#ERRAConference2025

Spain

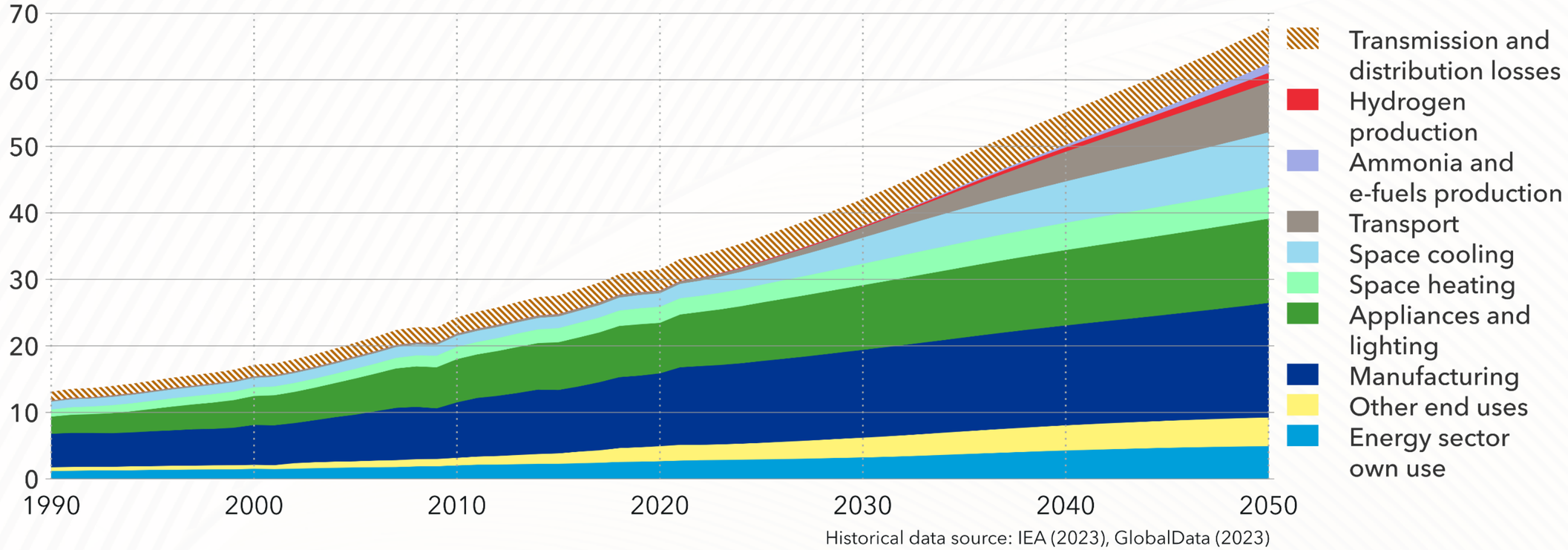
During a recent system blackout

- High Solar Penetration and Instability: An unusually high reliance on solar power (55% of supply) overwhelmed Spain's grid, which lacked sufficient firm power (e.g., fossil fuels, nuclear) to stabilize frequency when 15 gigawatts disconnected suddenly.
- Poor Grid Management: Critics pointed to inadequate scheduling of nuclear, hydroelectric, or fossil fuel plants to counterbalance the intermittent nature of solar, as highlighted by former energy official Jorge Sanz.
- Potential Cascade of Events: A combination of factors, such as high renewable reliance and simultaneous technical failures, likely contributed to the blackout, rather than a single cause.

