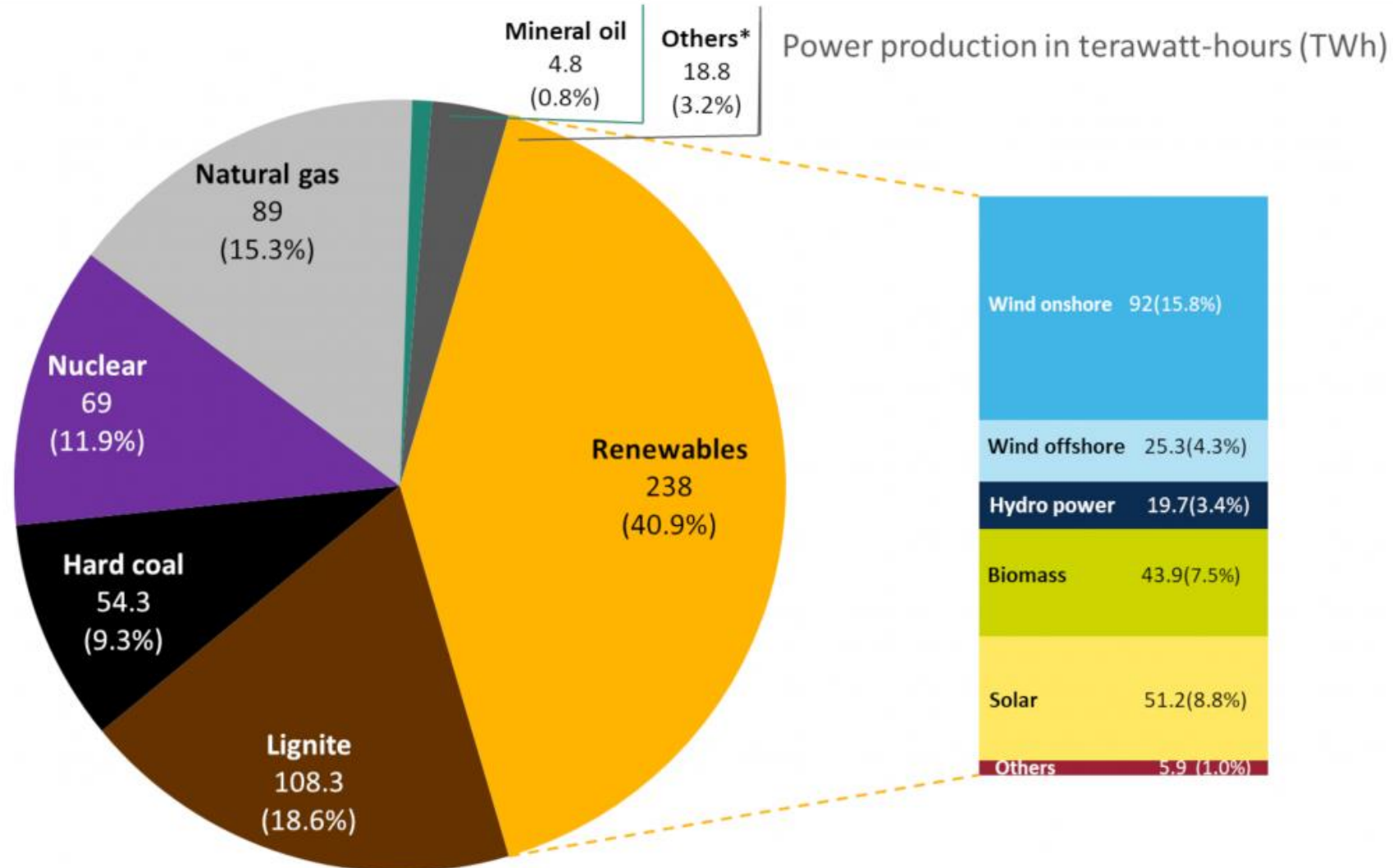
Data: BDEW 2021, data preliminary.



* Without power generation from pumped storage.

Share of energy sources in gross German power production in 2021.

Data: BDEW 2021, preliminary.



