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ENERGY RESEARCH

Energiewende im europäischen Stromsektor - Trends und Perspektiven

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Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

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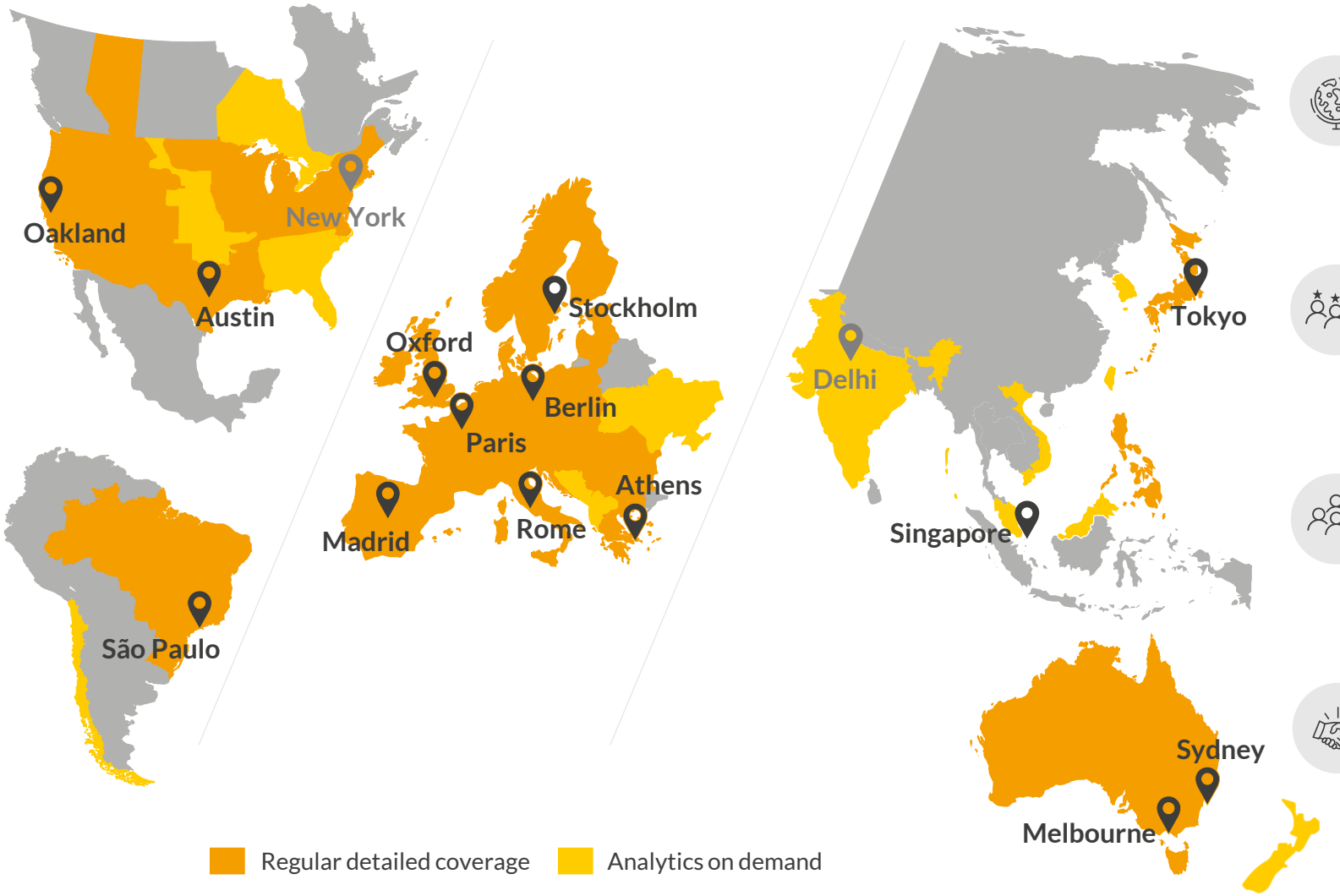
- Power markets
- Renewables & PPAs
- Storage
- Grid & Congestion
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



14 offices
and two more coming soon

600+
market experts

850+
subscribing companies

150+
transactions supported in 2023

Source: Aurora Energy Research

2023 was the year in which renewables have finally become the most important energy source for electricity generation in the EU

