Energy transition in Germany and the EU

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The EU and Germany have set themselves mid- and long-term climate and energy targets

	Germany				EU	
Targets	2030	2040	2045	2050	2030	2050
Climate						
Greenhouse gas emissions (GHG) reduction Reduction compared to 1990 levels, including all sectors.	65%	88%	GHG neutral	GHG net sink	55%	GHG neutral
Renewable energy sources (RES)						
RES share in gross final energy consumption	30%	45%		60%	>42.5%	
Energy efficiency						
Primary energy consumption reduction	30%			50%	32.5%	
	Increase in energy efficiency compared to 2008.				Increase in energy efficiency compared to PRIMES business-as-usual scenario.	

Source: Guidehouse 2023 based on BMWK 2022, Federal Government 2022 & EC 2022

Federal Foreign Office

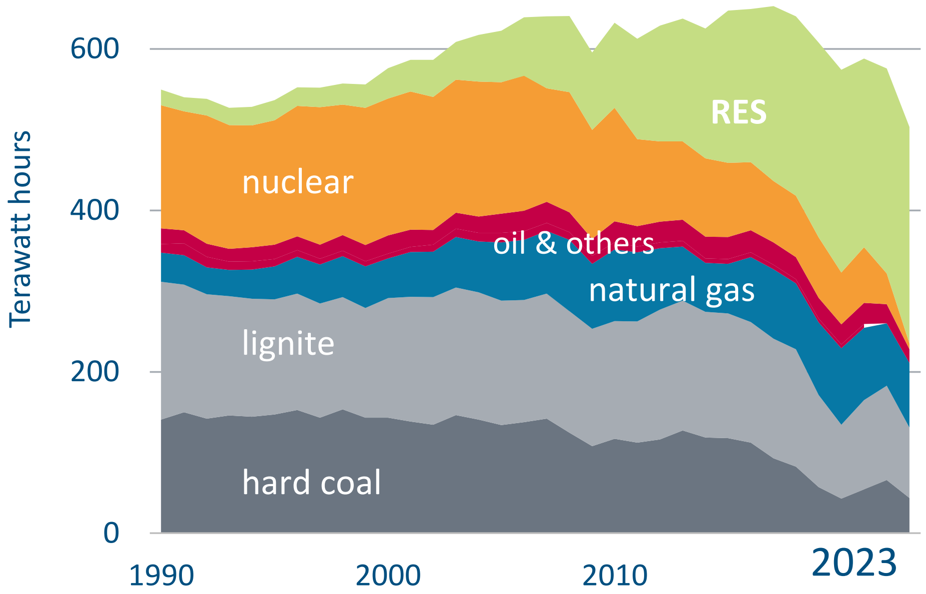
The energy transition is Germany's long-term energy and climate strategy

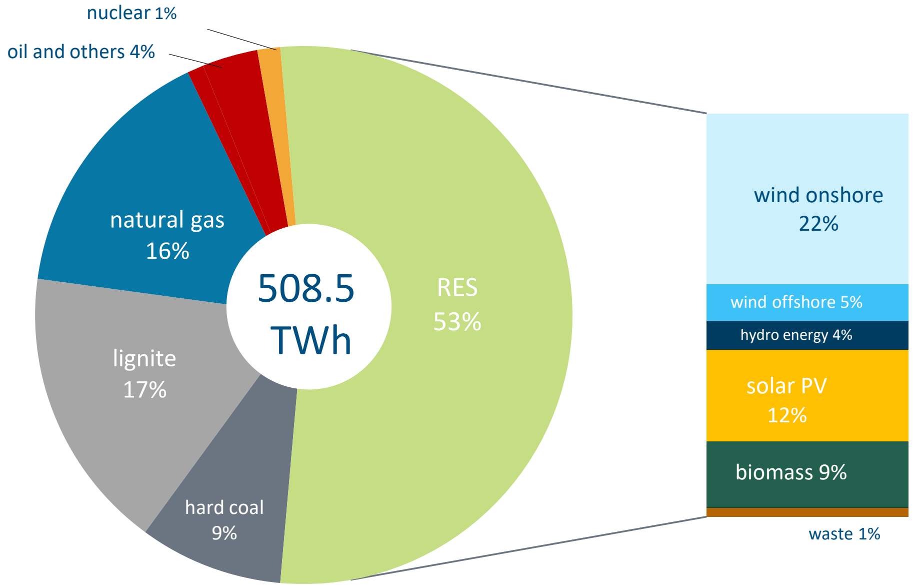
		2023	2030	2040	2045	2050
Climate	**Greenhouse gas emission (vs. 1990)**	**-46.1%** (2023)	-65%	-88%	GHG neutral	GHG sink
Renewable Energy	**Gross electricity consumption**	**51.8%** (2023)	80%			
	Gross final energy consumption	**22.0%** (2023)	30%	45%		60%
Energy Efficiency	**Primary energy consumption (vs. 2008)**	**-25.0%** (2023)	-30%			-50%
	Final energy productivity (vs. 2008)	**1.4% p.a.** (2008-20)	+2.1% p.a. (2008-2050)			

Source: Guidehouse April 2024, based on UBA 2024 & BMWK 2021

Renewables account for 53% of the total electricity generation in Germany

Development and status quo of gross electricity generation by sources in Germany in 2023

