



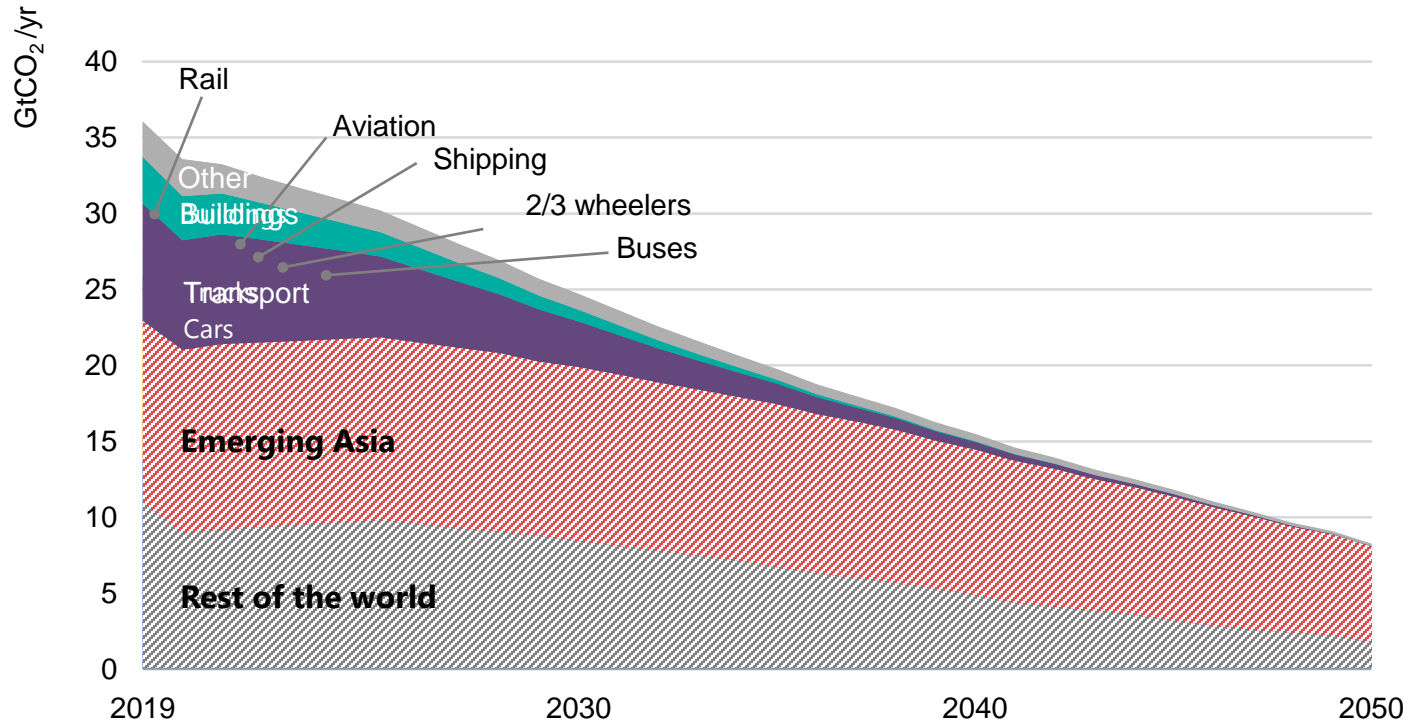
Hydrogen in the context of energy & climate goals