*Without power generation from pumped storage

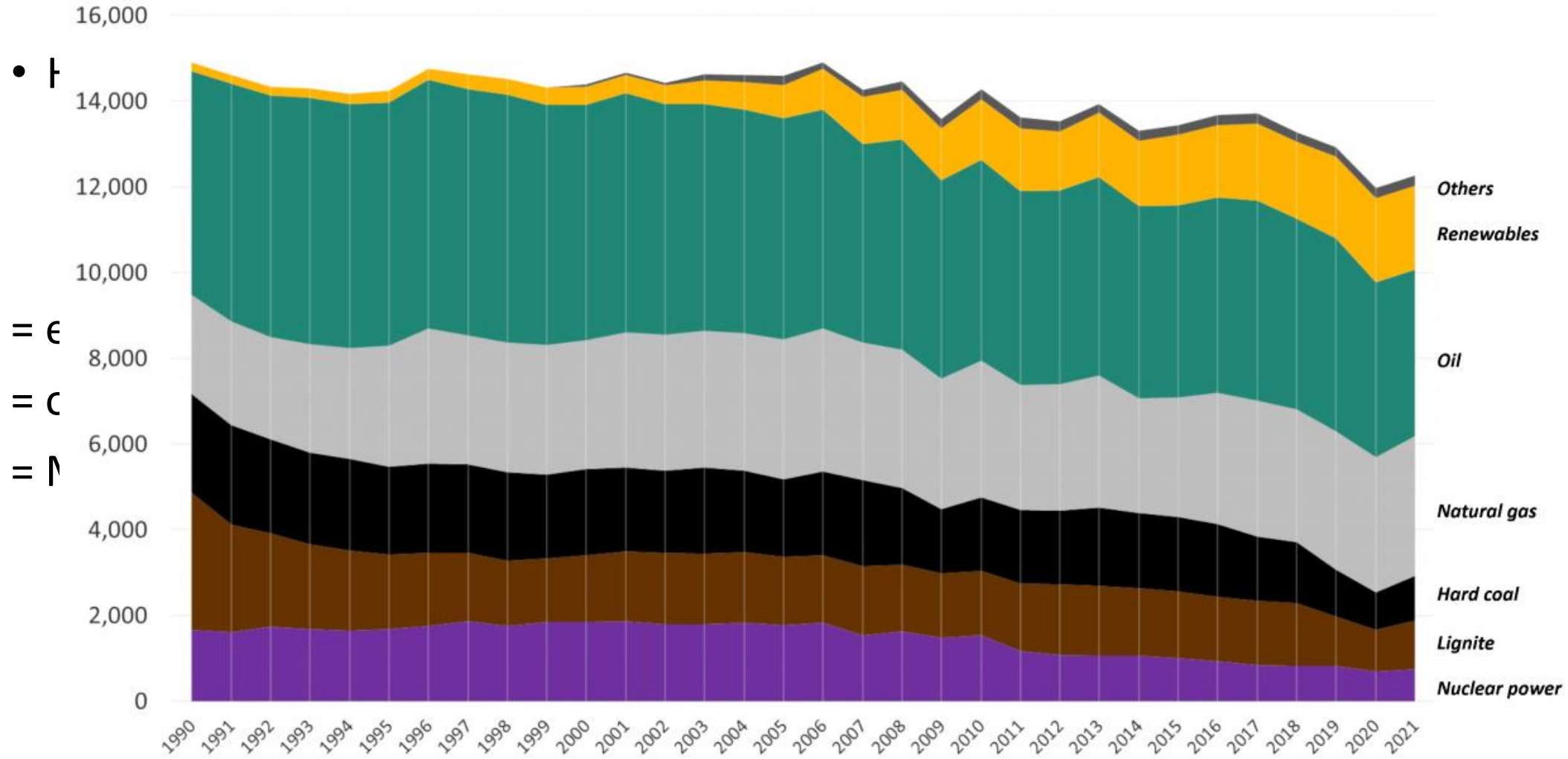
Note: Government renewables targets are in relation to total power consumption (561.8 TWh in 2021), not production. Renewables share in gross German power consumption 2021 (without pumped storage): 42.4%.

German energy sources' share in primary energy consumption 1990 - 2021.

Data: AG Energiebilanzen 2021, preliminary.