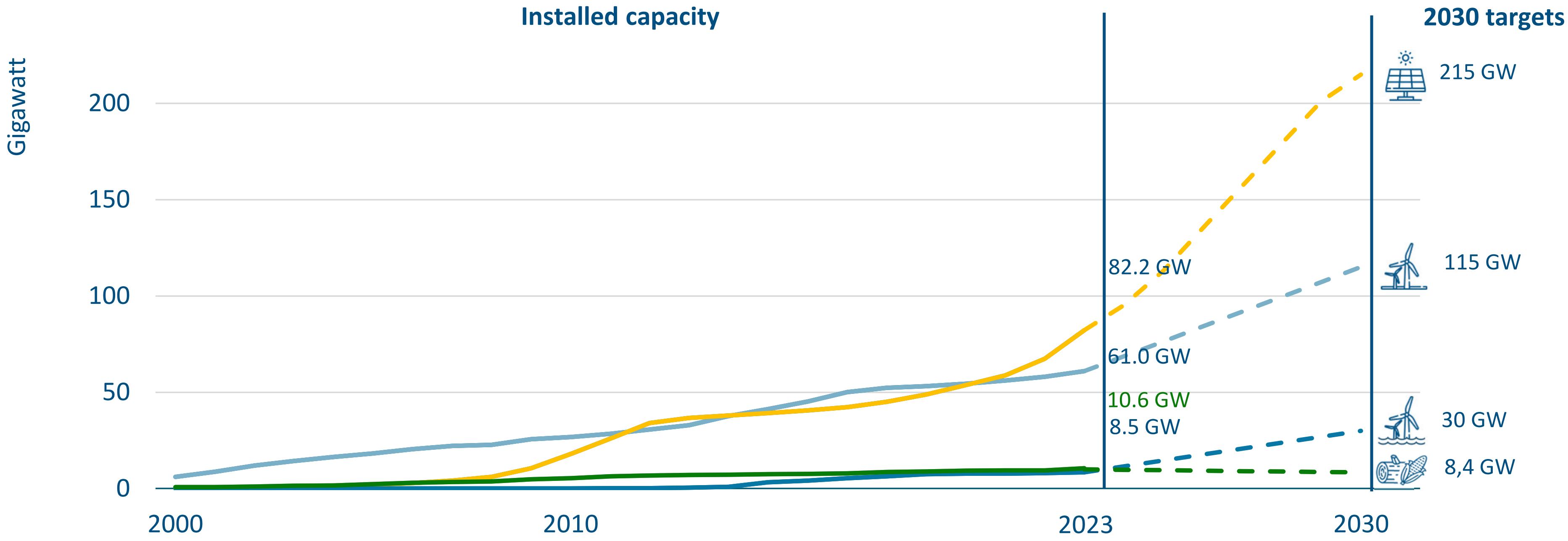




Source: Guidehouse, March 2024 based on Agora 2024, UBA 2023 & BDEW 2023

Germany has set ambitious capacity targets for renewable energies

Renewable energy installed capacity 2000-2023 and capacity targets for 2030 per technology



Source: Guidehouse 2024 based on UBA 2024; Icons from flaticon.com

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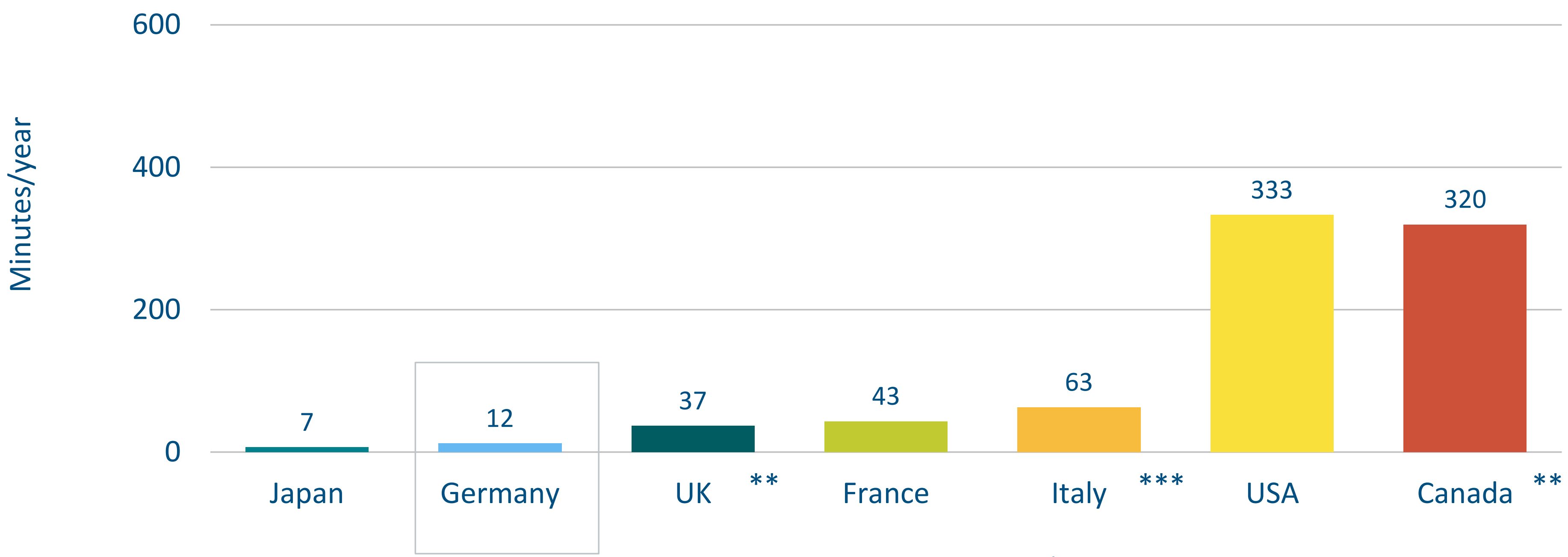
The security of Germany’s electricity supply remains one of the highest worldwide

Duration of unplanned electricity outages per year based on SAIDI* in 2022 for G7 countries



** SAIDI = System Average Interruption Duration Index*
*** 2020 value*
**** 2021 value*

Sources: Guidehouse, 2024 based on BNetzA 2023, Of-gem 2022, Enedis 2023, ARERA 2022, OCCTO 2023 & EIA 2022

Federal Foreign Office

National Hydrogen Strategy 2.0: Key action areas for 2023 – 2030 (Phase 2)

1. Ensuring sufficient supply

- 2030: **10+ GW domestic** ELY capacity, **50-70% H2 imports**
- Domestic, EU and international **funding instruments**

2. Building up H2 infrastructure
(terminals & pipelines; storage; fuelling)

- H2-ready and dedicated **port terminals**
- 1,800 km in Germany (“**Start grid**”) via IPCEI *until 2027/28*
- +4,500 km EHB (“**Core grid**”; 2/3 repurposed) *until 2032*
- H2 storage and fuelling stations

3. Establishing H2 applications

- **Industry** (supported by EU-IPCEI, CCfDs and domestic industrial decarbonization funding programmes)
- Heavy **transport**, **aviation**, maritime **shipping**
- **Power sector** (flexibility, system integration)g

4. Creating an appropriate regulatory and market environment

- Simplified, accelerated **planning** & **permitting** procedures
- Standards & **certification**
- **R&D, Innovation**

Federal Ministry
for Economic Affairs
and Climate Action

The strategy sketches the short term (2023) and medium-term measures (2024/25) for reaching those goals