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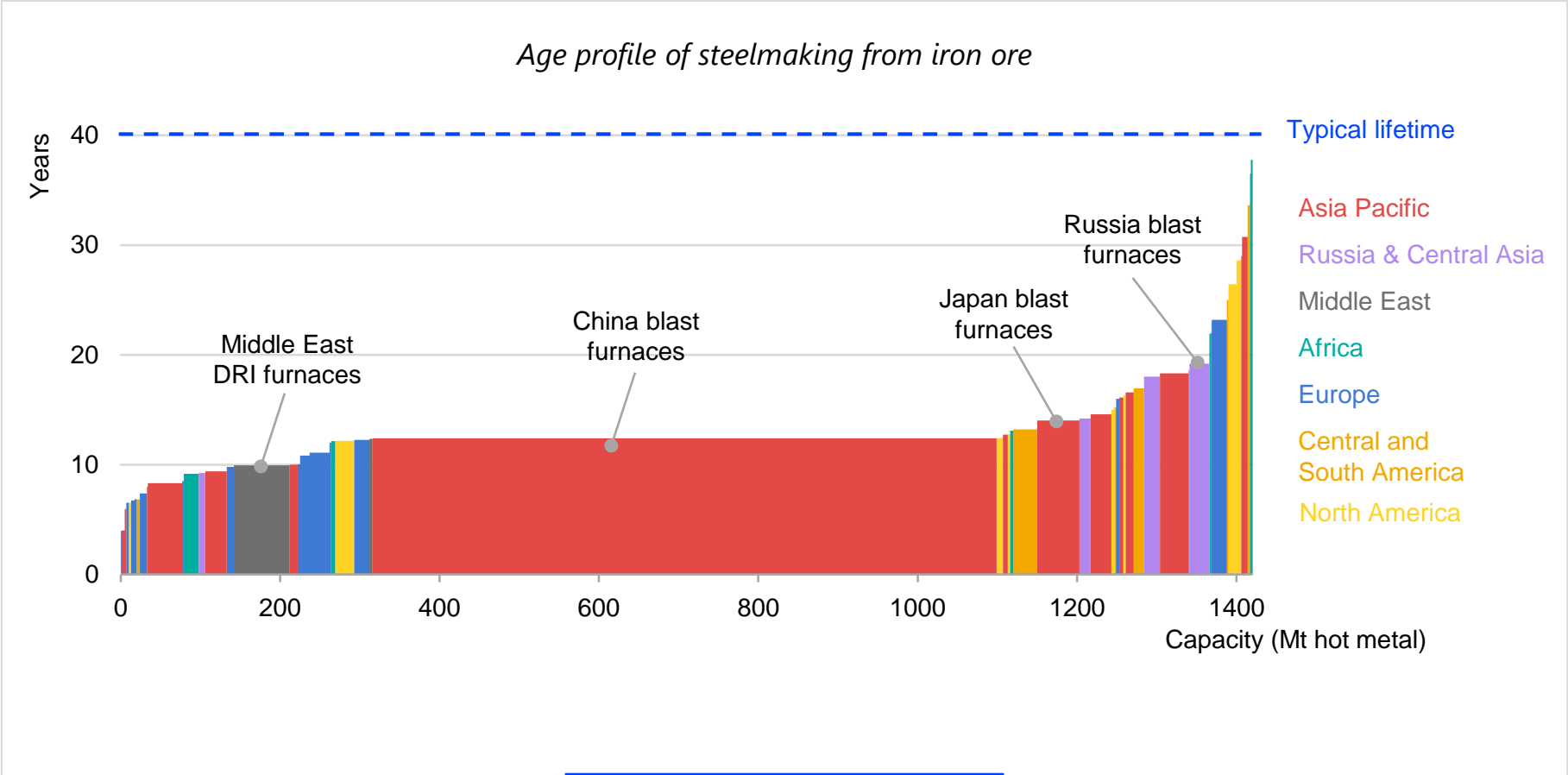
- A growing number of governments & companies are making ambitious pledges to reach net-zero emissions in coming decades. But achieving those goals & ensuring energy security is a big challenge.
- Major progress has been made: the rise of solar PV, wind and batteries has significantly reduced the costs of renewable electricity and electric cars.
- But transitioning the energy system to net-zero emissions requires broader technology efforts – hydrogen can be an important contributor

