Energy Perspectives 2030

Key results

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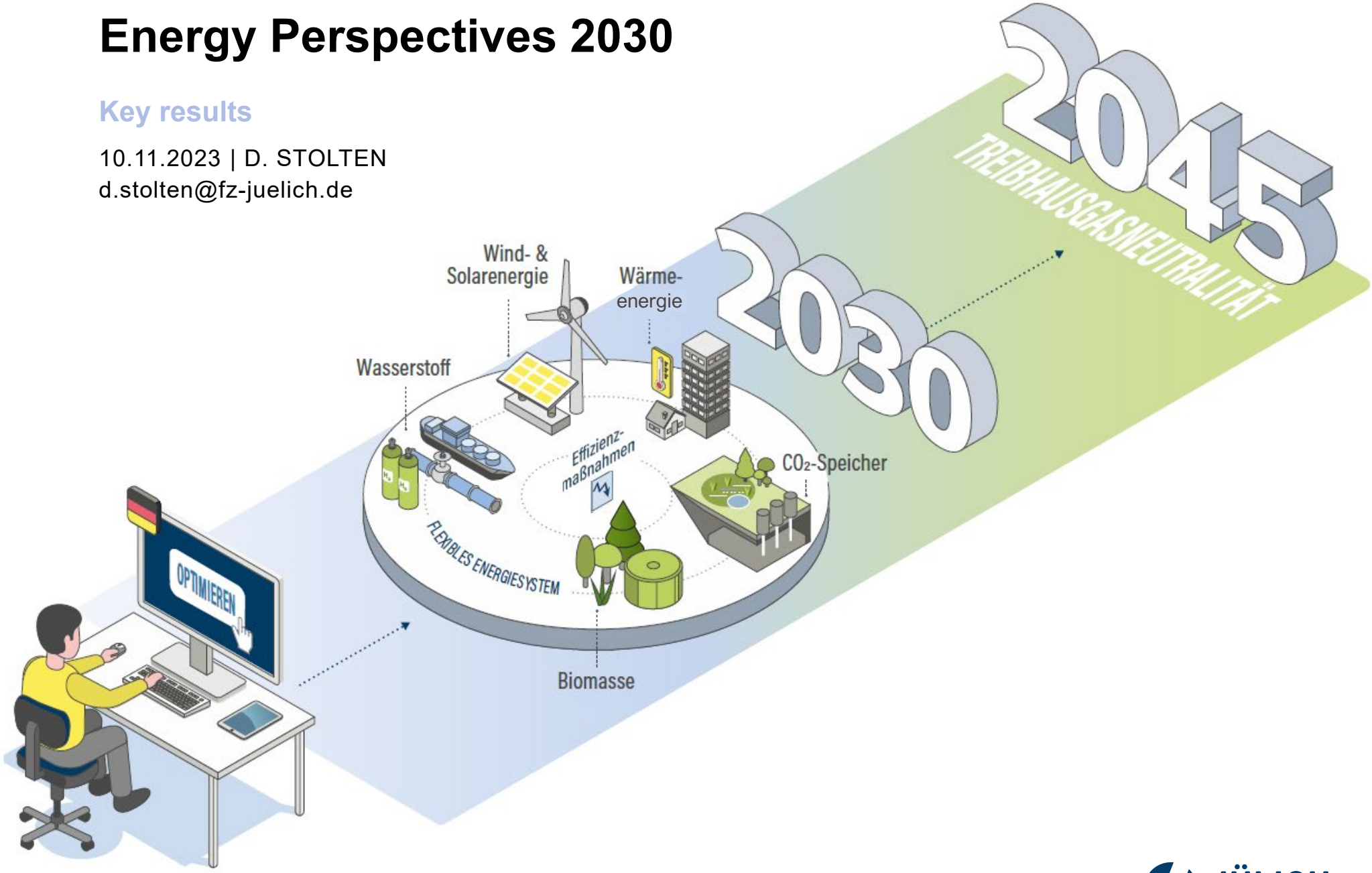
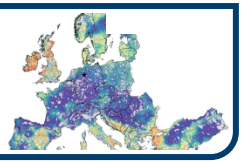