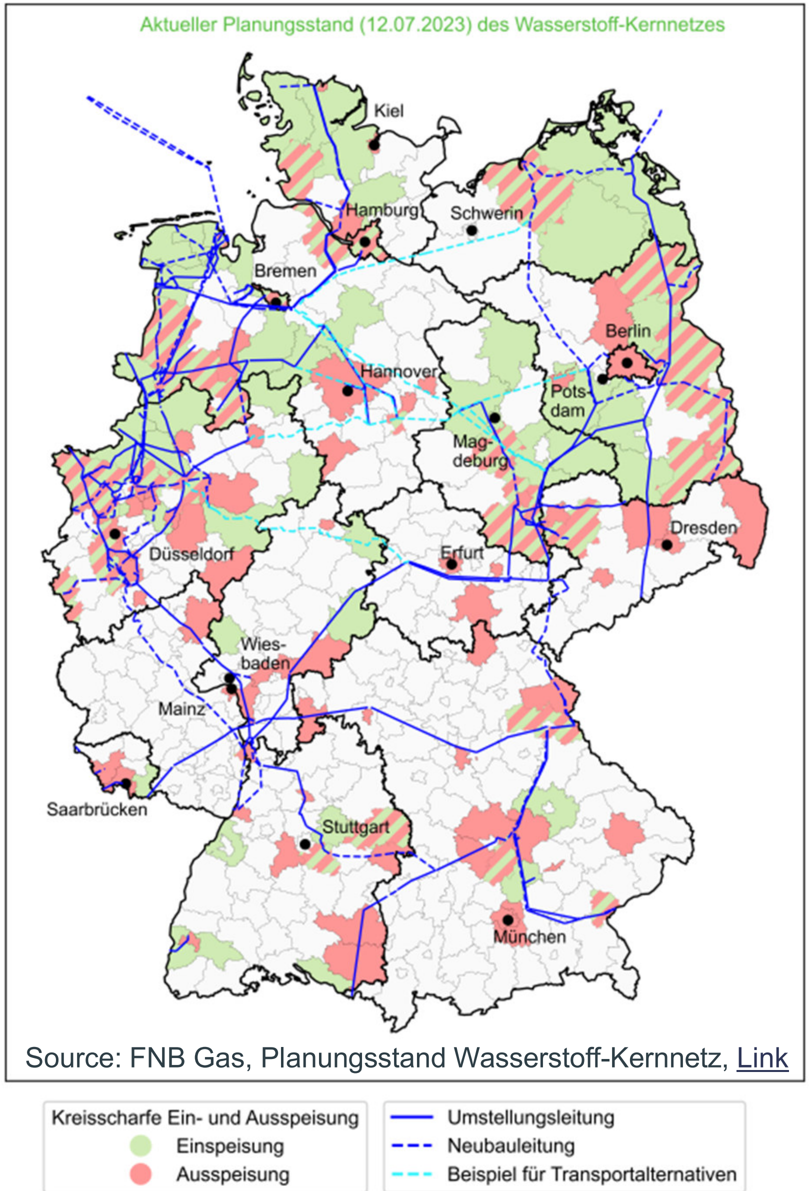
National Hydrogen Core Network

Significance and state of play

- German TSOs to build pipeline network of 9,700 km, connecting major import- and supply hubs with (industrial) demand hubs by 2037
- Government sets up a so-called amortization account for the collection of TSO revenues and costs
- Grid fees are capped; If deficits remain by 2055, government will offset these
- Coalition has agreed; TSOs must now determine if investments will follow and hand in proposal to regulator
- Next steps:

Grid fees must be determined,

Extension / Connection of core network to gas grids on distribution level



Source: FNB Gas, Planungsstand Wasserstoff-Kernnetz, Link

Germany applies a range of instruments to support the decarbonisation of its energy-intensive industry

Carbon pricing

EU Emission trading system puts a price on carbon

Carbon Border Adjustment Mechanism aligns the carbon prices of goods imported into the EU with goods produced in the EU

Funding programmes

Carbon Contracts for Difference offset additional costs of climate-friendly production technologies

Important Projects of Common European Interest receive financial support to innovative industry projects, e.g. on hydrogen

Regulation

Green lead markets to enhance the attractiveness of green industrial products

Carbon Management Strategy sets regulatory framework for CC(U)S for hard to abate sectors, such as cement

Source: Guidehouse, March 2024, based on BMWK 2023; Icons by flaticon.com

Carbon Management Strategy

Germany's cornerstones for a Carbon Management Strategy (26 February 2024)

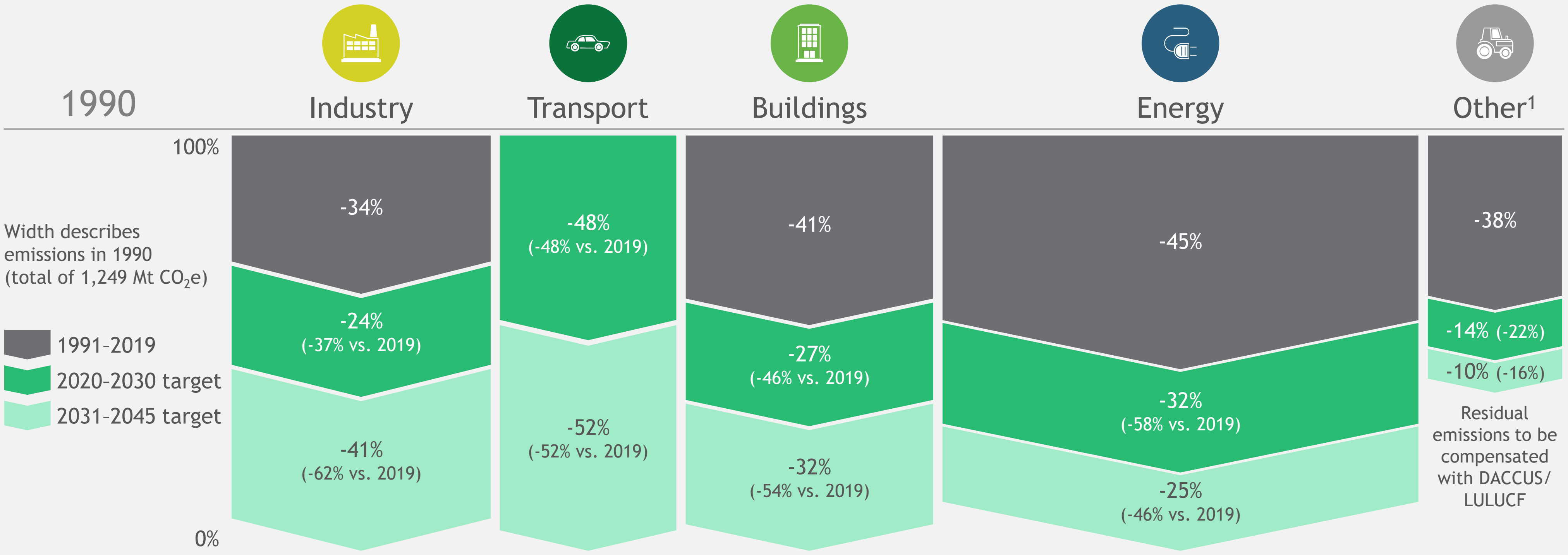
Value chain	Sector	Allowed?	Explanation
Carbon capture	Industry	✓	▪ CCS/CCU to focus on **hard-to-abate industries** such as cement, lime and waste ▪ **Government support**, e.g. Carbon CfDs (CCfDs)
Carbon capture	Power generation	Gas & bio ✓ / Coal ✗	▪ CCS/CCU **allowed for natural gas** power plants (but no government support) and **biomass (BECCS)** ▪ CCS/CCU **not allowed for coal**-fired power plants
Carbon transport	Domestic	✓	▪ Amendment of legal framework to **facilitate carbon transport** in privately operated **domestic** pipelines
Carbon transport	Export	✓	▪ Ratification of London protocol and amendment of national legal framework to **enable carbon export to offshore** storage abroad
Carbon storage	Onshore	✗ ?	▪ **No federal permission for onshore** carbon storage ▪ But **opt-in for federal states** to permit onshore storage
Carbon storage	Offshore	✓	▪ Amendment of German carbon dioxide storage law (KSpG) to **enable offshore storage** in German exclusive economic zone (AWZ)