Our existing energy infrastructure is too big to ignore

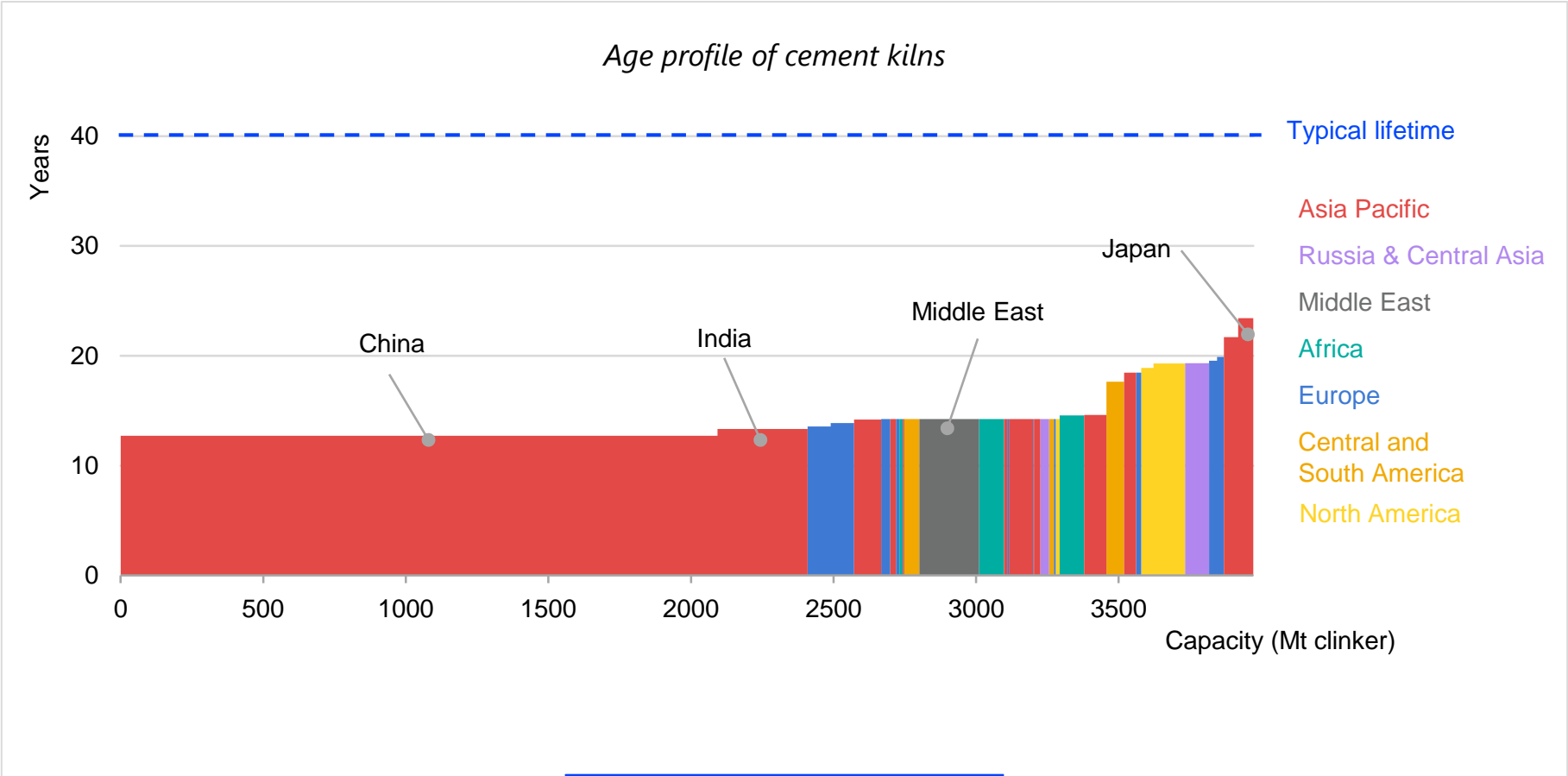


Reaching net-zero emissions requires tackling emissions from long-lived assets in power generation and heavy-industries. In emerging Asia, 80% of existing coal power capacity was built in the past 20 years.