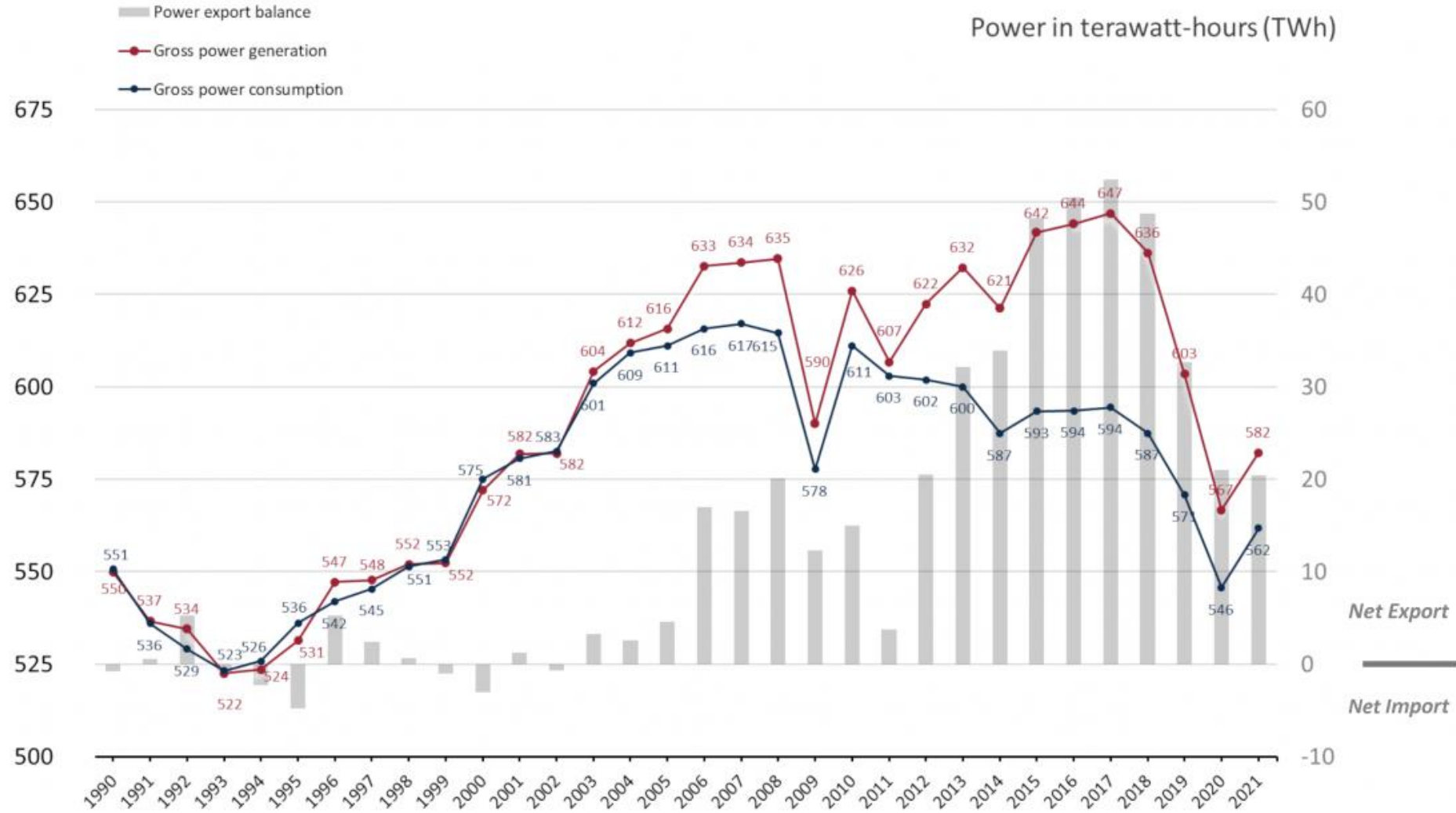


Primary energy consumption in petajoules (PJ)