Source: LinkedIn, Matthias Janssen,
https://www.linkedin.com/feed/update/urn:li:activity:7168506881269874688/

Climate Change Act: Sector targets in 2030, GHG neutrality in 2045

Relative emissions development in Germany by sector 1990—2045

% of 1990 emissions



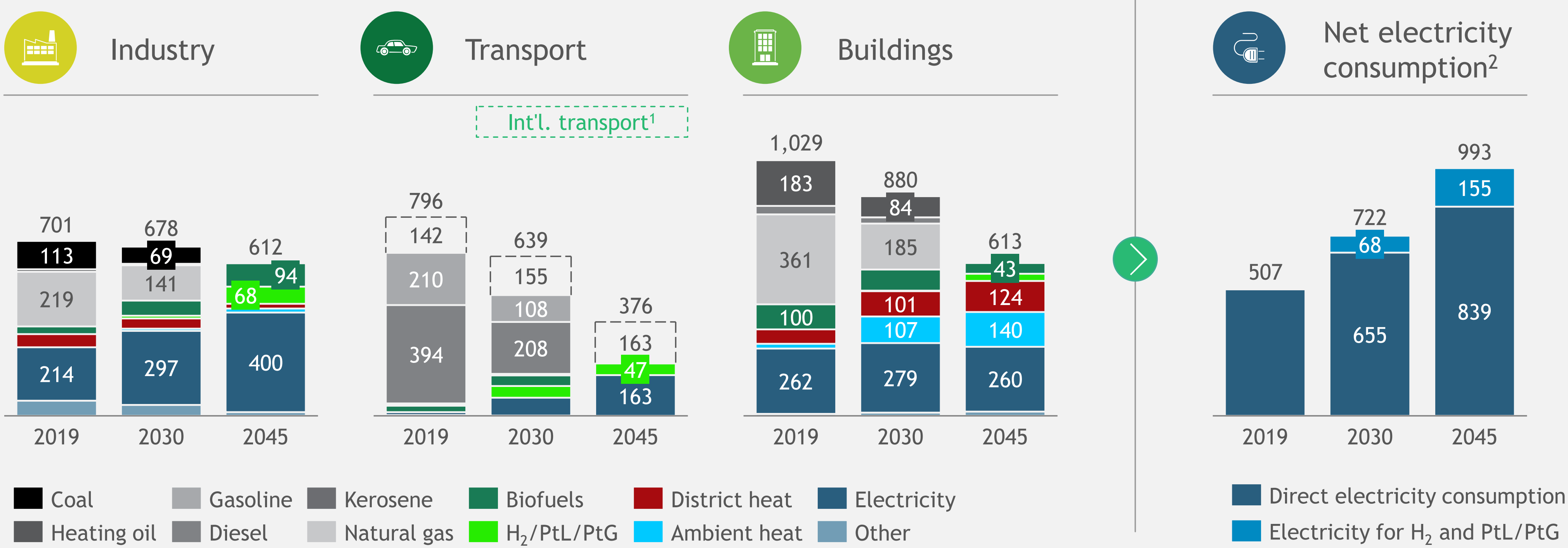
1. Agriculture, waste management, and other | Note: Transport in 2019 largely stable compared to 1990; bioenergy with carbon capture, utilization, and storage (BECCUS) is displayed as negative emissions in the industrial and energy sector; DACCUS = direct air carbon capture, utilization, and storage; LULUCF = land use, land-use change, and forestry