Many industry assets are still young – iron and steel production

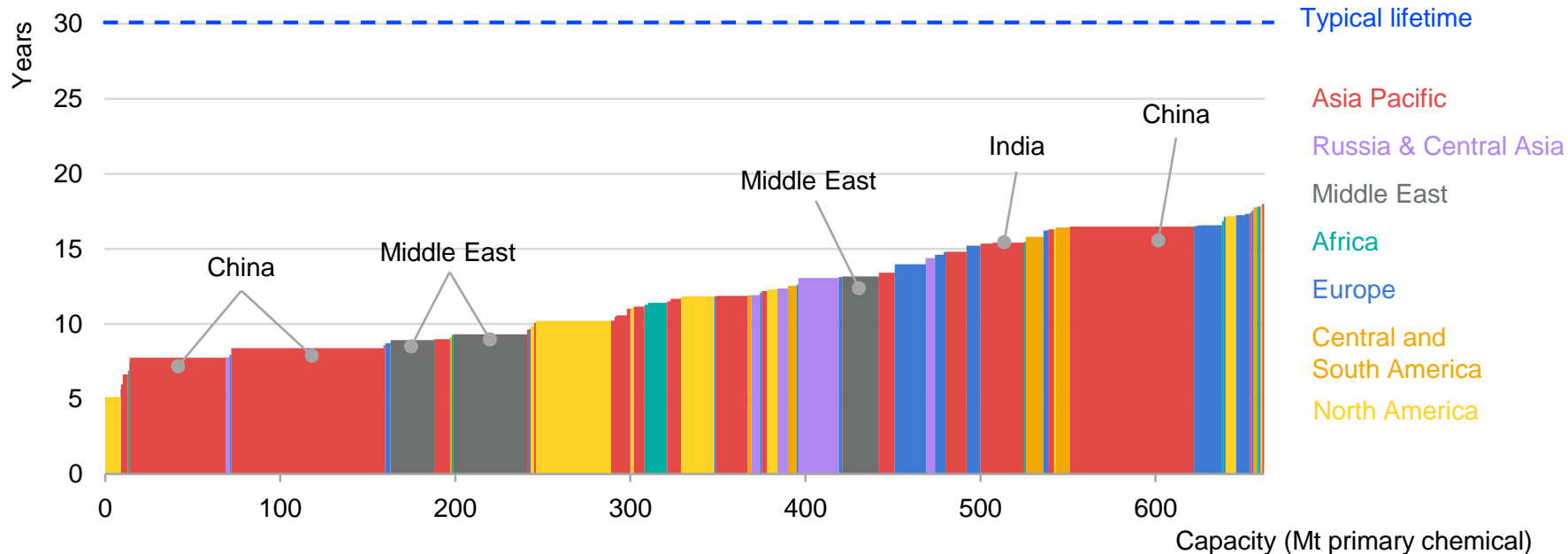


Many industry assets are still young – cement production



Many industry assets are still young – chemicals production

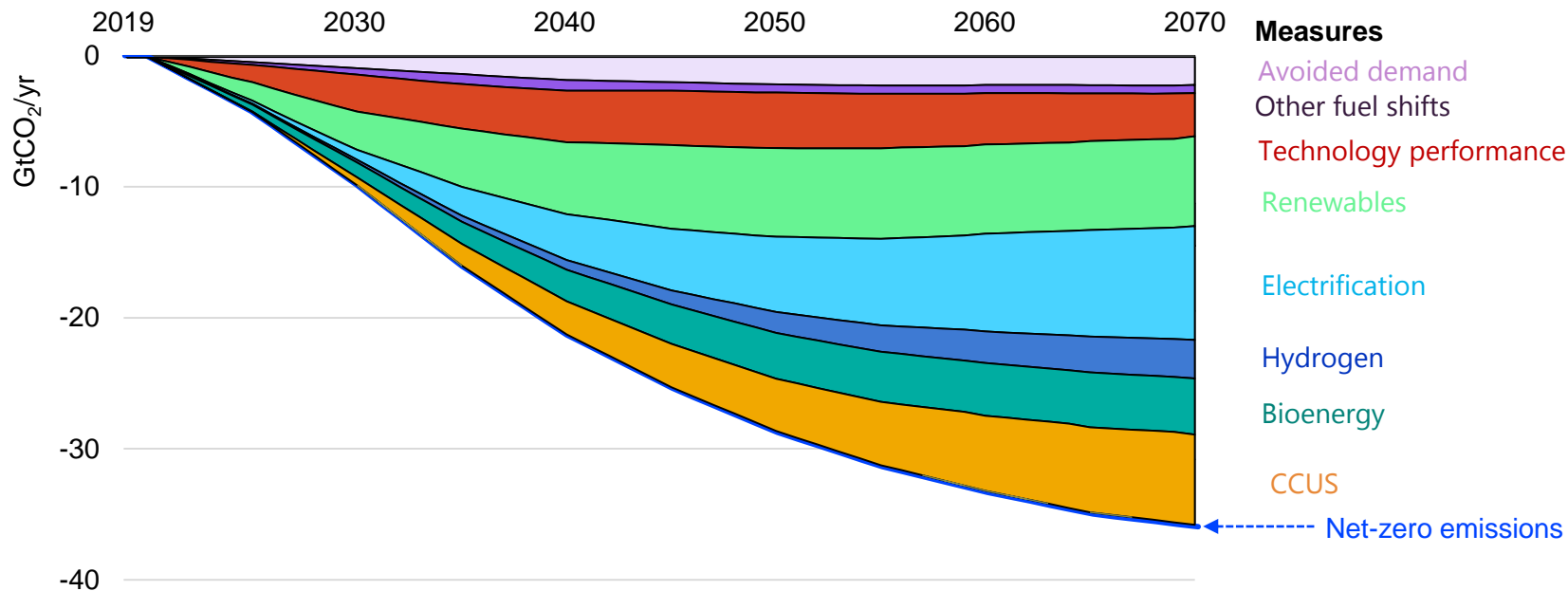
Age profile of primary chemicals production facilities