ETHOS: Energy Transformation PatHway Optimization Suite

Renewable Energy Resources

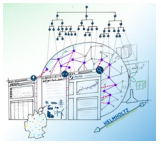


Electricity transmission & distribution grids

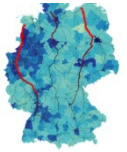
Societal feasibility

Gas transmission grid

Technology Database

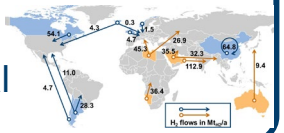


H_2 and PtX Infrastructure

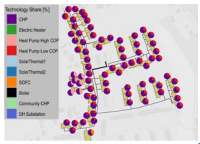


Buildings

H_2 global

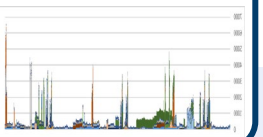


Districts

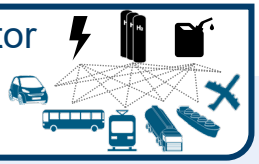


Activity-based transport demand

From demand to load profile

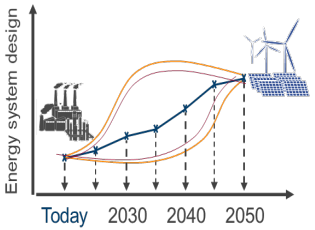


Transport sector
– Passenger
– Freight



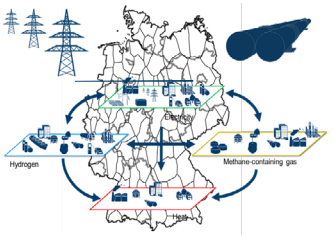
Integrated Hourly Optimization

Single-node



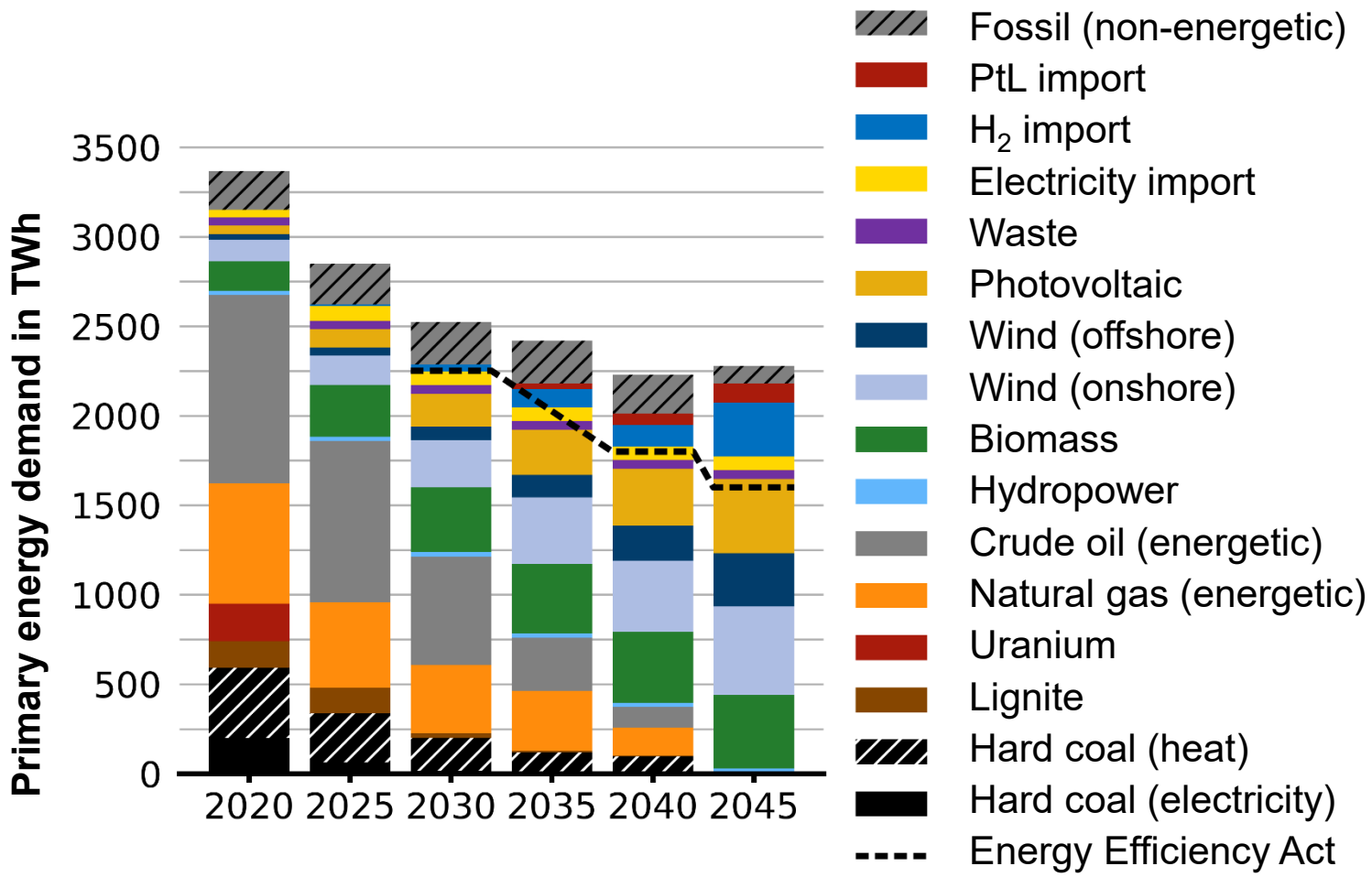
Cost-optimized energy systems

Multi-node



Regionalized via **local demand and infrastructure**

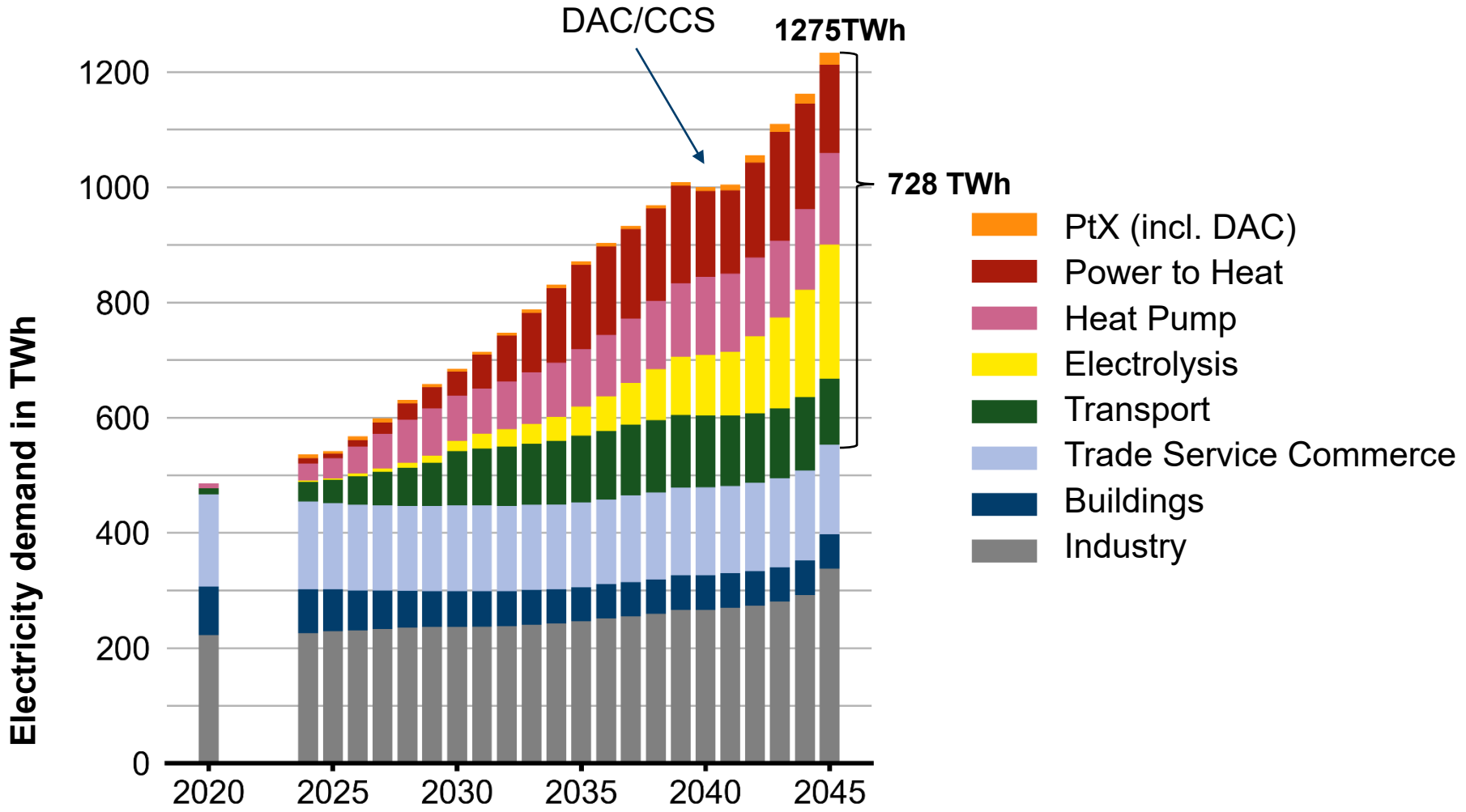
Primary Energy Demand



► Energy import quota falls from 69% in 2022* to 26% in 2045
► Cost-optimal scenario does not achieve the targets from the Energy Efficiency Act with economic and population growth