Source: German Environment Agency (2021); BCG analysis

Electricity is the transformation's central energy carrier

Final energy consumption and net electricity consumption

TWh

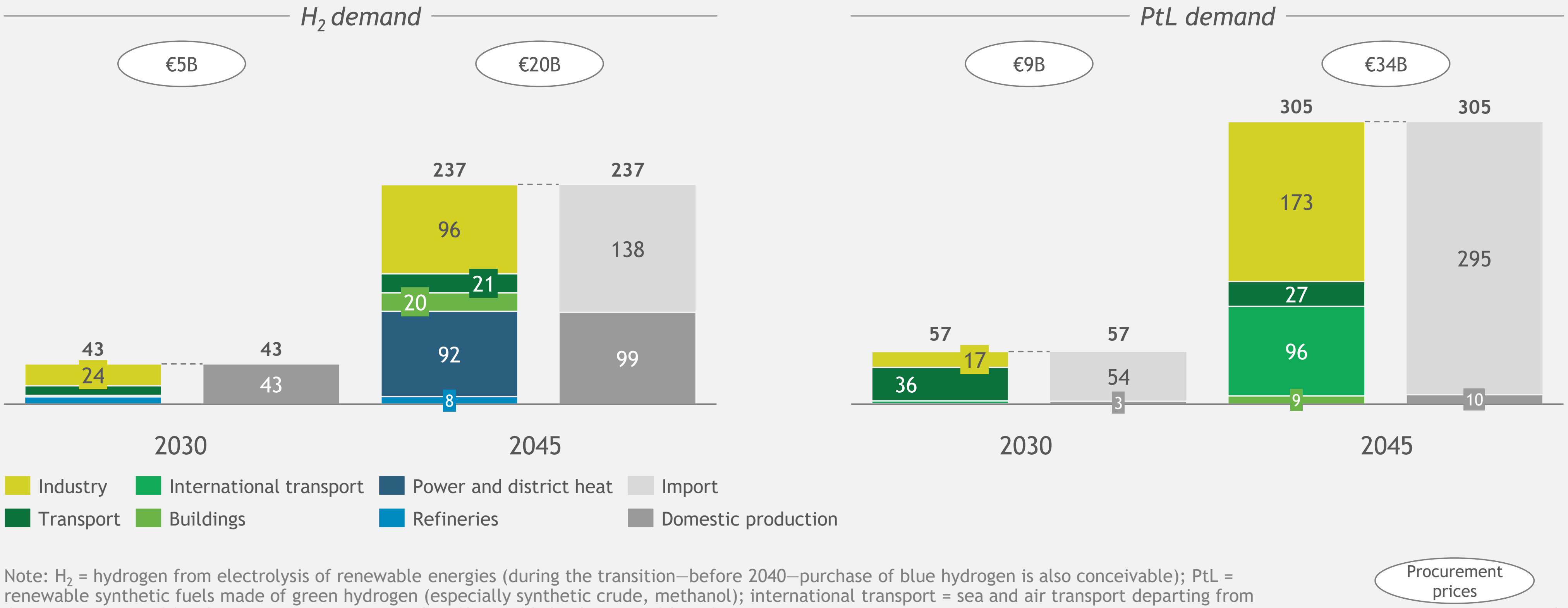


1. Assumption: International transport originating in Germany should also be converted to carbon-neutral fuels by 2045 2. Total power consumption from all sector applications excl. the power plant's own consumption or import/export; includes domestic hydrogen production | Note: Excl. Material consumption H_2/PtL/PtG for Naphtha and Bitumen | Source: BCG analysis

Industry, transport & energy sector drive H_2/PtL demand

H_2 and PtL demand by sector and application 2030–2045

TWh

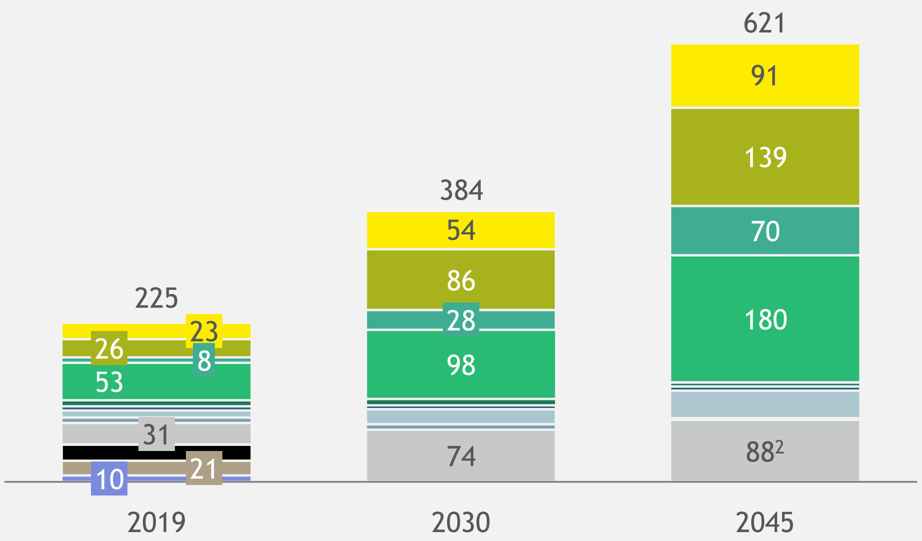


Note: H_2 = hydrogen from electrolysis of renewable energies (during the transition—before 2040—purchase of blue hydrogen is also conceivable); PtL = renewable synthetic fuels made of green hydrogen (especially synthetic crude, methanol); international transport = sea and air transport departing from Germany; import of fossil energy carriers amounted to €91B in 2019 | Source: BCG analysis

Strong increase in renewable power generation already before 2030

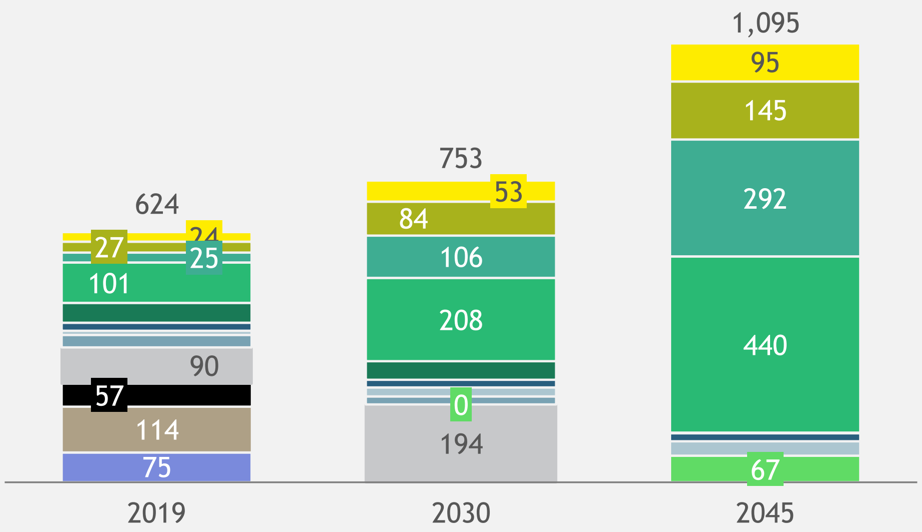
Net generation capacity in the target path