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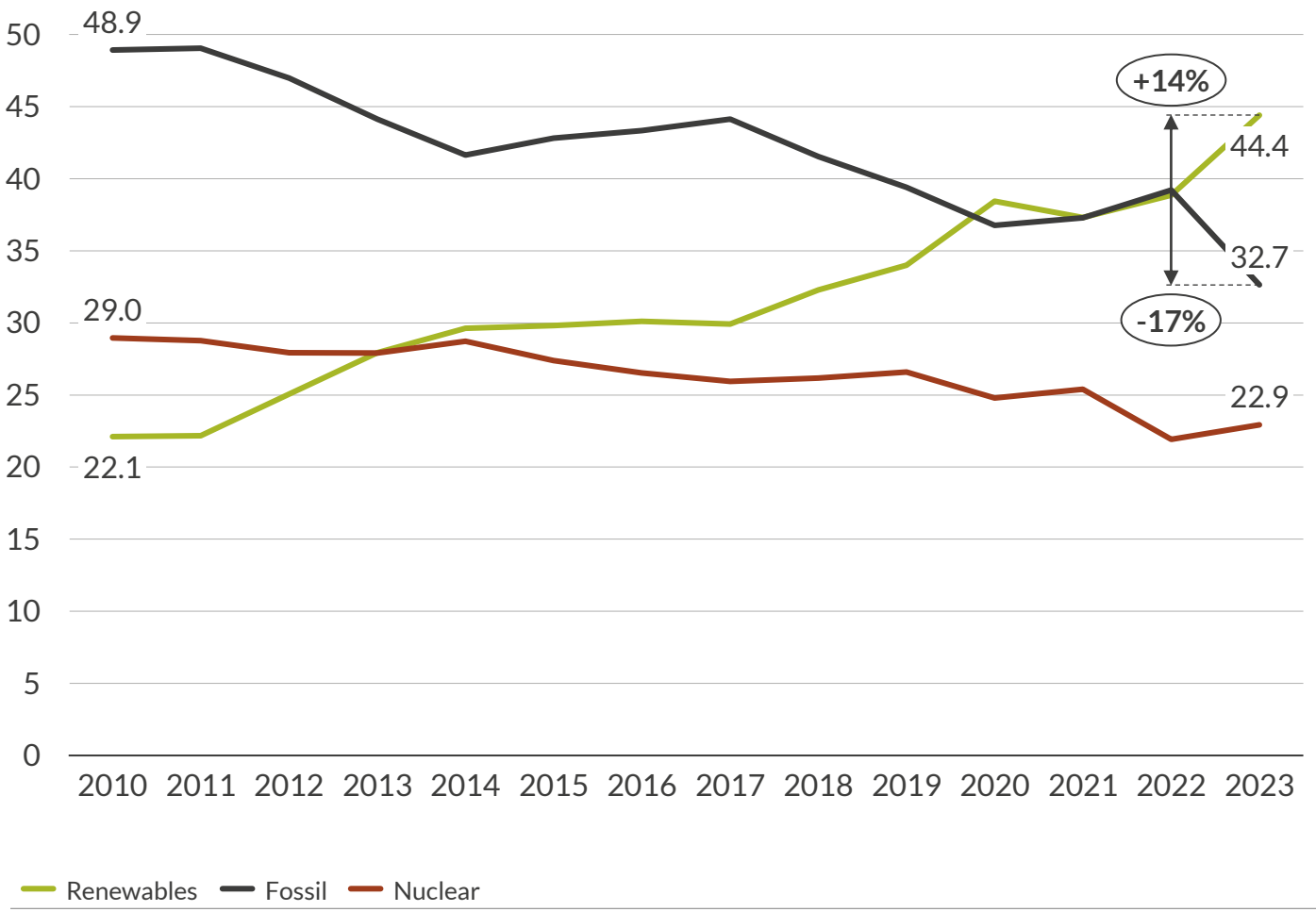
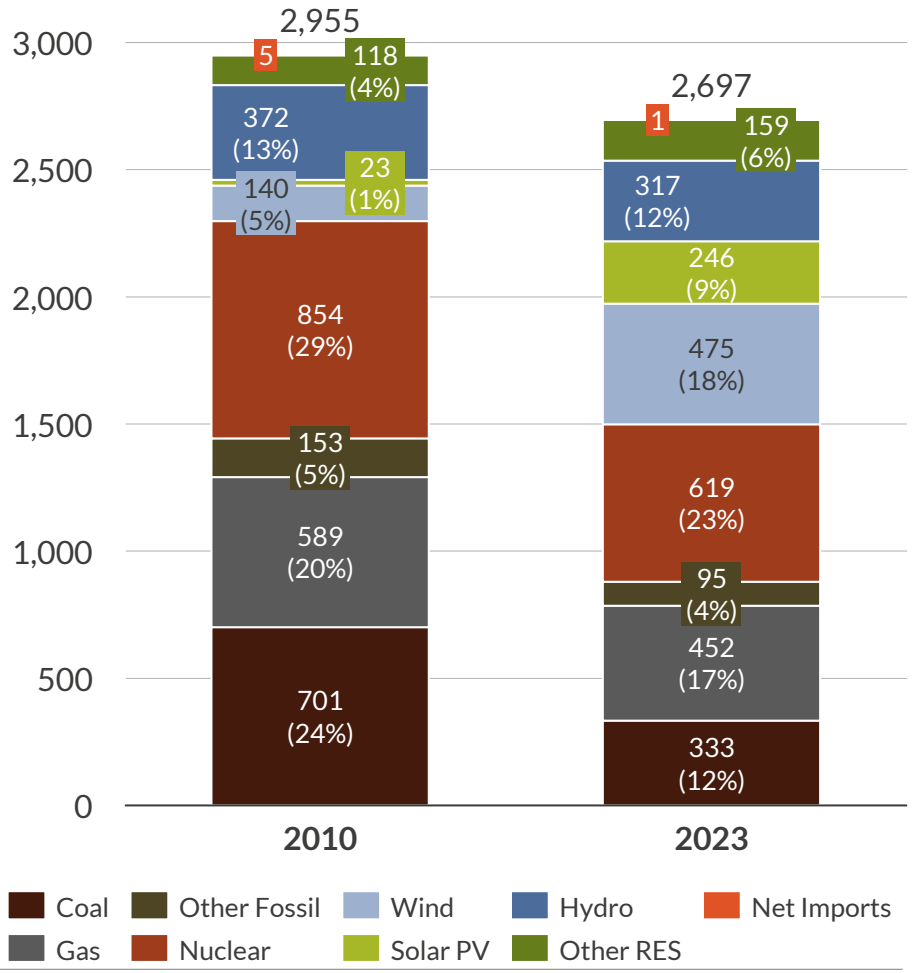
Power generation share by type of energy source in the EU27