China's middling-to-young production capacity accounts for upwards of 50% of the global total in key industrial sub-sectors. India and the Middle East are also key regions.

Focusing on the power sector is not enough to reach climate goals

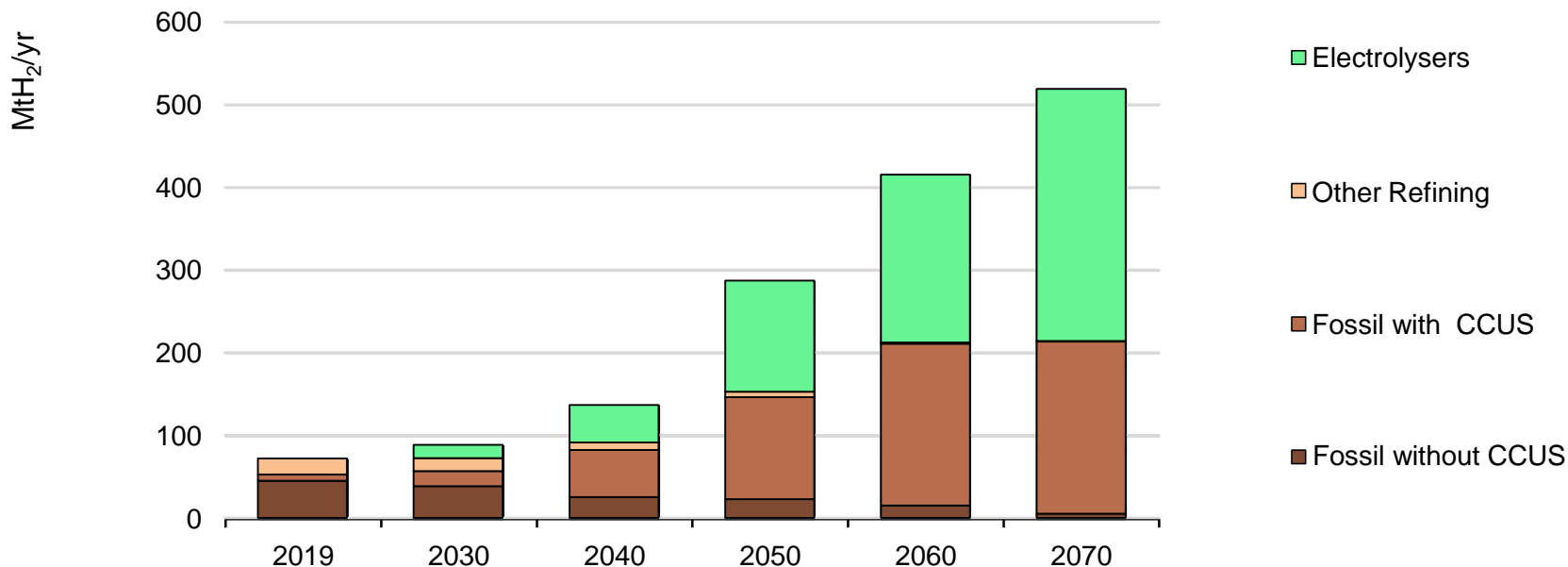
Global CO₂ emissions reductions in the Sustainable Development Scenario, relative to baseline trends