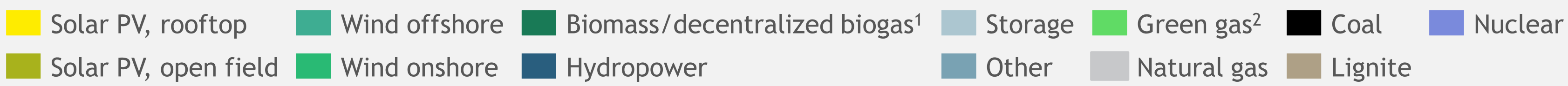
GW



Net electricity generation in the target path

TWh



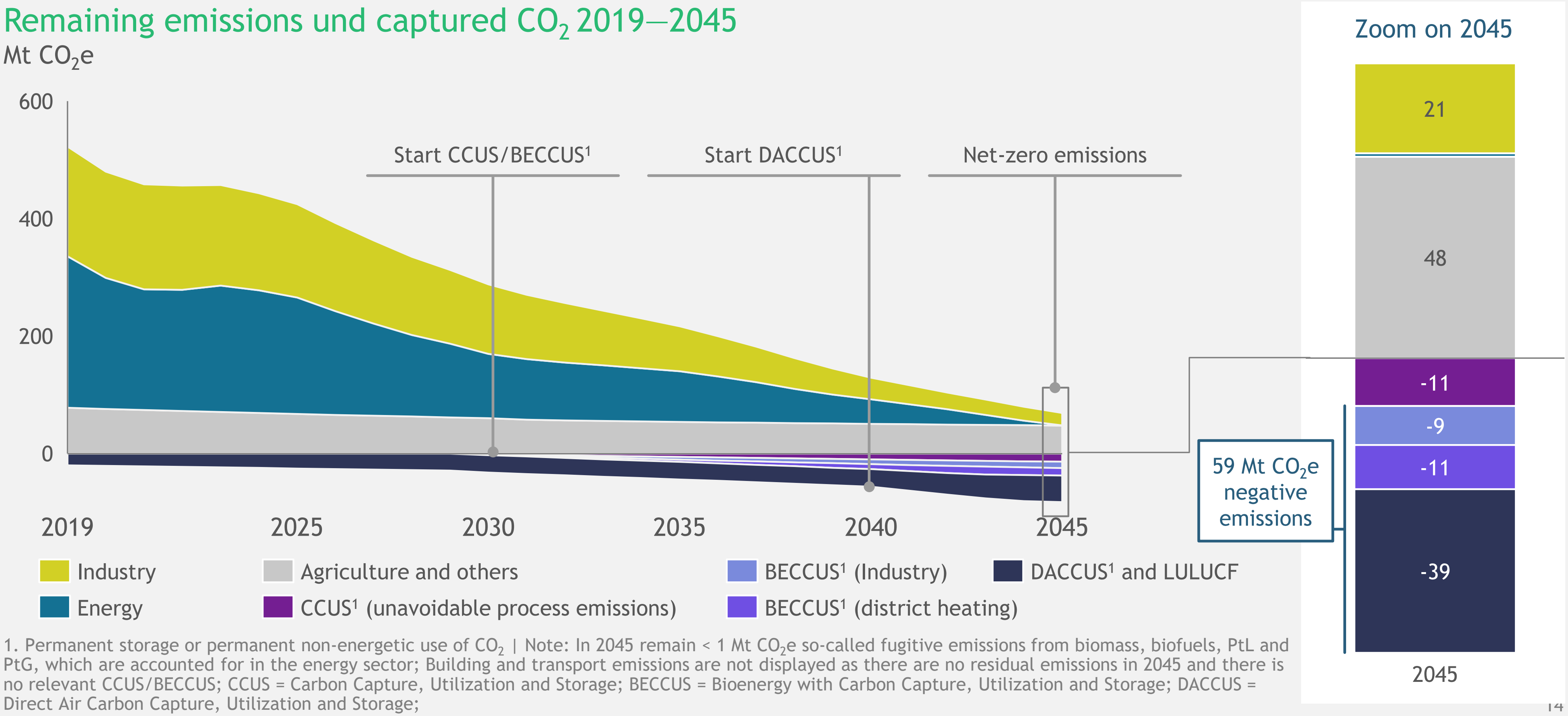


1. Solid biomass and decentralized conversion of biomethane into electricity (currently) in Renewable Energy Act (EEG)-funded plants 2. Green hydrogen, PtX, biomethane in gas-fired power plants | Note: Net electricity generation describes all domestic electricity generation except for the power plant's own consumption | Source: BCG analysis

CCUS necessary for net-zero emissions in 2045

Remaining emissions und captured CO_2 2019—2045

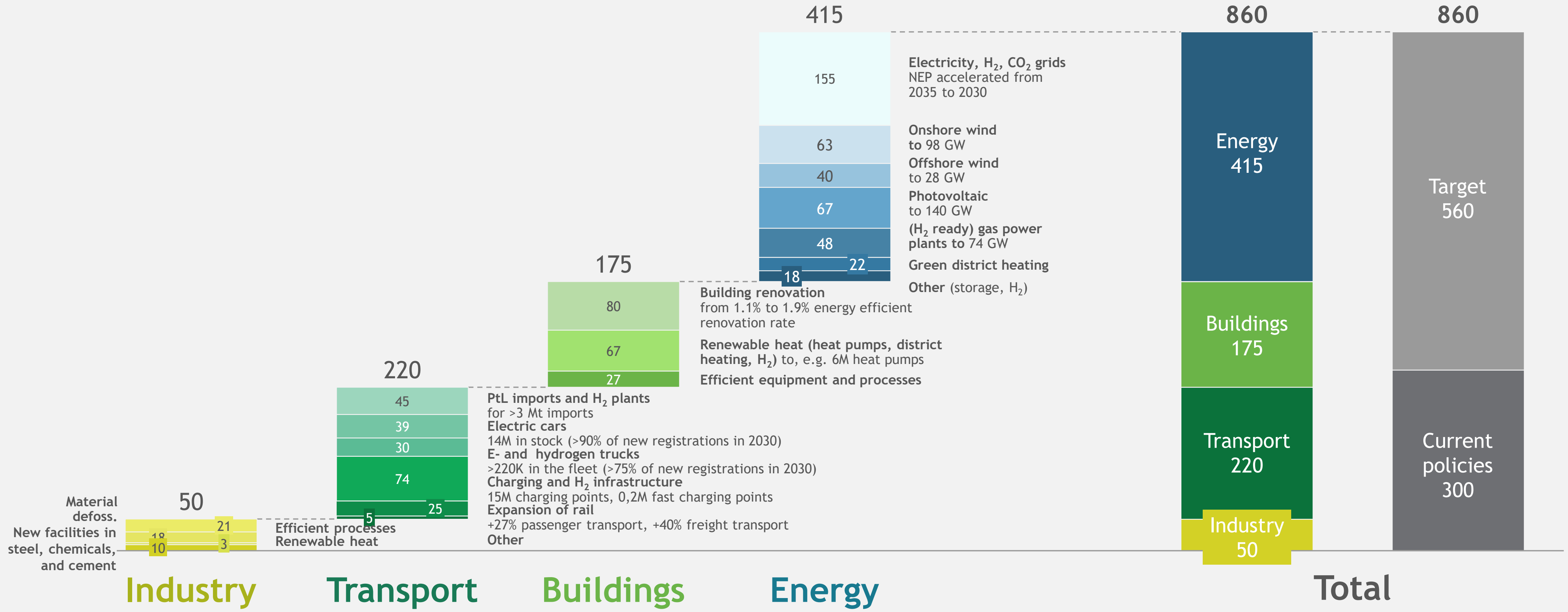
Mt CO_2e



1. Permanent storage or permanent non-energetic use of CO_2 | Note: In 2045 remain < 1 Mt CO_2e so-called fugitive emissions from biomass, biofuels, PtL and PtG, which are accounted for in the energy sector; Building and transport emissions are not displayed as there are no residual emissions in 2045 and there is no relevant CCUS/BECCUS; CCUS = Carbon Capture, Utilization and Storage; BECCUS = Bioenergy with Carbon Capture, Utilization and Storage; DACCUS = Direct Air Carbon Capture, Utilization and Storage;
LULUCF = Land Use, Land-Use Change and Forestry | Source: BCG analysis