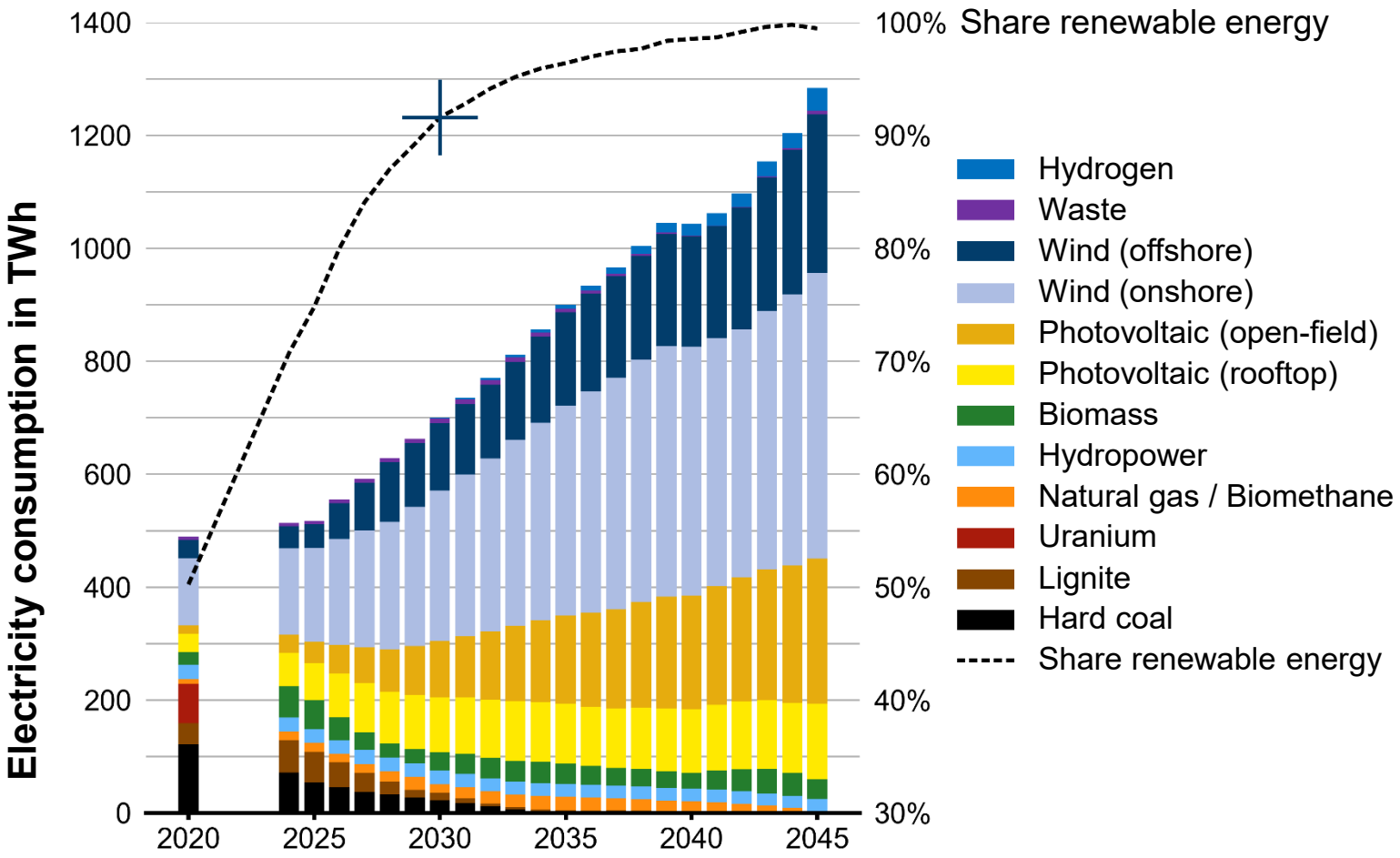
* AGEB: Bilanz 2022, https://ag-energiebilanzen.de/wp-content/uploads/2023/04/AGEB_Infografik_04_2023_Importabhaengigkeit_2022.pdf

Electricity Demand



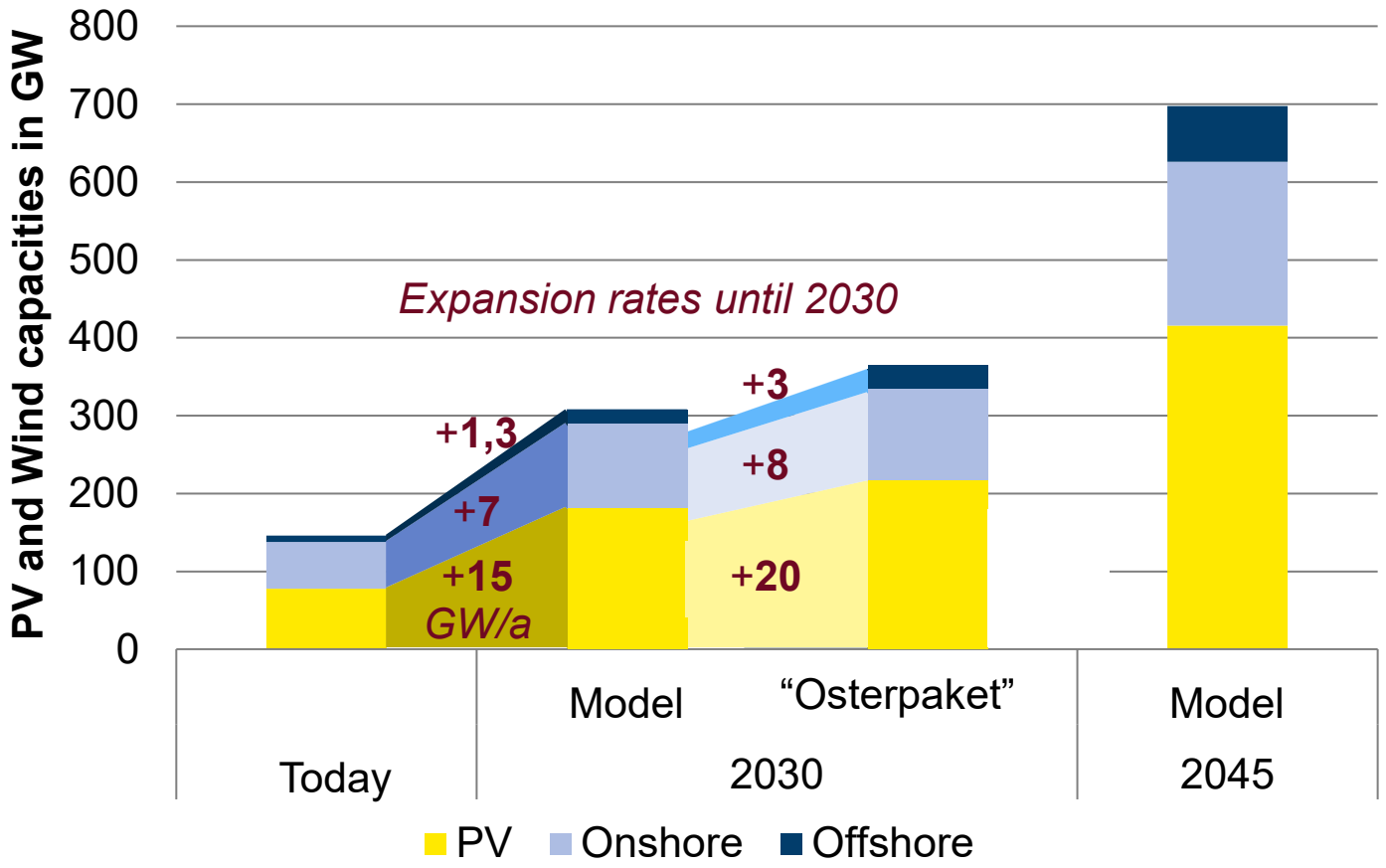
- Despite implementation of efficiency measures, electricity consumption increases by 25% until 2030
- By 2045: electricity consumption increases to 1275 TWh due to sector coupling