Global Electricity Demand

Doubles by 2050 to circa 70 PWh/y

World annual electricity demand by segment



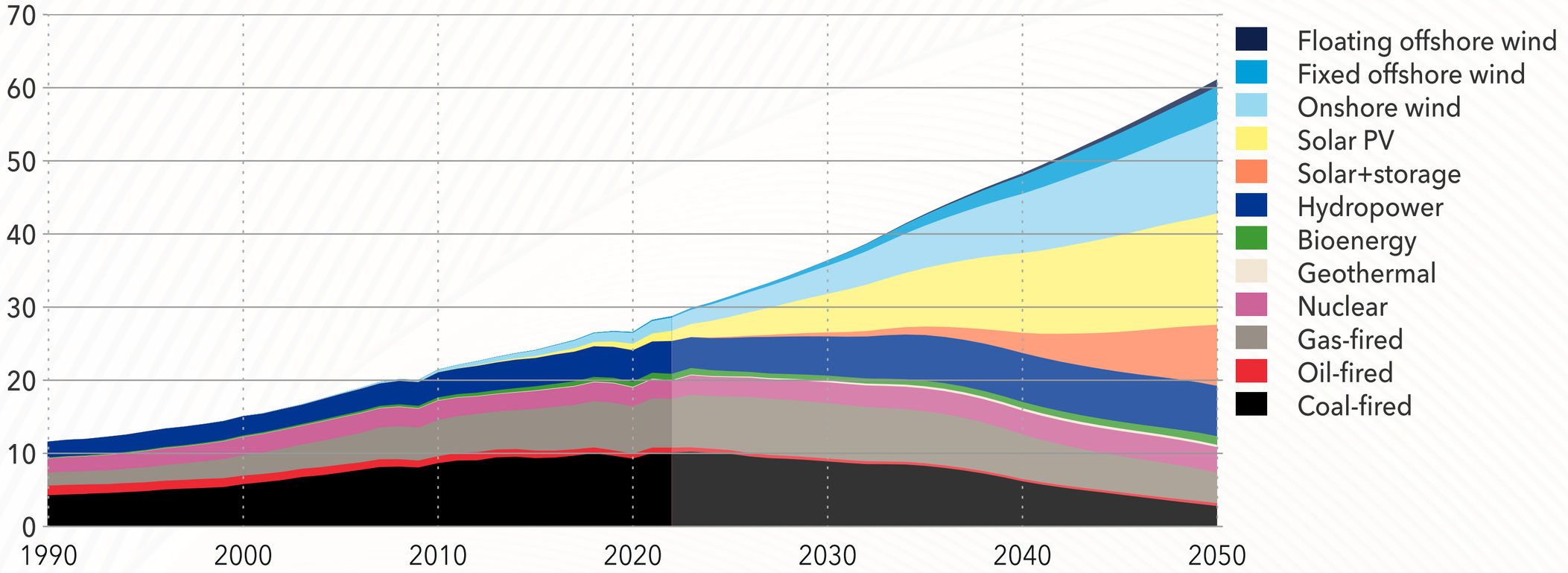
Historical data source: IEA (2023), GlobalData (2023)