Clean energy technology progress in the power sector and with electric cars is encouraging, but alone not sufficient to reach climate goals. A broad portfolio of technologies will be needed for a transition to net-zero emissions.

Hydrogen – a key pillar for reaching energy & climate goals

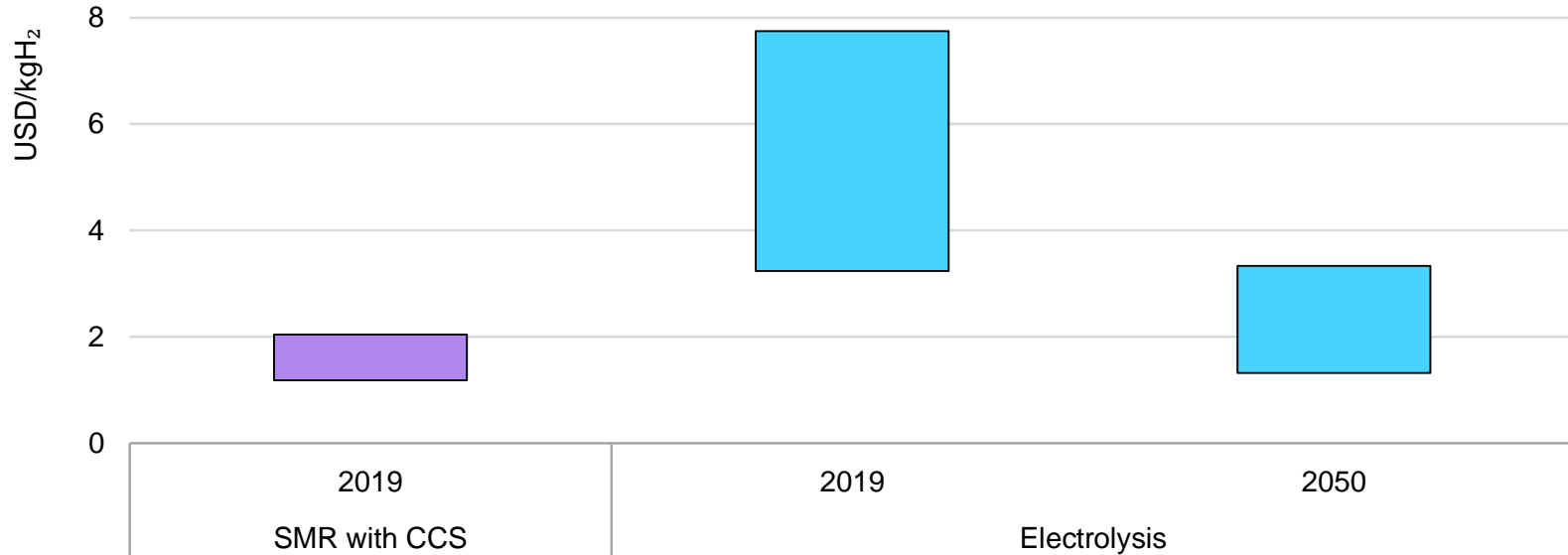
Global hydrogen production and use by sector in the Sustainable Development Scenario, 2019-2070