Electricity Consumption



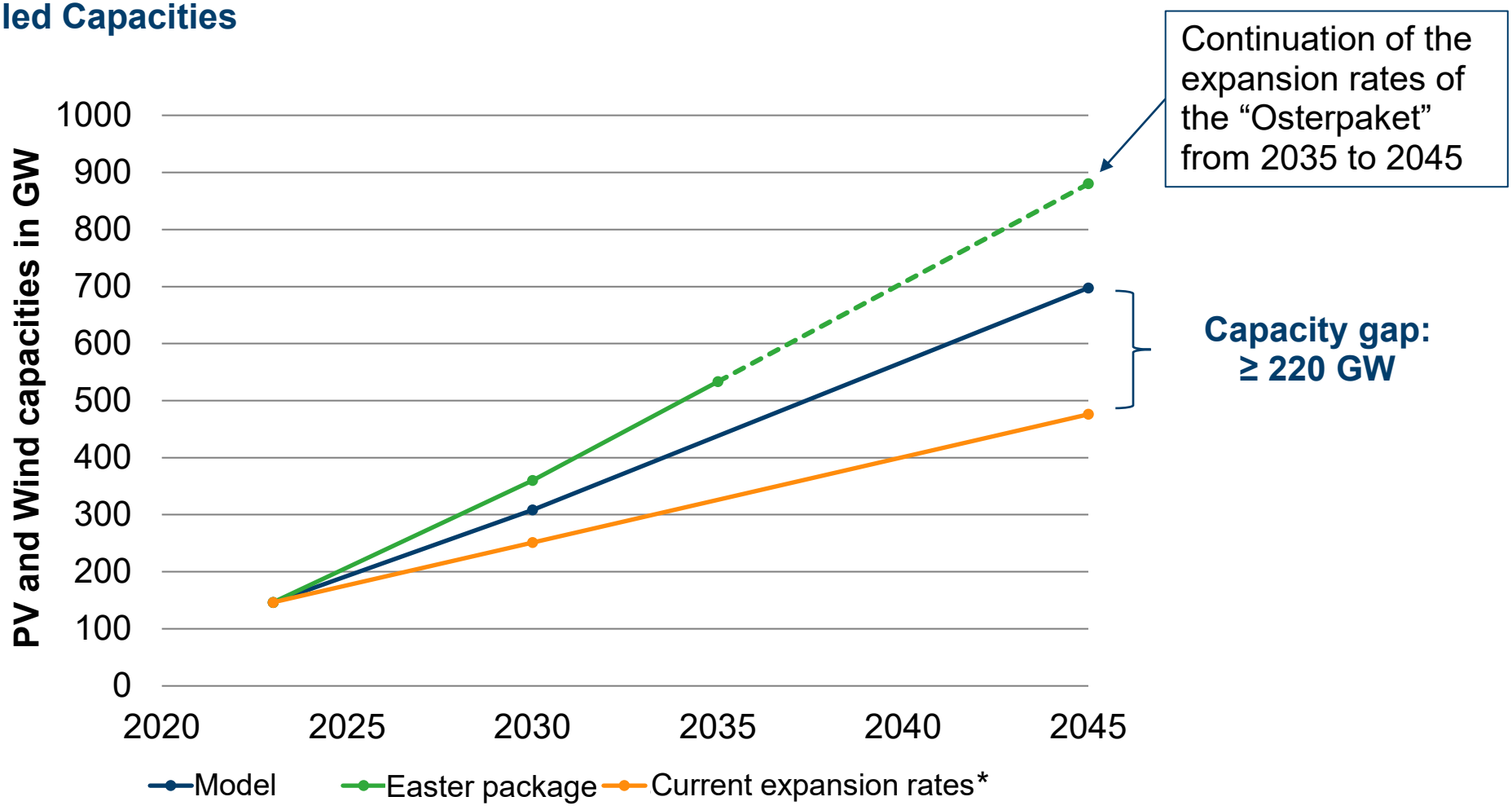
- By 2030: Share of renewables increases to >90% - key prerequisite for sector coupling
- Wind energy with over 60% share of electricity generation in 2045

Installed Capacities



- Cost-effective energy efficiency: expansion of PV and wind energy slightly below the “Osterpaket”
- Nevertheless, doubling of today's installed capacity by 2030 necessary