Solar and Wind

70% of electricity by 2050

World grid-connected electricity generation by power station type

Units: **PWh/yr**

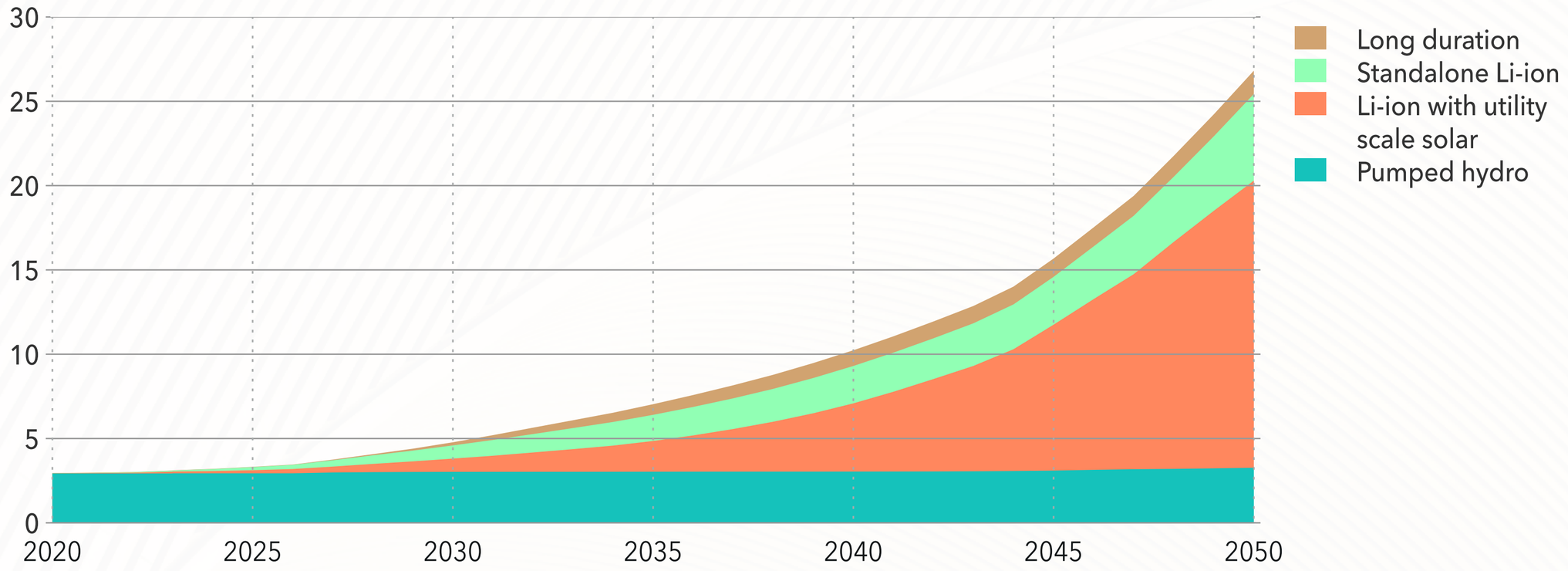


Historical data source: IEA (2023), GlobalData (2023)