€860B investments in climate protection by 2030

Cumulative additional investments 2021-2030 in B€



Note: In the case of renewable heat and alternative powertrains in transport, the additional investments describe the acquisition costs compared to conventional technologies

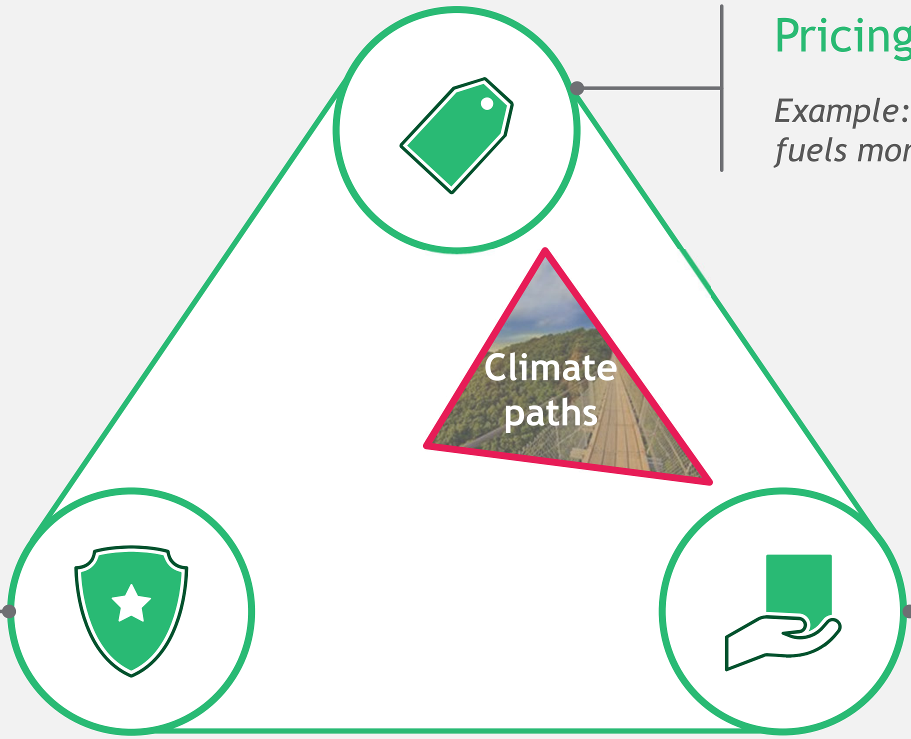
Source: Federal Office of Statistics Germany, KfW, IMF, BCG analysis

Instruments have to combine difference approaches

Three types of regulatory instruments

Pricing

Example: Emissions trading to make fossil fuels more expensive



Regulatory law

Example: Fuel quota obligating kerosene distributors to addition of CO2-neutral kerosene

Subsidies

Example: Purchase premiums for battery-electric cars provided by the government

Regulatory law

Subsidies

Quelle: BCG-Analyse

A Program for Climate & Germany's Future Development

- Make use of fossil fuels less attractive
- Incentivize switch to electricity
- National infrastructure program
- National biomass strategy

Industry	Transport	Buildings	Energy
Carbon contracts (CCfDs)	Infrastructure subsidy	Infrastructure planning	Renewables offensive
Investment incentives	Purchase incentives e-cars	Renovation schedules	Accelerated grid expansion
Efficiency subsidies	Carbon-based truck toll	Modular building subsidies	Flexibilized elect. consump.
Green lead markets	PtX quota and auctions	Renewable req. new buildings	Central capacity market
Carbon leakage protection	Social compensation		

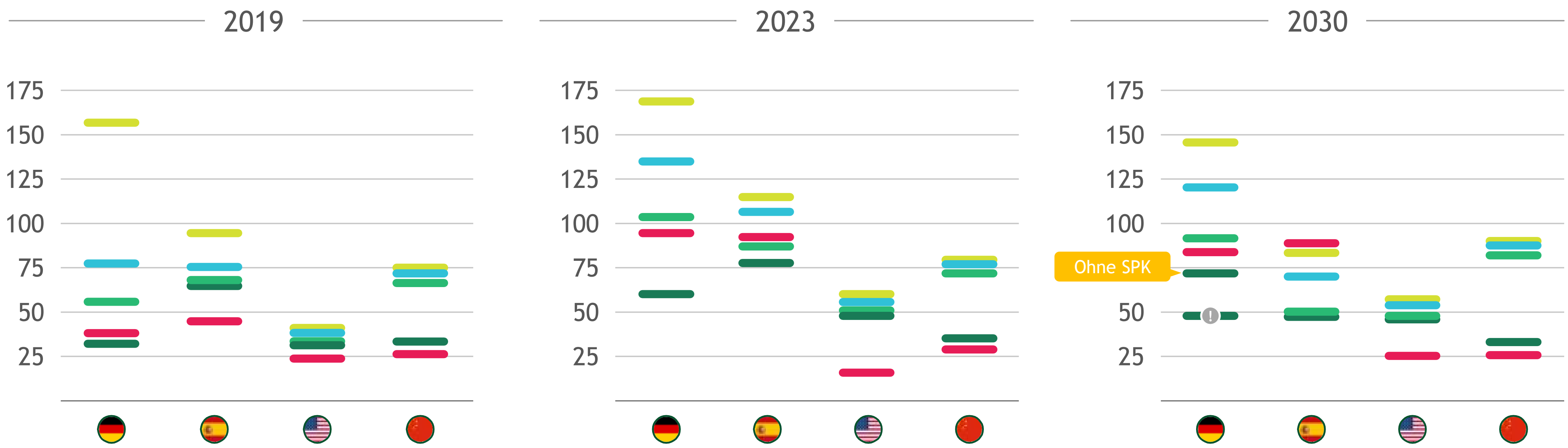
Funding sources

Electricity costs remain not competitive in 2030 in Germany for most consumers

Szenario unter Annahme aktueller Regulierung, Preisbildungsmechanismen & planmäßigem Netzaus- und Kraftwerkszubau