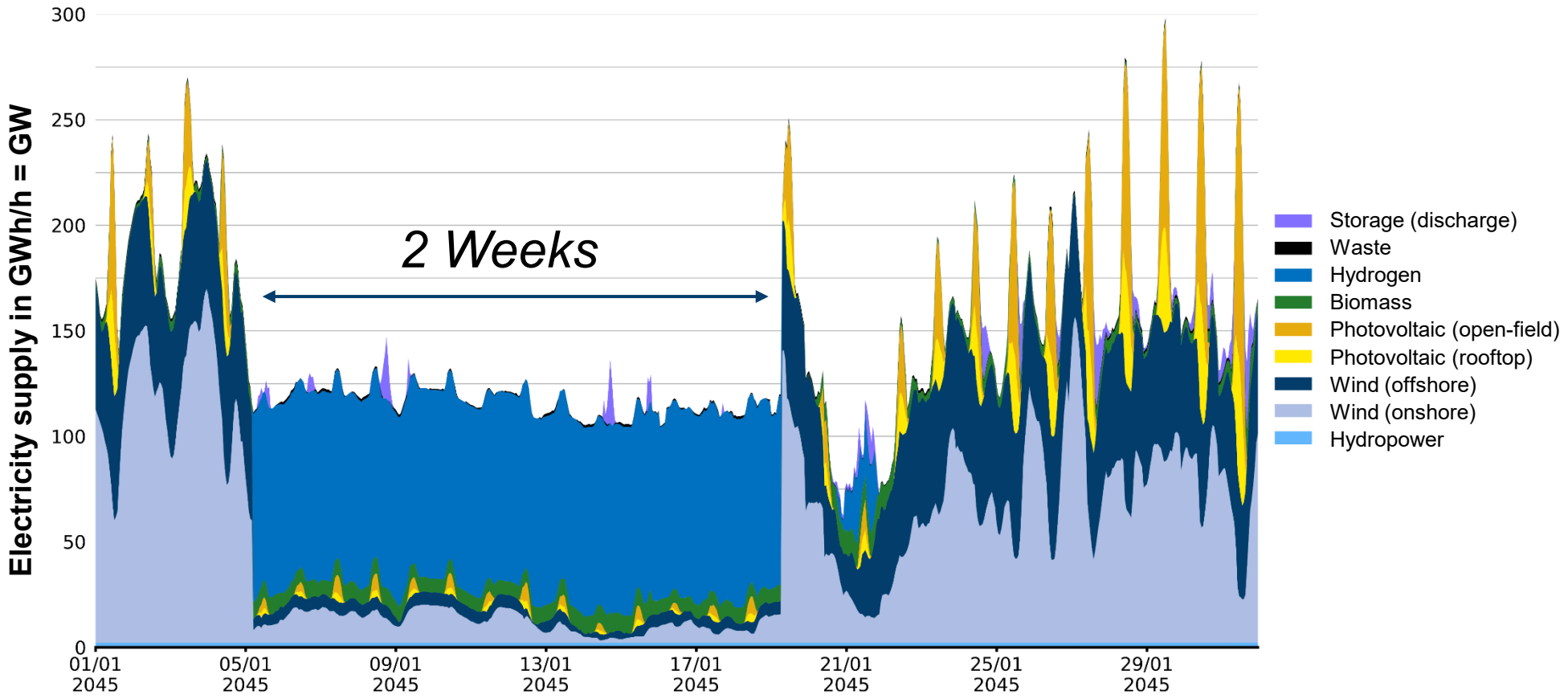
Installed Capacities



* PV: 12,5 GW/a; Wind Onshore: 1,9 GW/a; Wind Offshore: 0,6 GW/a

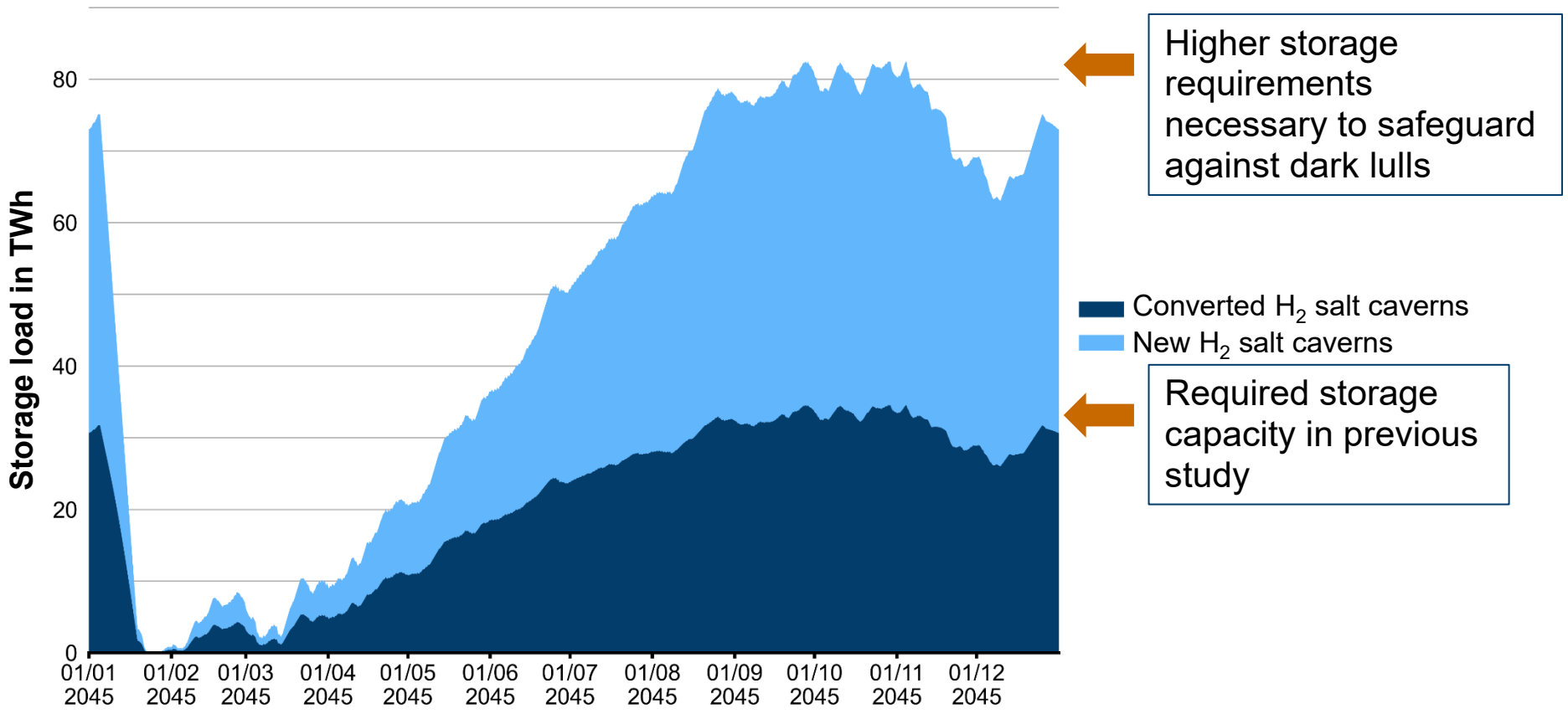
► With the current expansion rates for PV and wind, capacities of at least 55 GW will be missing in 2030