Storage is Essential

For variable renewable electricity

World utility-scale electricity storage capacity

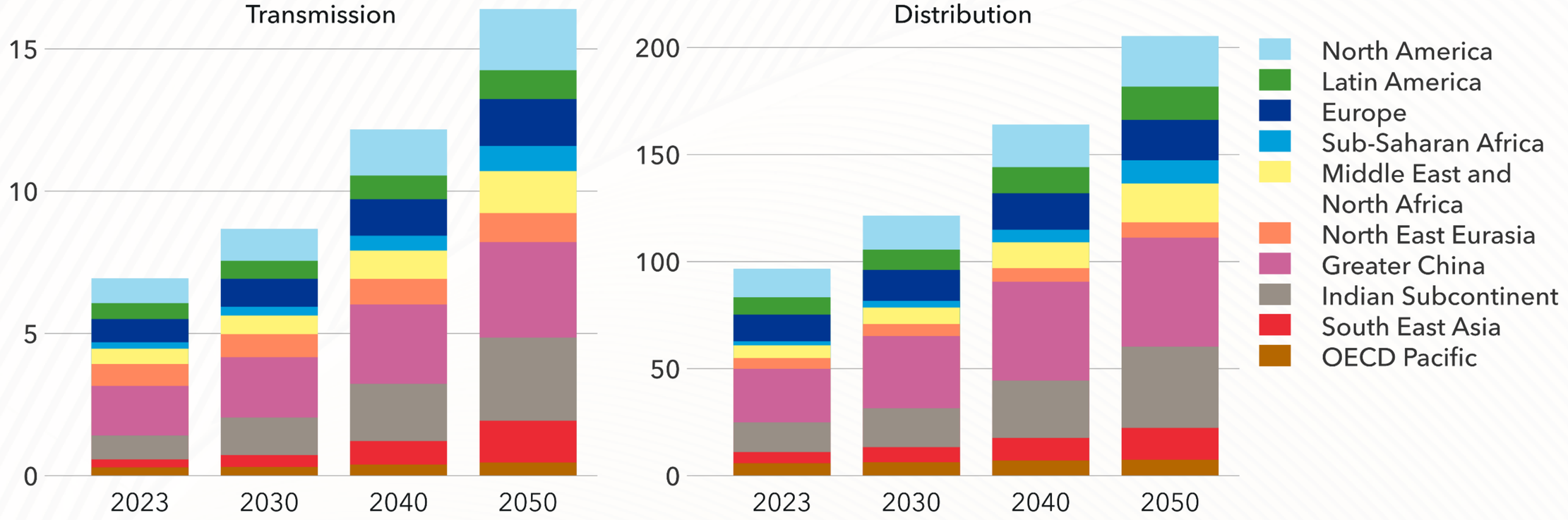


Grid Expansion

2.5x growth

Transmission and distribution power-line length by region

Units: **Million circuit-km**

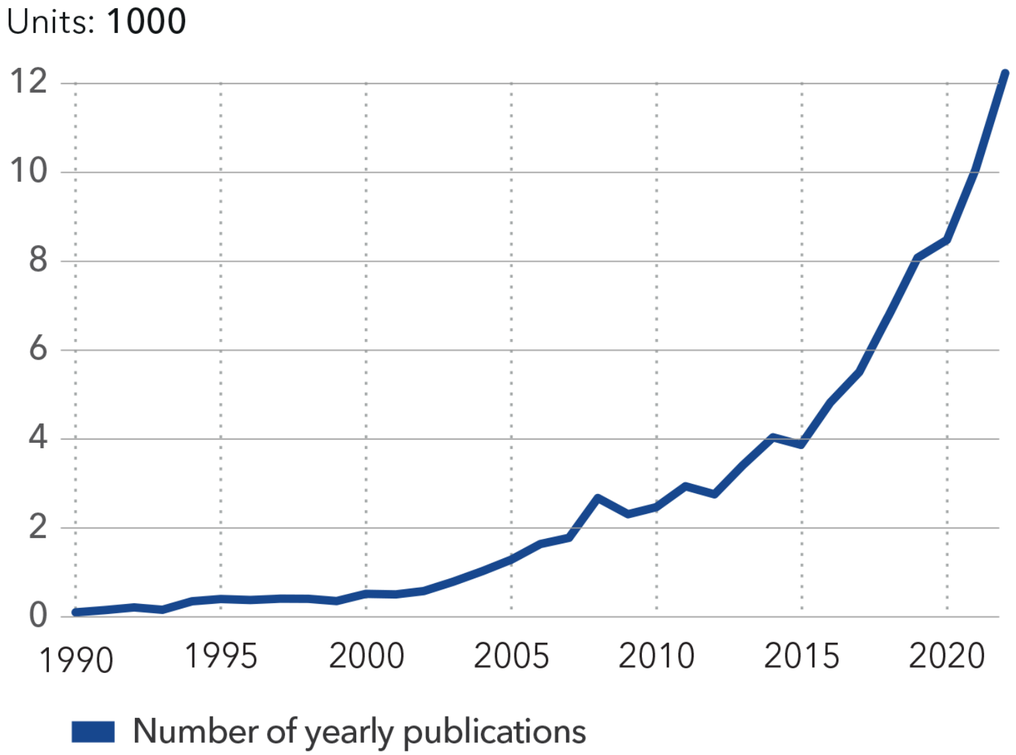


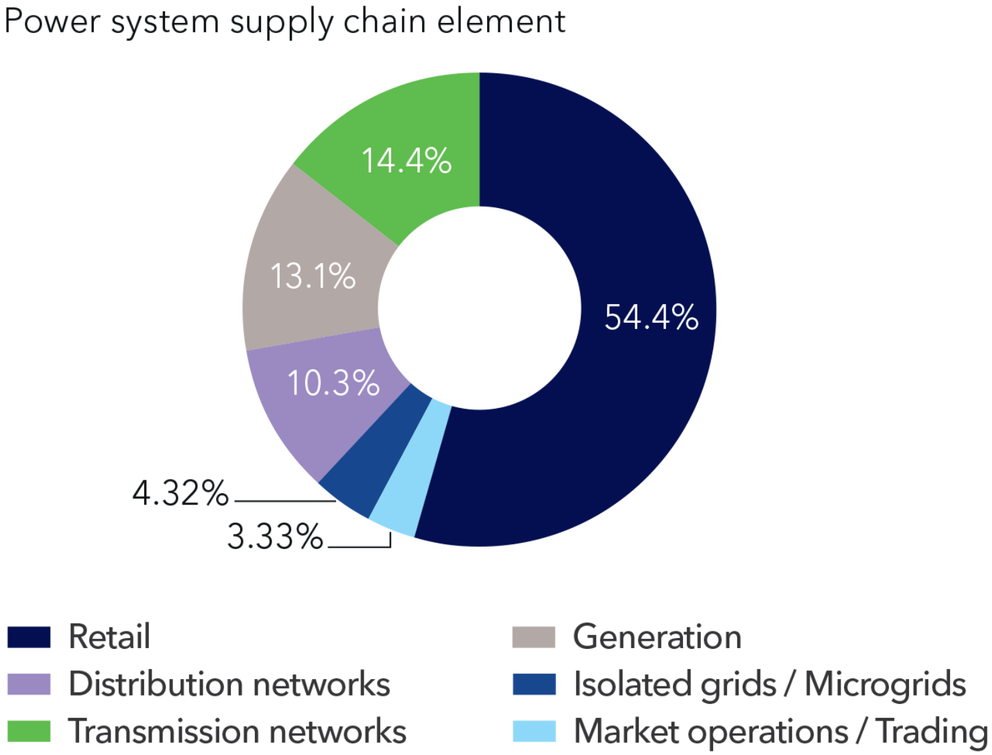
Historical data source: GlobalData (2023), DNV analysis