Global hydrogen production and use grows sevenfold by 2070 compared to today in the Sustainable Development Scenario, with demand growth almost completely met by low-carbon hydrogen.

Opportunities to reduce clean hydrogen production costs

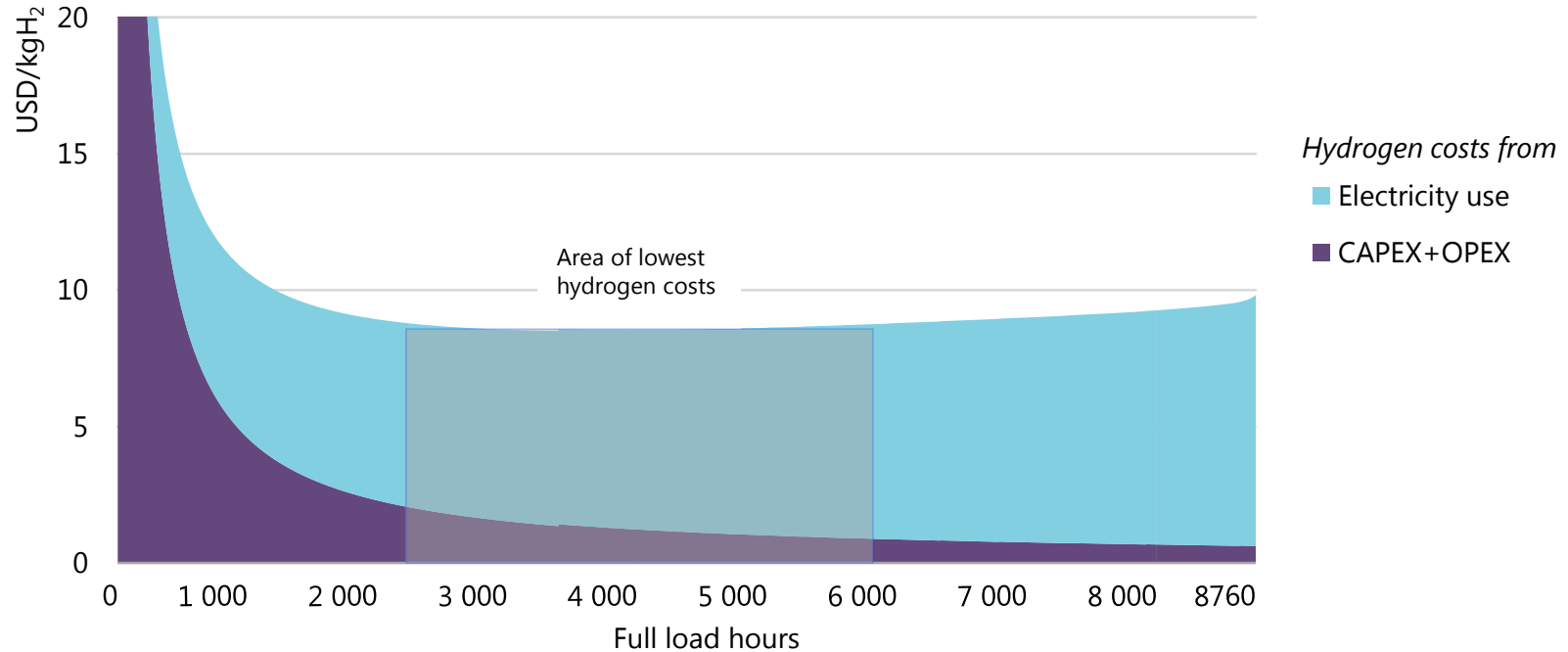
Hydrogen production costs by technology in the Sustainable Development Scenario, 2019 and 2050



Low-carbon hydrogen production through electrolysis is not currently competitive with that based on fossil fuels, but could become competitive in the long term as large-scale deployment brings down costs.