Dark Lull in 2045



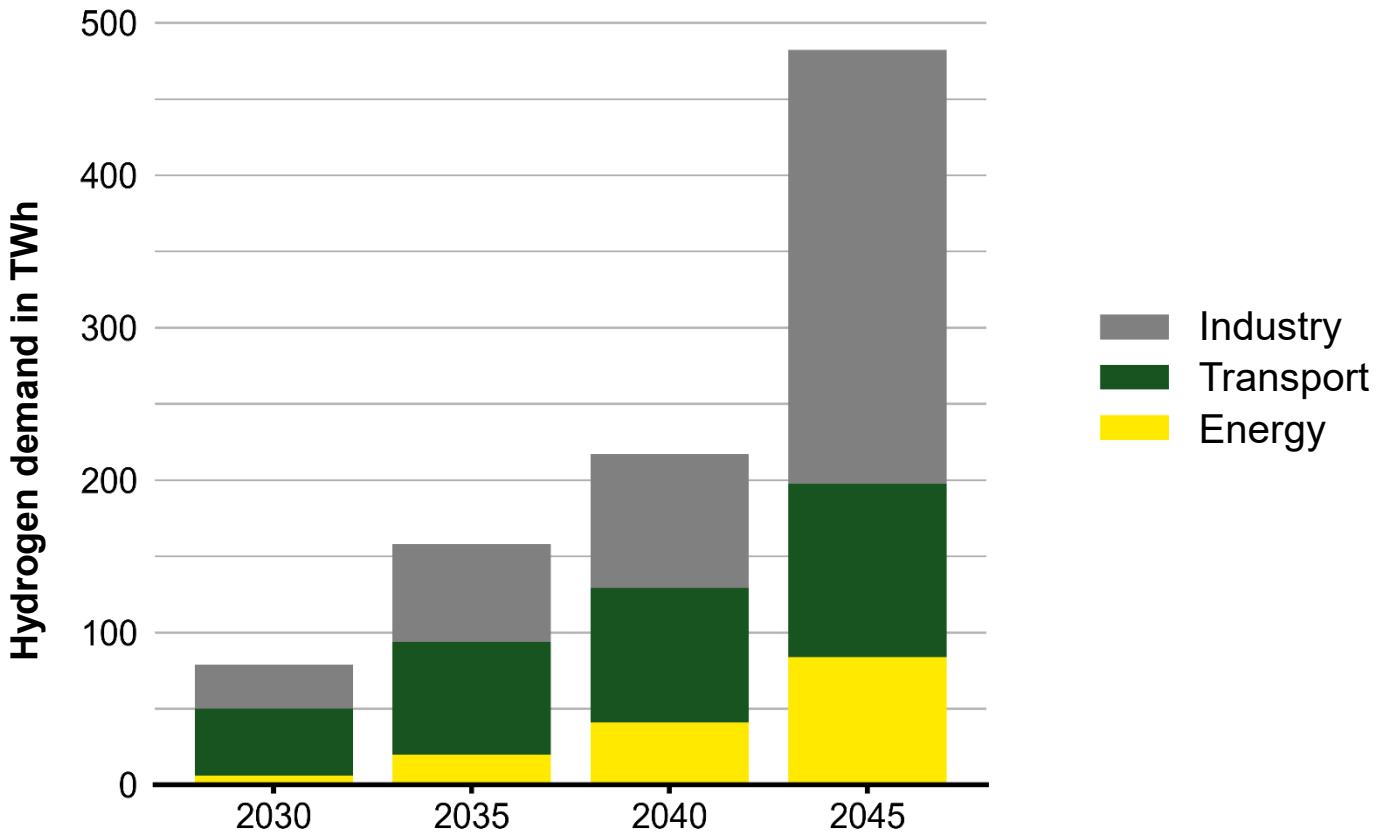
- 2030: 6 GW | 2045: 90 GW H_2 gas turbines required to bridge the dark lulls
- 90% share of H_2 in bridging the dark lulls

Hydrogen for Seasonal Storage in 2045



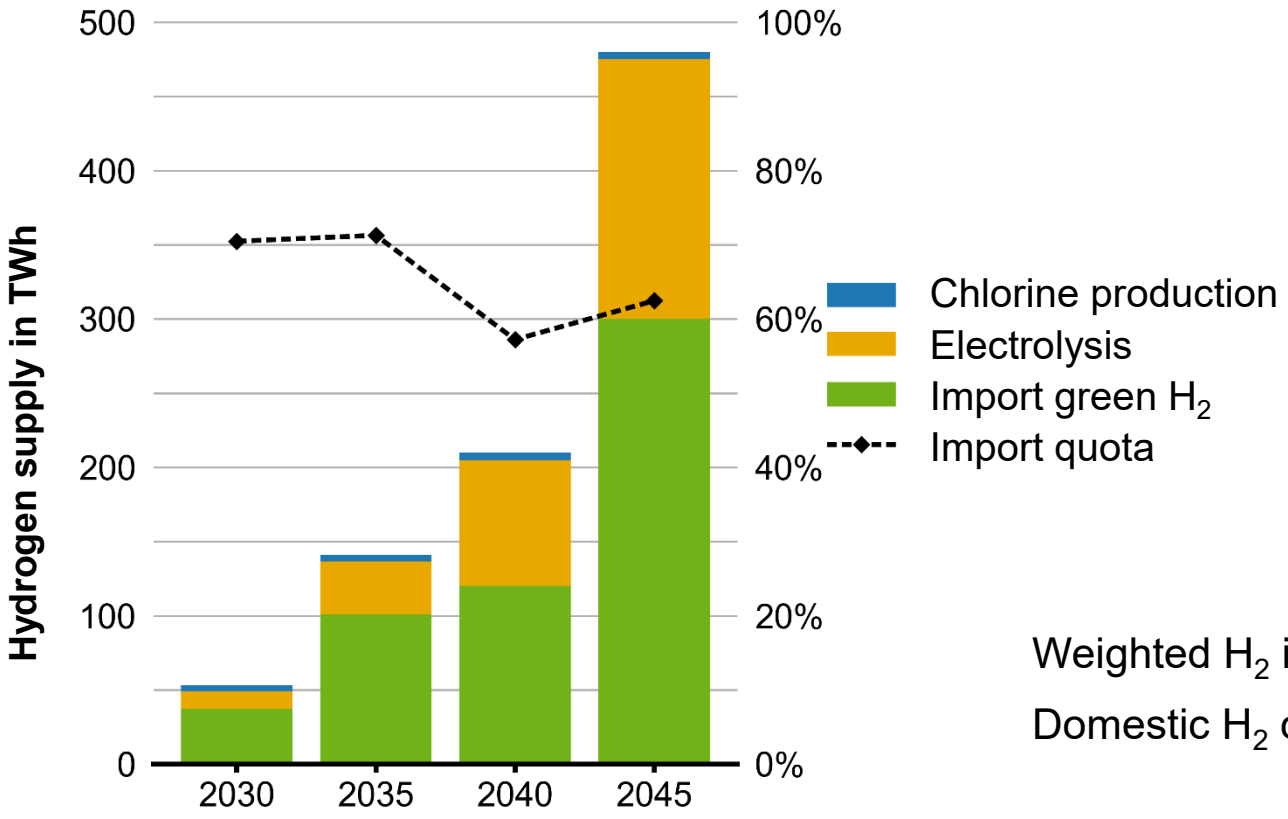
- By 2030: Conversion of existing natural gas caverns (5 TWh H_2), 16% of convertible caverns
- H_2 storage in salt caverns with approximately 82 TWh storage capacity in 2045

Hydrogen Demand



- Demand for hydrogen will already reach 80 TWh - 2.4 million tons in 2030
- Increase to 482 TWh in 2045, with 60% consumed in industry