%



Total power generation in the EU27 by type of energy source

TWh



Sources: Ember, Aurora Energy Research

2023 was the year with the highest year-on-year reductions in fossil power generation and power sector CO_2 emissions in the EU

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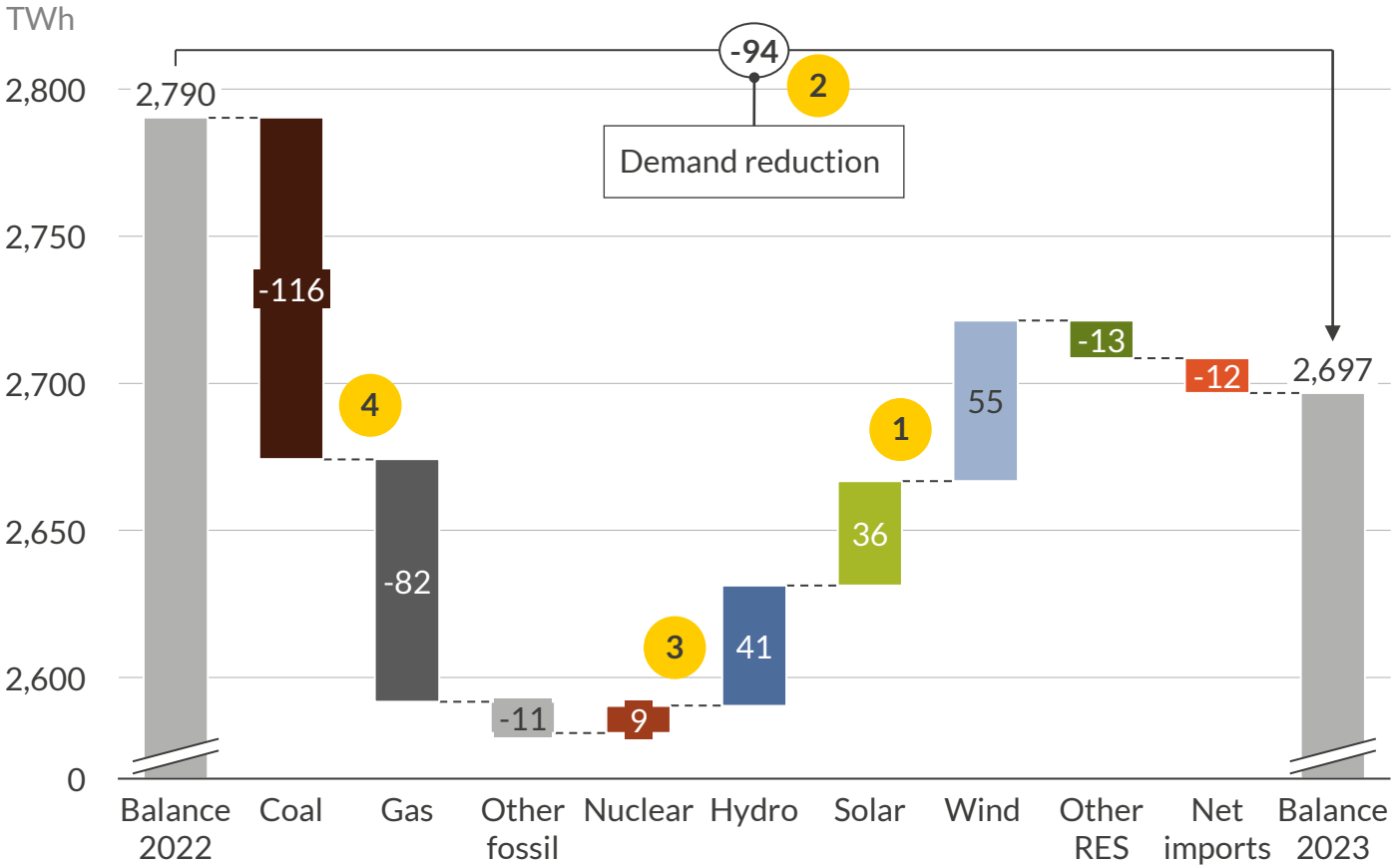
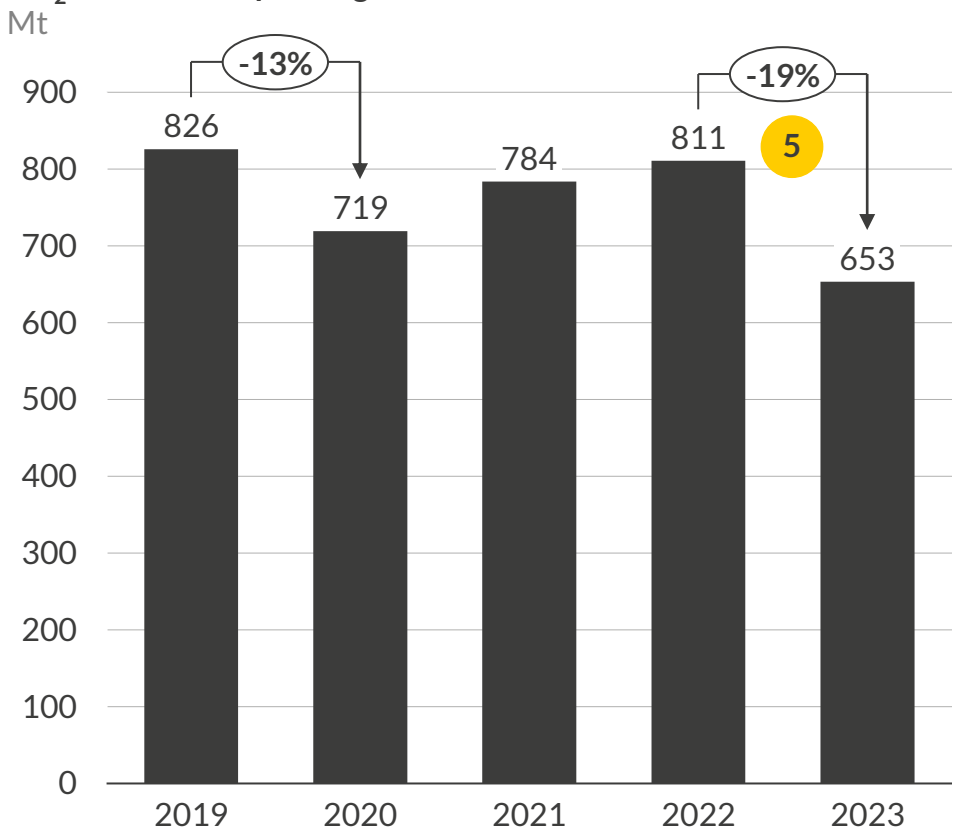
A **strong increase in renewable power** generation and a **reduction in power demand** were the drivers behind a **record decline in fossil power** generation, which…

…led to a **record fall in CO_2 emissions of power generation.**

Annual change in EU power generation by technology



CO_2 emissions of power generation in the EU



Main developments

Sources: Ember, Aurora Energy Research

Fossil power generation in Q4 2023 was lower than in Q4 2022 despite higher demand because clean power output rose by 68 TWh