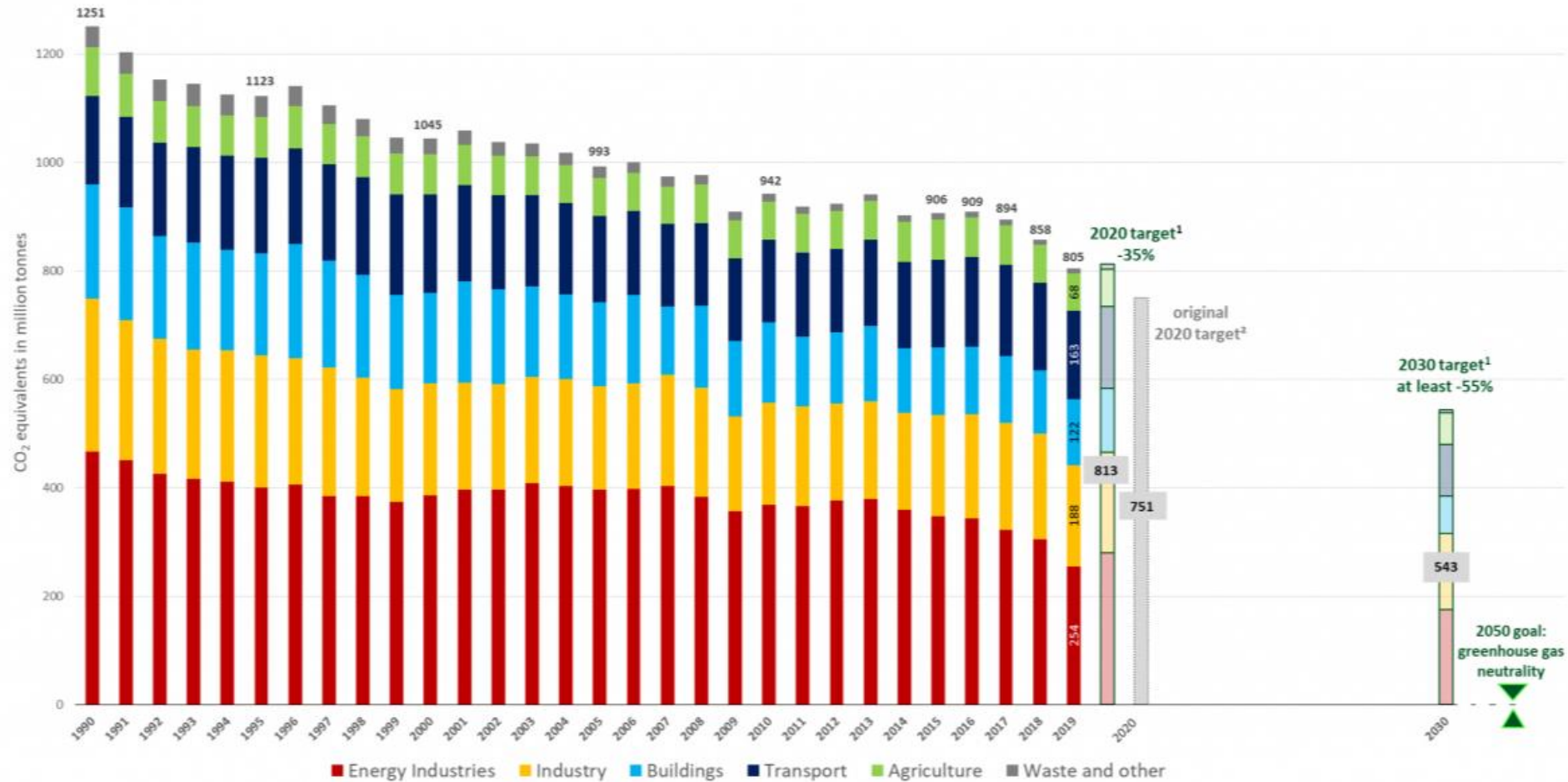
German power export balance 1990 - 2021.

Data: BDEW 2021 (2021 data preliminary).



Note: Without power generation from pumped storage.

GHG trends by sector



1) 2020 and 2030 targets as stated in the Climate Action Law.

2) The German government abandoned its original 2020 target with the introduction of the Climate Action Law in 2019.

Sources

- BMWi (2015): Making a success of the energy transition.
- Clean Energy Wire
- Černoch et.al.(2017): Energiewende and the Energy Security of the Czech Republic and Poland
- IEA (2019): World Energy Investment 2019
- AleaSoft (2019): European electricity markets panorama: Germany
- Clean Energy Wire (2019): Germany's energy consumption and power mix in charts