Supply of Green Hydrogen



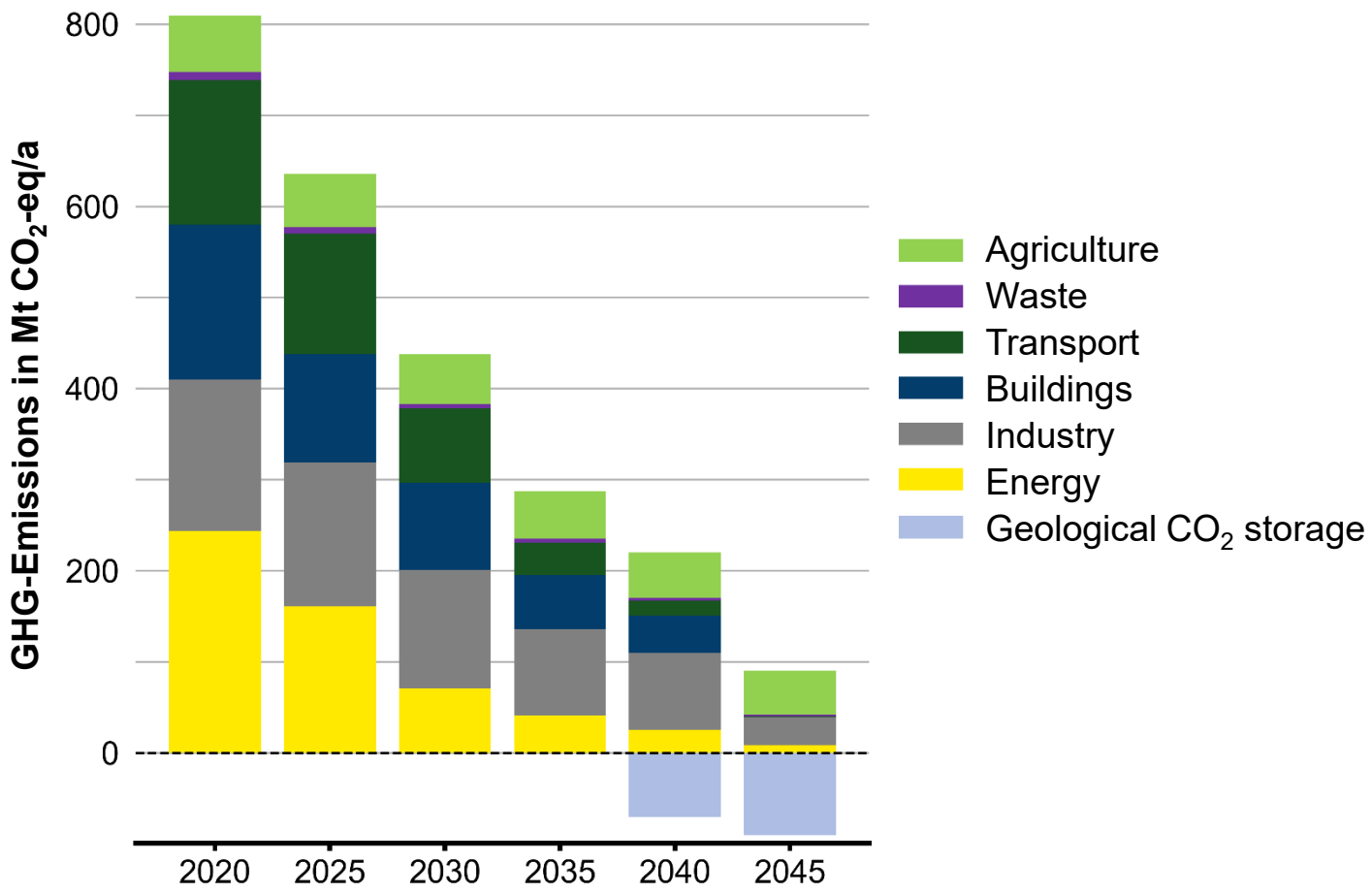
Origin	Import 2045
Netherlands	32 TWh
Denmark	41 TWh
Norway	76 TWh
Spain	76 TWh
Morocco	76 TWh

Weighted H_2 import costs: 2,1 €/kg in 2045

Domestic H_2 costs: 3,2 €/kg in 2045

- Cost-efficient import share of 70% in 2030 - corresponding import paths necessary
- Most cost-effective import option via pipeline from Europe + North Africa

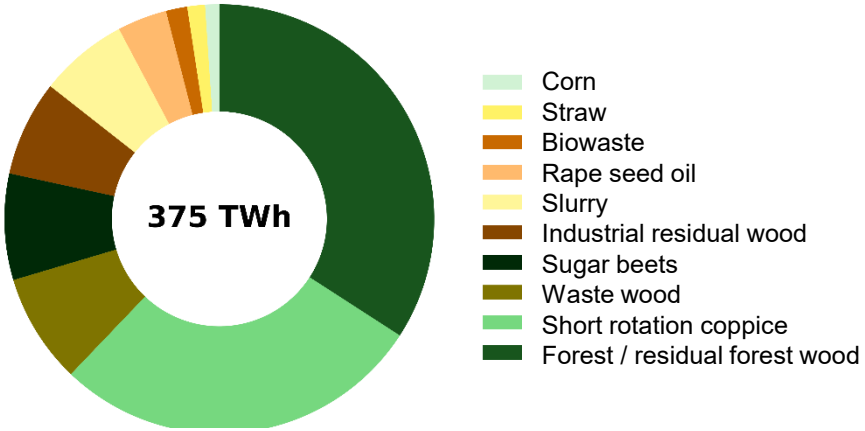
Greenhouse Gas Emissions



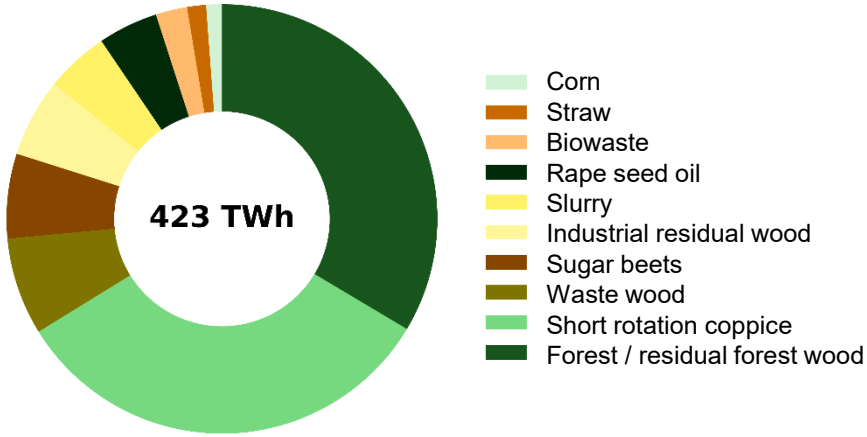
- By 2030: emissions reduction of 72% compared to 2022 in the energy sector enables sector coupling
- By 2030: create framework conditions for permanent CO_2 storage