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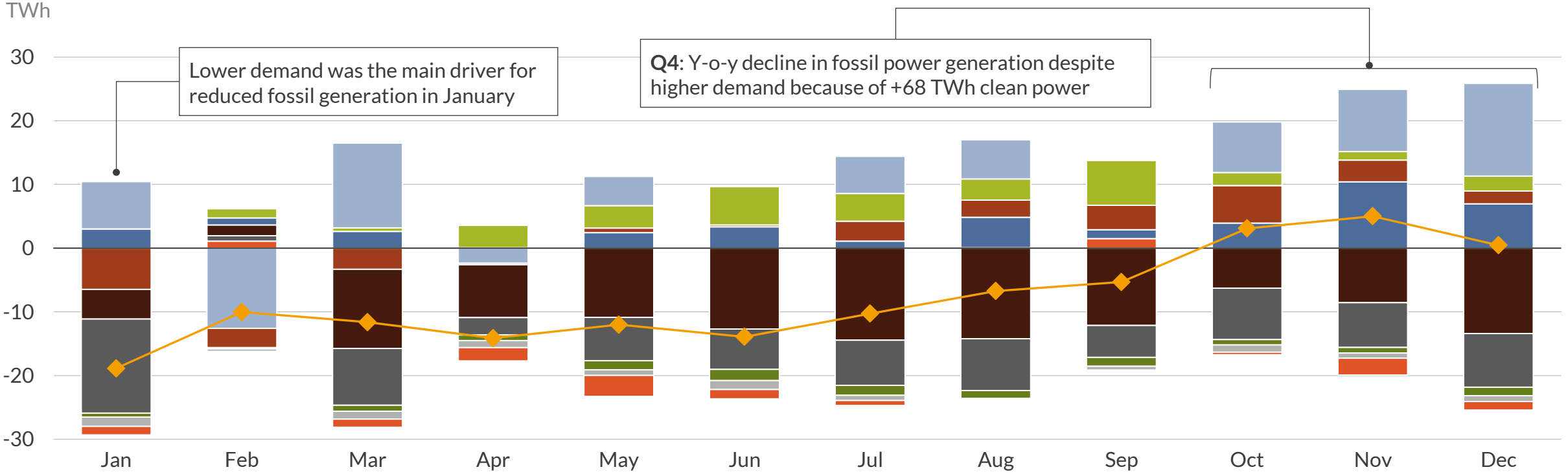
Monthly year-on-year change in EU power generation and demand, 2023 vs. 2022

TWh



- Except for February, monthly **fossil power generation remained consistently below 2022 levels**.
- In the **beginning of the year**, **lower demand** was the **main driver for reduced fossil power generation**. But even **in Q4**, in which **demand rose above the previous year's level**, **fossil power generation was still significantly lower than in Q4 2022 due to a strong increase in clean power generation**.

Demand | Wind | Solar PV | Nuclear | Hydro | Coal | Gas | Other renewable | Other fossil | Net imports

Sources: Ember, Aurora Energy Research

Europe[1] has set ambitious renewable targets by 2030, requiring almost a tripling of renewable installed capacity relative to 2023

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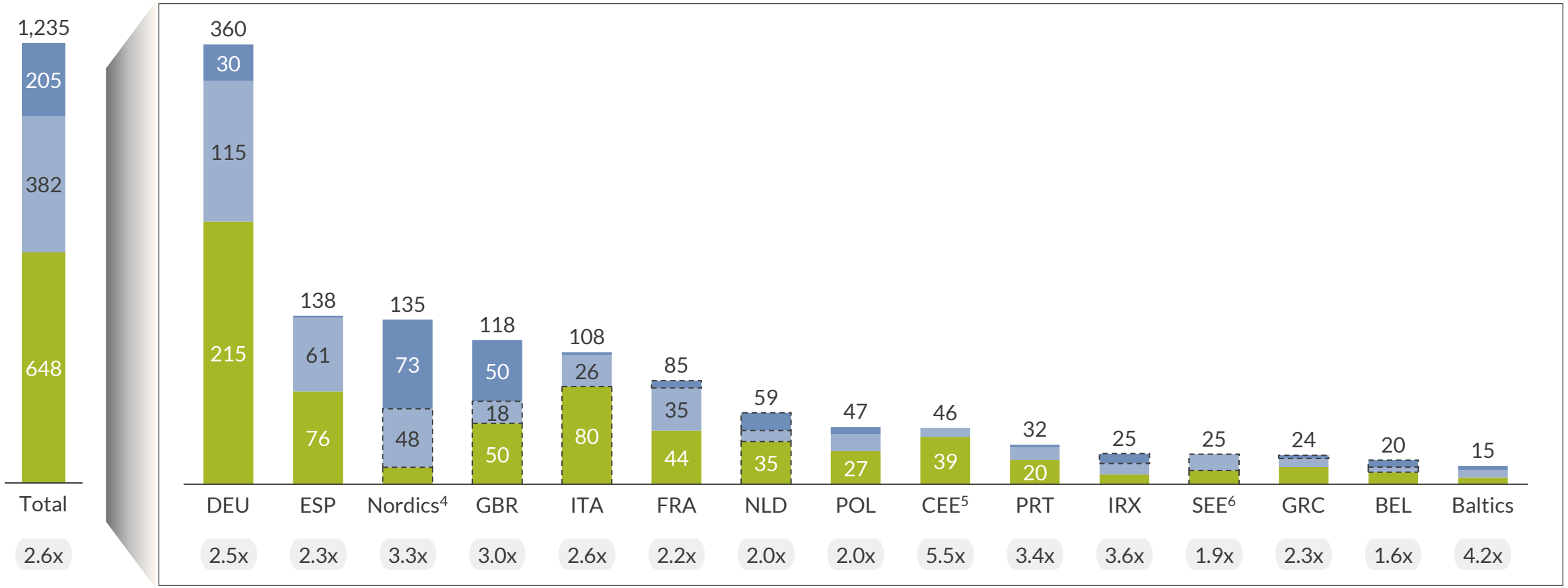
Target RES[2] installed capacity by 2030[3]
GW