Artificial Intelligence

Rapidly growing influence

Published material relating to AI in the power industry



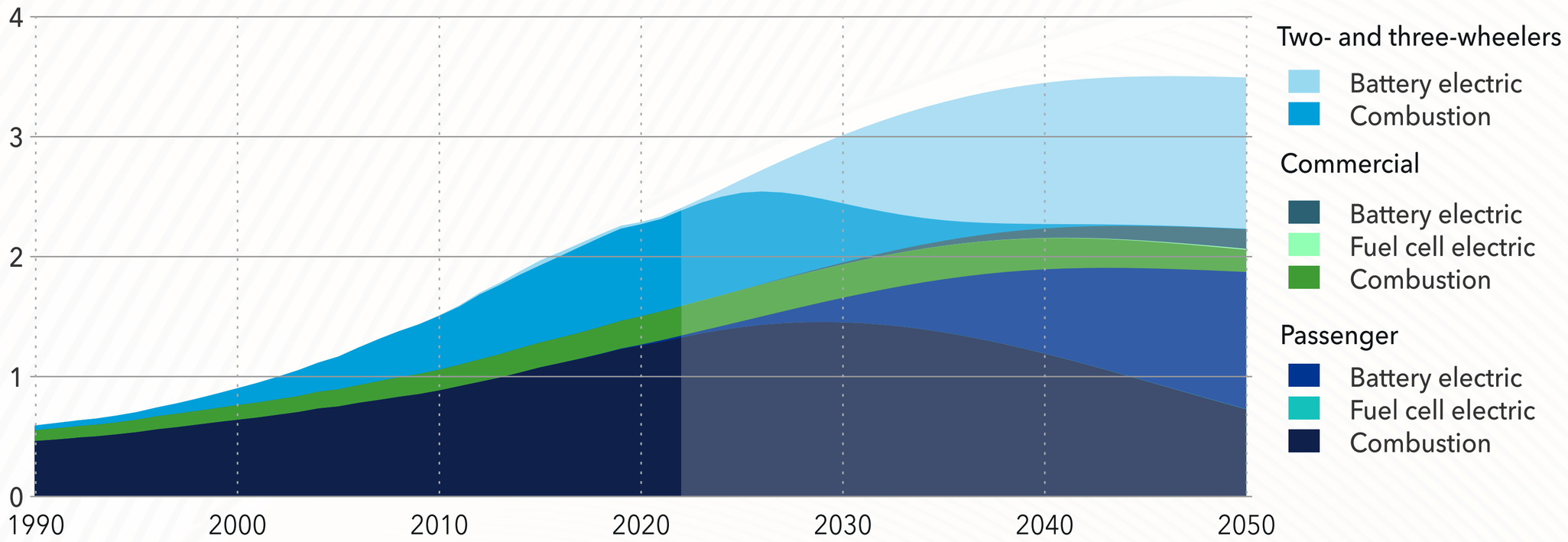


Charts redrawn from F. Heymann, H. Quest, T. Lopez Garcia, C. Ballif, M. Galus, *Reviewing 40 years of artificial intelligence applied to power systems – A taxonomic perspective,* **Energy and AI**, Volume 15, 2024.