Bioenergy

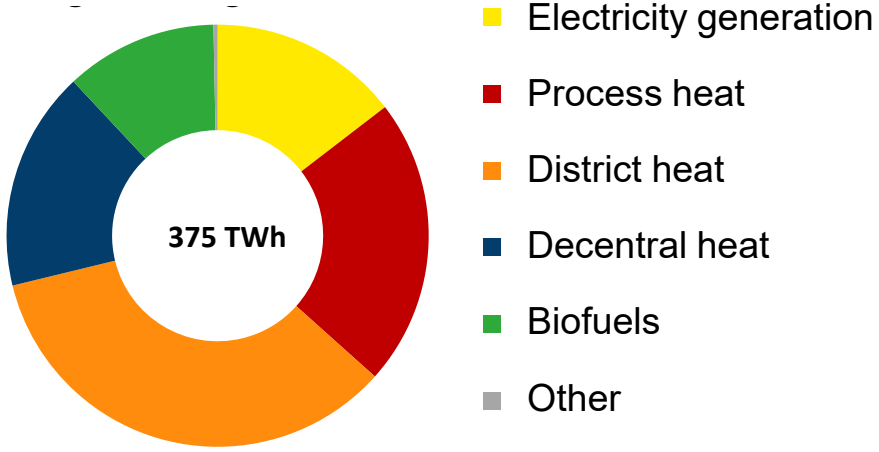
Bioenergy supply in 2030 in TWh



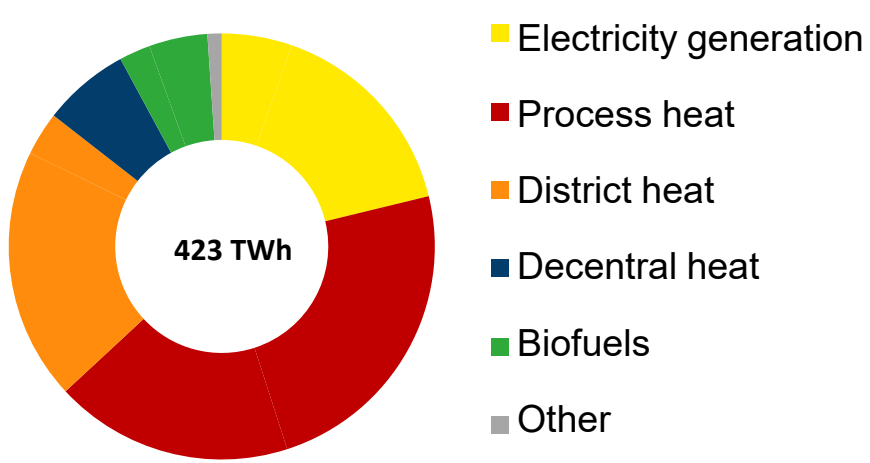
Bioenergy supply in 2045 in TWh



Bioenergy demand in 2030 in TWh

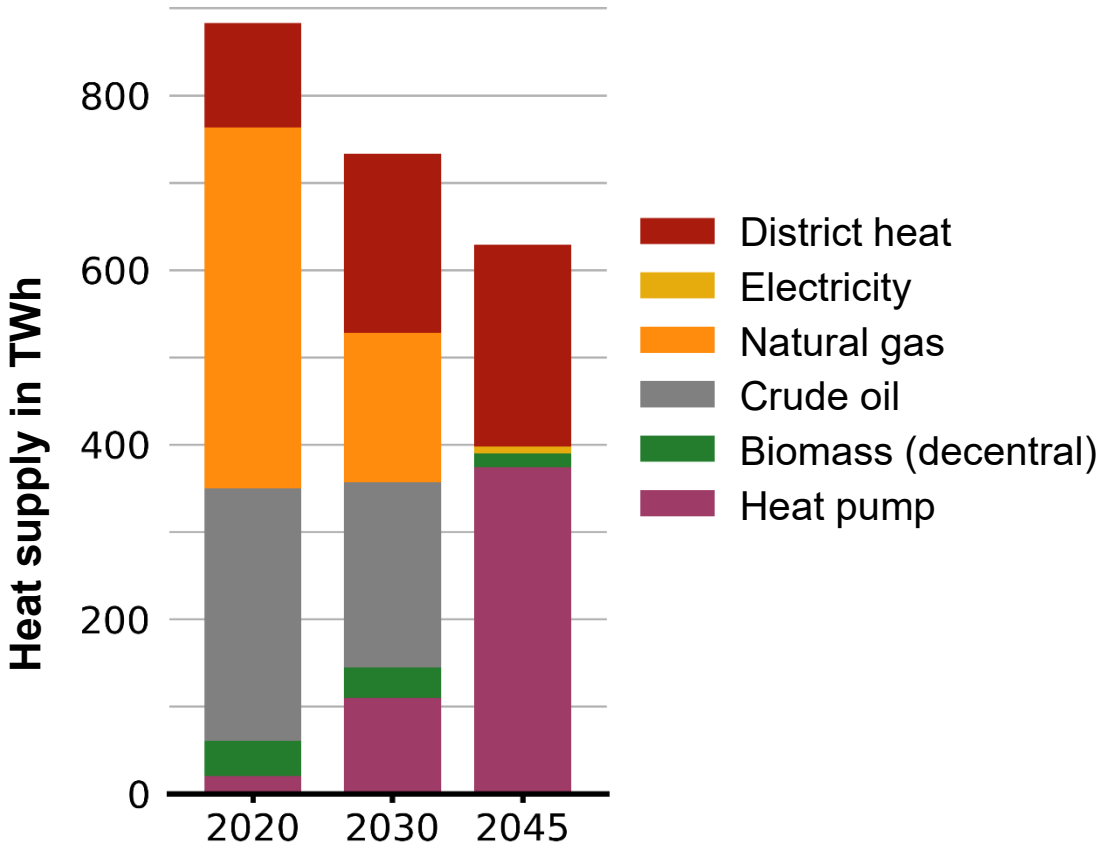


Bioenergy demand in 2045 in TWh



- By 2030: Increase the utilization of biogenic waste and residuals
- Increase sustainable cultivated area - taking the food chain into account

Heat Supply for Room Heating and Hot Water



- Expansion of heat pumps as a key measure for the heating transition
- Sensible: 1. building refurbishment; 2. replacement of fossil fuel boilers with heat pumps

At a Glance

Measures until 2030

Biomass utilization	**375 TWh**
Average energetic refurbishment rate	**2%**
Average expansion rate of onshore wind power	**7 GW/a**
Average expansion rate of photovoltaic	**15 GW/a**
Hydrogen gas turbines	**6 GW**
Conversion of natural gas salt caverns	**16 %**

Setting the course for beyond 2030

Create legal framework for CO_2 storage	until 2045: **90 Mt CO_2/a**
Flexible operation of heat pumps and electrolysis	**Dark lulls**

Additional costs of transformation over 22 years	**816 bn. €**

- ► **Transformation is technically and economically feasible**
- ► **Implementation of important measures and course-setting essential until 2030**

Thank you for your attention