1) Europe here includes the EU27, GB, CHE, NOR & SRB but excludes LUX, CZE, SVK, MLT & CYP. 2) Renewables. 3) National Energy and Climate Plans (2020) or 2023 drafts where available at the time of the analysis. 4) Capacity targets based on Nordic TSO forecast and announced offshore wind tenders. 5) Central Europe (AUT, CHE, HUN & SVN). 6) Southeastern Europe (BGR, HRV, ROU & SRB). 7) Estimated based on draft targets, announced targets in TWh and/or relevant Aurora assumptions where applicable.
Sources: Aurora Energy Research, European Commission, RTE, Nordic TSO, NECPs, National energy strategies

Aurora's forecasts assume that 2030 targets are not met; the path towards Net Zero requires a further acceleration of RES deployment

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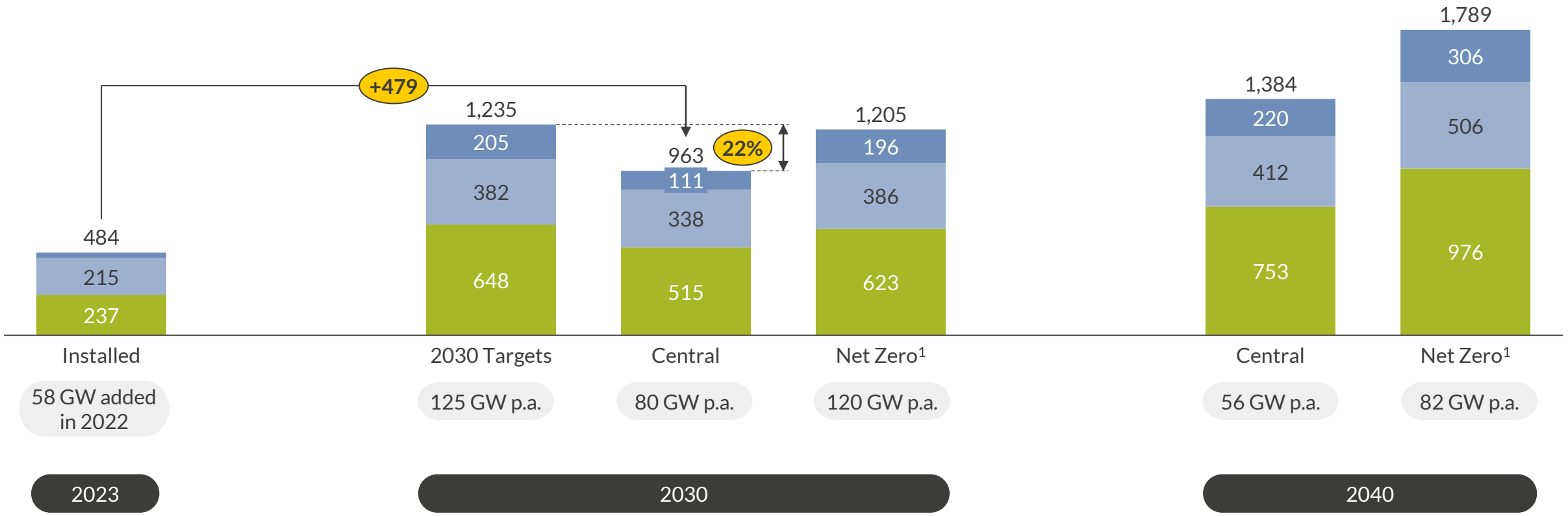
Installed RES capacity across Europe by Aurora scenario
GW



1) For markets where Aurora does not model a separate Net Zero scenario: Nordics and Baltics are assumed to meet 2030 goals, CHE and AUT use Central which approaches Net Zero.