Electricity cost per group of consumers for 2019, 2023 und 2030

In €/MWh real 2023



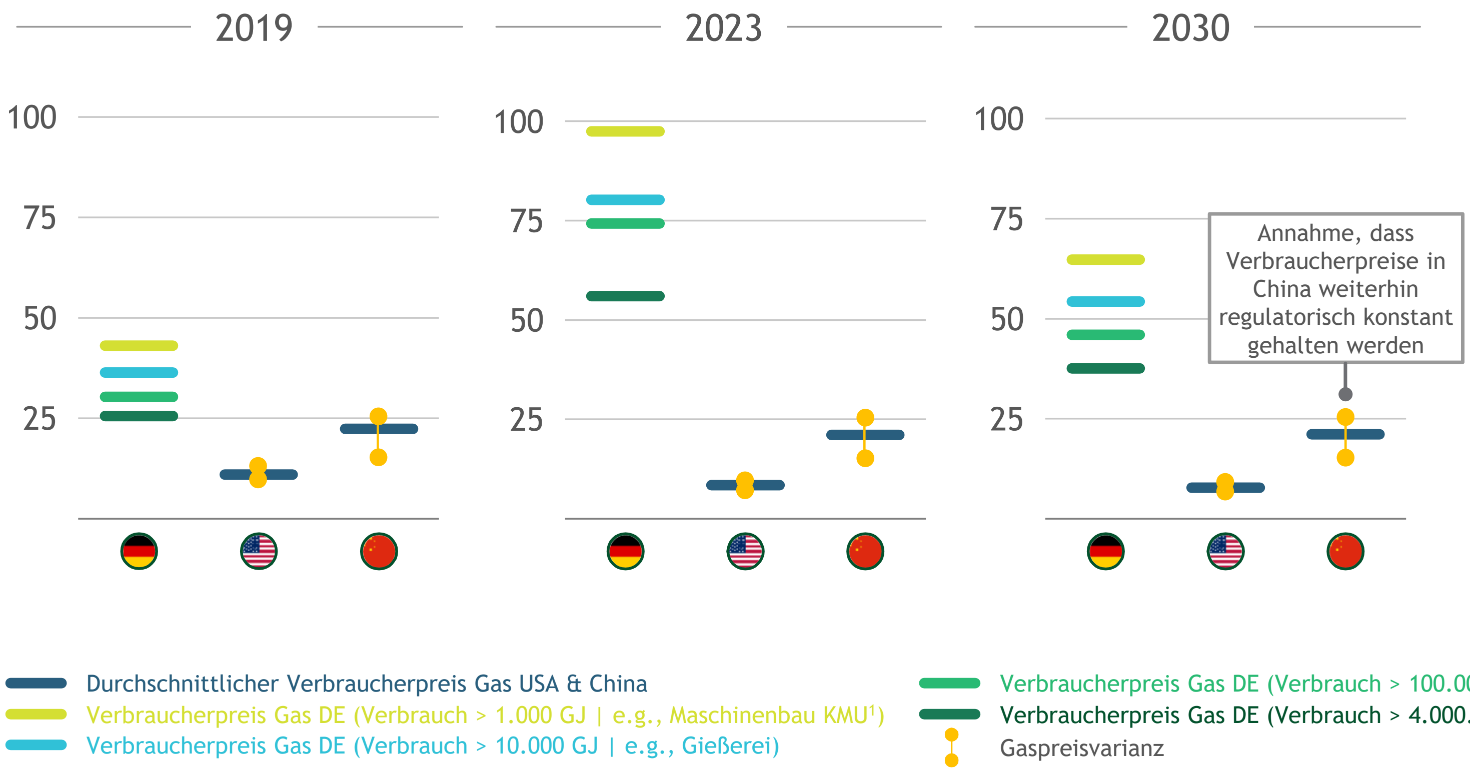
- Eigenerzeugung
- A Strompreis max. entlastete Verbrauchergruppe
- B Strompreis max. entlastete Verbraucher-gruppe ohne Strompreiskompensation
- C Strompreis durchschnittlich entlastete Verbrauchergruppe
- D Strompreis wenig entlastete Verbrauchergruppe
- ! SPK nach aktueller Regulatorik - evtl. CBAM-Einfluss nicht berücksichtigt

Hinweis zu China: Innere Mongolei als Vergleichsregion für maximal entlastete Verbraucher sowie 70% Eigenerzeugung angenommen, Guangdong für weitere Verbrauchergruppen ohne Eigenerzeugung; USA: Texas als Vergleichsregion für alle Verbrauchergruppen; Unter Annahme aktueller Preissetzungsmechanismen | Quelle: Aurora Energy Research; Eikon; BDI Projektteam

Gas prices stay 3-5 times higher in Germany compared to other countries Faktor 3-5

Gas prices per group of consumers for 2019, 2023 und 2030

In €/MWh real 2023



Beobachtungen

In 2019 hatten industrielle Verbraucher in Deutschland ähnliche Preise wie in China, und höhere Gaspreise als in den USA

Während der Energiekrise wurde in Deutschland günstiges russisches Gas durch teures LNG vom Spotmarkt ersetzt

USA profitiert von günstiger Eigenproduktion und China subventioniert Verbraucherpreise deutlich, um gestiegene LNG-Preise auszugleichen

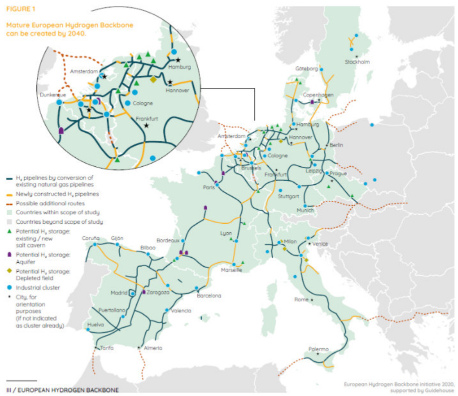
Auch in 2030 werden Verbraucherpreise in Deutschland 3-5x über den Preisen in USA und China liegen

1. KMU = Kleine und mittelständische Unternehmen | Hinweis: Preise in USA beziehen sich auf Texas, Bandbreite in China basierend auf Preisen in Guangdong und Innerer Mongolei | Quelle: Eurostat, Aurora, EIA, Henry Hub, World Energy Outlook, Wind, Projektteam

EU 2024plus - what remains to be done?

Complementing the Green Deal by an EU Industrial Deal – some elements

- Providing European infrastructure for industrial decarbonization (H2, CO2, electricity)
- Making licensing procedures radically more simple and faster (e.g. reversal of the burden of proof)
- Incentivising private investments for new production processes (CfDs…)
- Ensuring internationaly competitive power prices for industry (grid cost)
- Preventing carbon leakage – revisiting CBAM
- Changing EU energy taxation by giving carbon content a bigger weight
- Formulating a strategy for a carbon pricing architecture post 2030
- Creating markets for green products
- Designing an Art. 6 compatible carbon trading instrument (offsets)



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