Electricity Vehicles

60% more vehicles – 70% being EVs by 2050

World number of road vehicles by type and drivetrain



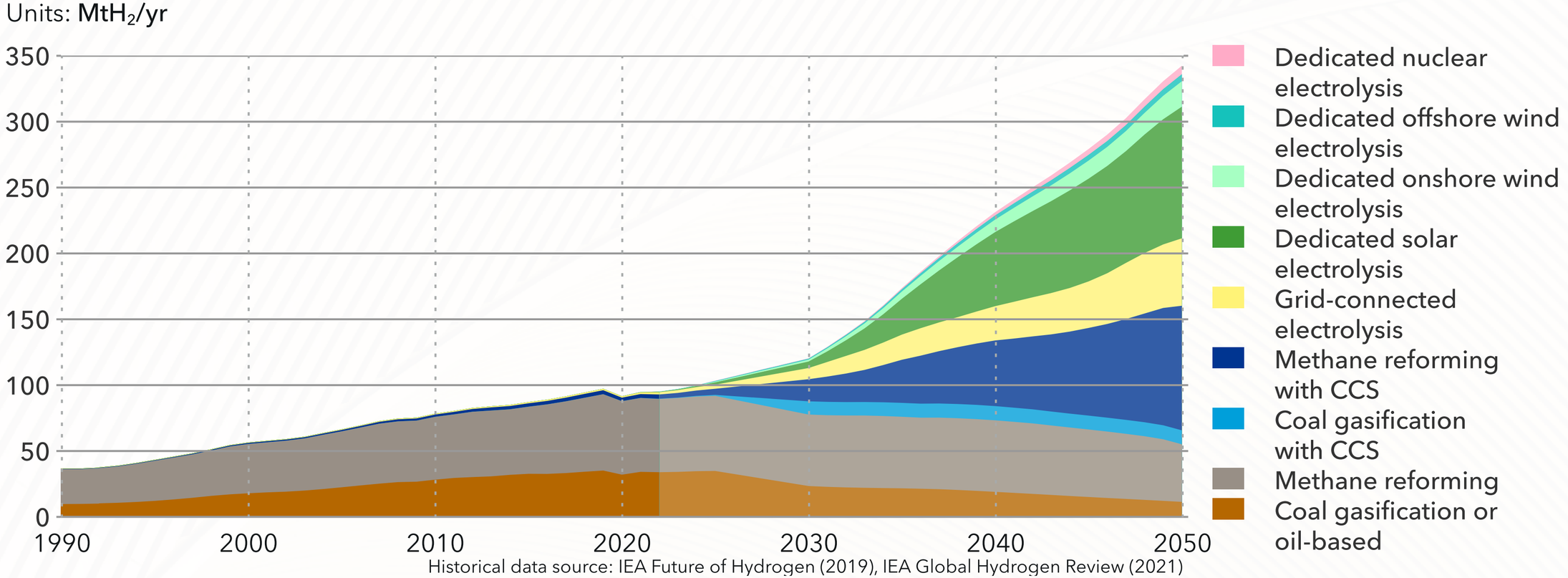
Combustion vehicles include ICEs and PHEVs.

Historical data source: Marklines (2022), IEA EV Outlook (2023), EV Volumes (2022)