Source: Aurora Energy Research

There are several challenges in achieving Net Zero ambitions, but grids are becoming the key bottleneck

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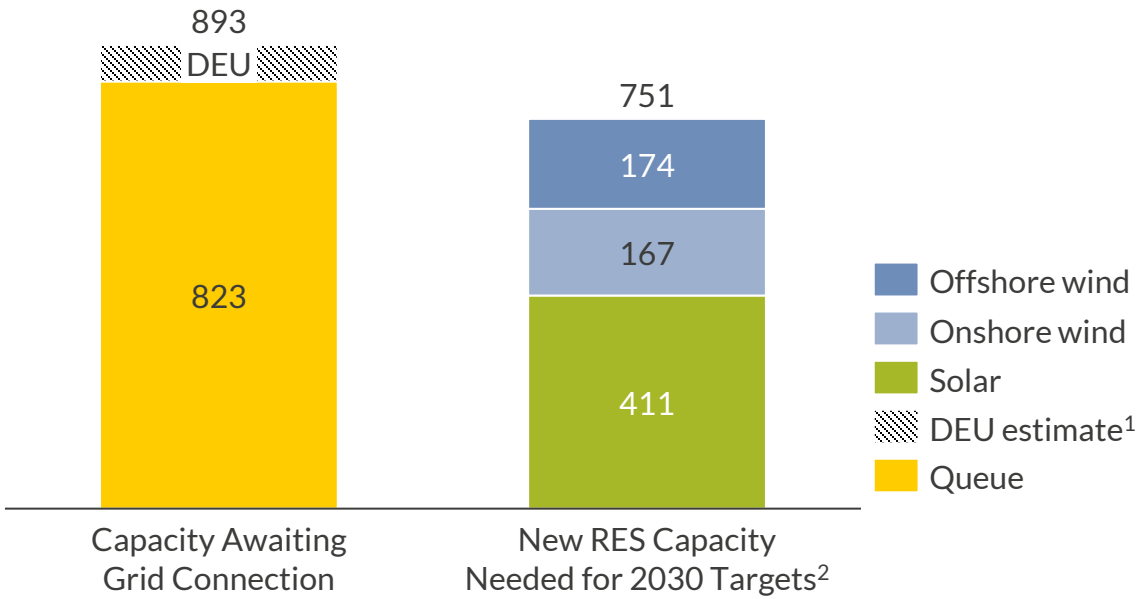
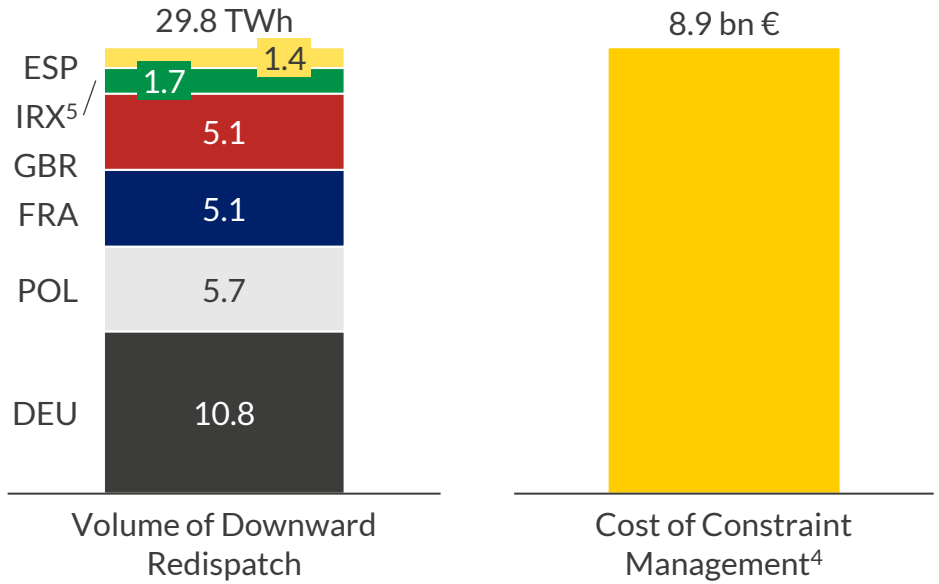
Grid connections

Queued RES capacity vs. required buildout in Europe
GW



Grid operability

Constraint management measures in 2023[3]
TWh and bn €



Other challenges (non-exhaustive)

- Security of supply concerns
- Capital cost and availability
- Regulation and market design
- Supply chain capacity and availability
- Permitting and site availability
- RES cannibalisation

1) Estimate for DEU based on onshore and solar buildout plan until 2026 minus pre-registered capacity. 2) RES capacity for 2030 for all Europe, capacity queue for GBR, France, Germany, Poland, Italy, Spain, and Portugal. 3) Based on downward dispatch actions reported by individual TSOs in most congested grids. 4) For the 6 displayed countries.

Source: Aurora Energy Research

Power demand in Europe[1] is expected to rise due to electrification of heat, transport & industry as well as H_2 production

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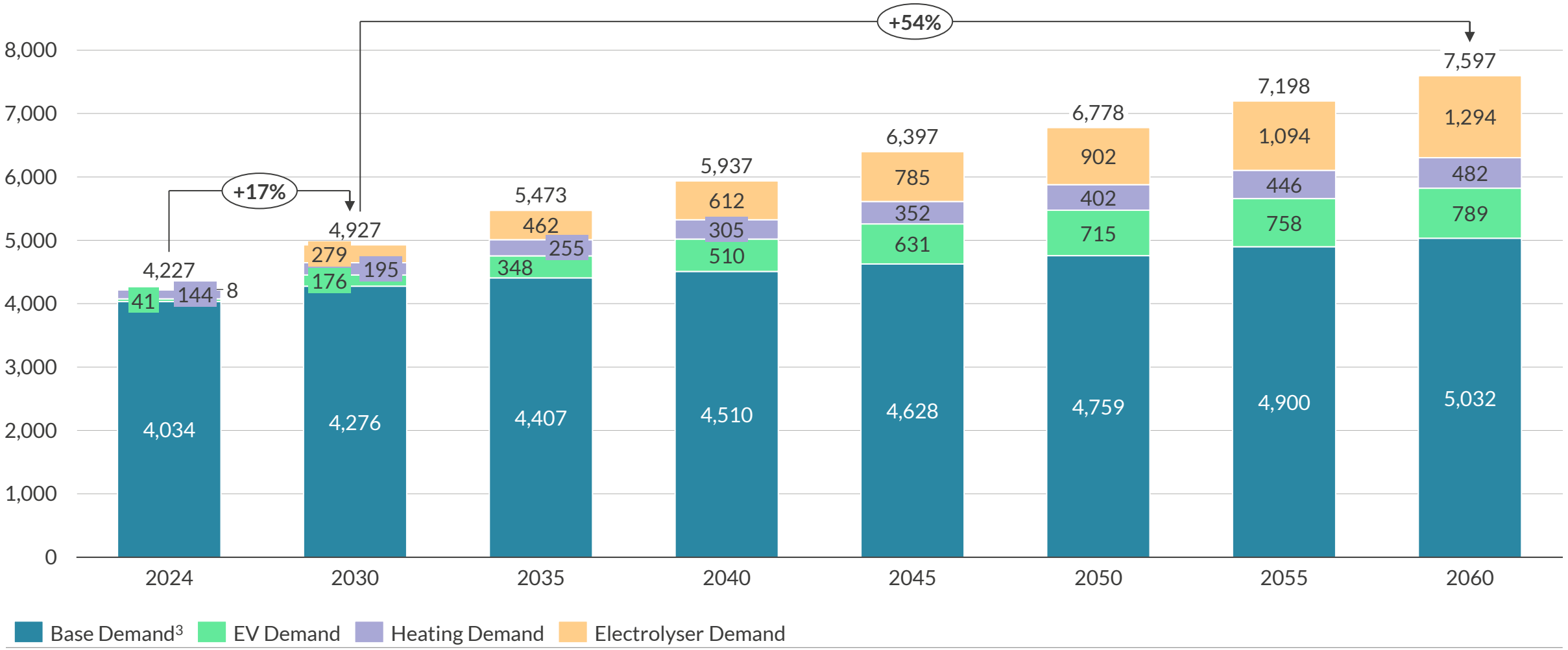
Net annual power demand by type[2] – Aurora Central scenario

TWh



1) Europe here includes the EU27, GB, CHE, NOR & SRB but excludes LUX, CZE, SVK, MLT & CYP. 2) Net power demand includes sectoral demand as well as transmission losses. Power plant self-consumption and demand from efficiency losses of storage are excluded. 3) Underlying base demand from industry, households, commerce and transport excluding heat pumps, electric vehicles, and electrolysis.

Source: Aurora Energy Research

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