Green Hydrogen

Electrolyser demand 3.4 PWh

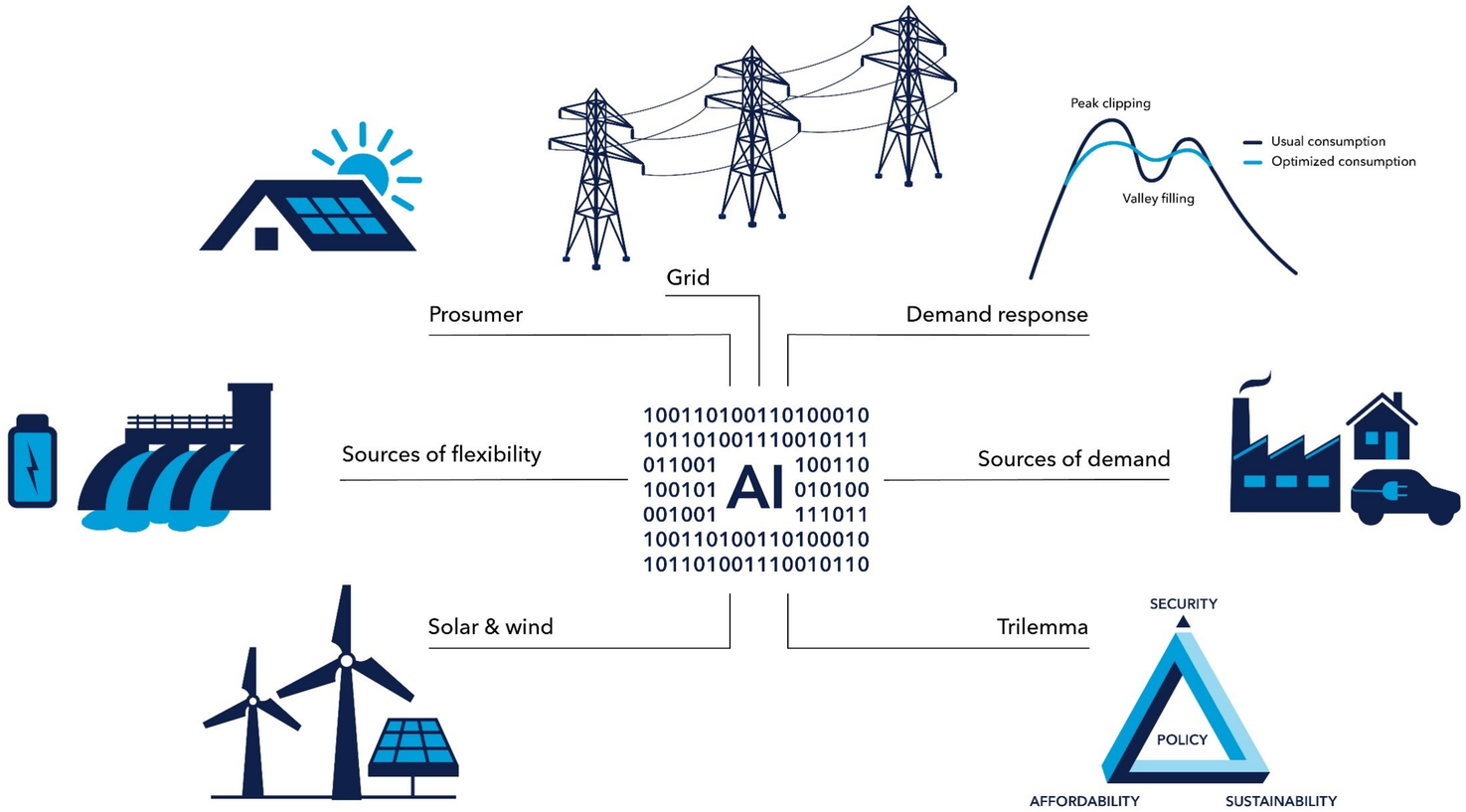
World hydrogen production by production route



Historical data source: IEA Future of Hydrogen (2019), IEA Global Hydrogen Review (2021)

Systems Thinking

Essential for stability, security, affordability



Middle East and North Africa (MEA)

Rapid deployment

- This region will see a marked increase in solar and wind contributions to the electricity mix, with significant growth expected from the mid-2040s onwards as these technologies become more feasible and integrated with storage solutions. The region is ideal for solar power with integrated storage due to its high solar irradiance, abundant uninhabited land, alignment of solar generation with peak energy demand for cooling, and the opportunity to enhance exports by reducing domestic reliance on fossil fuels.


ERRA
22ND ANNUAL CONFERENCE
هيئة تنظيم الخدمات العامة
Authority for Public Services Regulation
Moving Forward with Confidence
رؤية عُمان 2040
THANK YOU
mohammed.atif@dnv.com
#ERRAConference2025