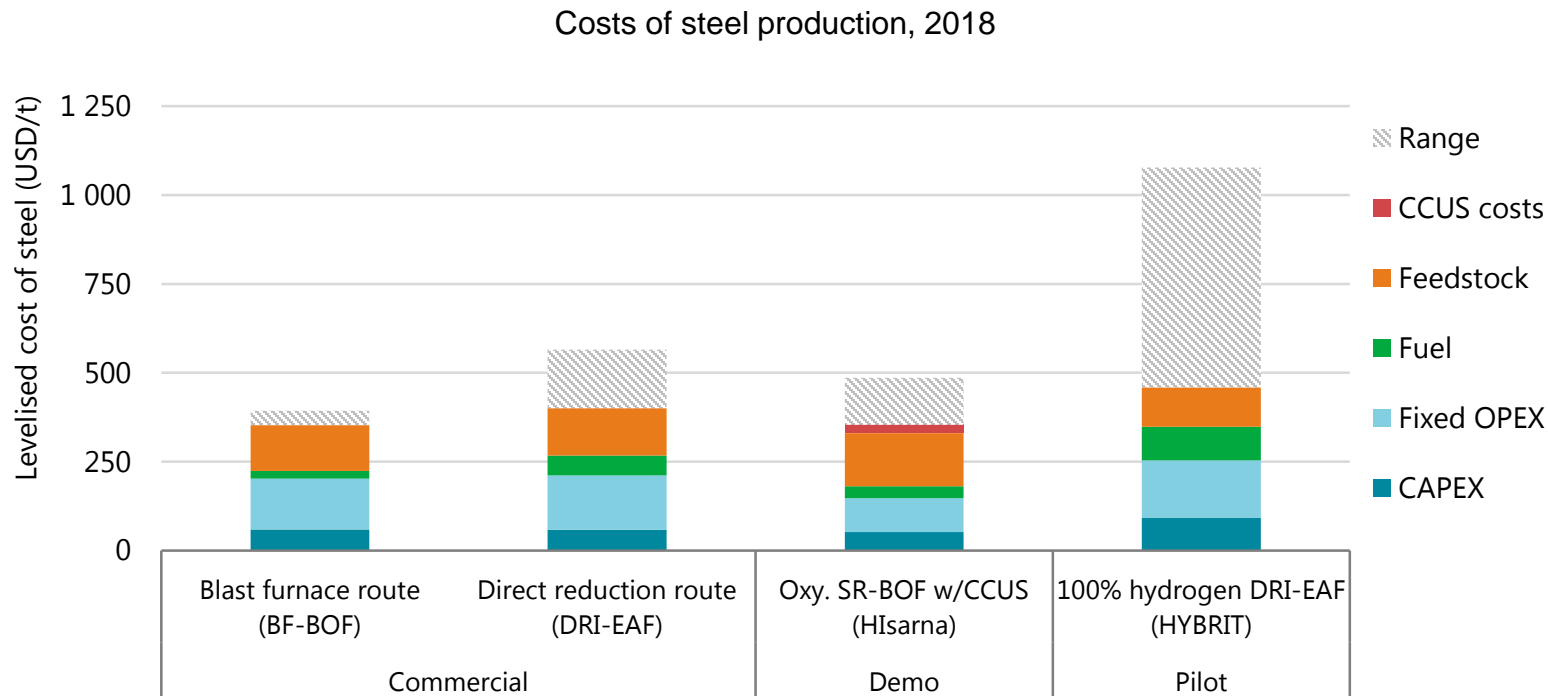
A sweet spot for electrolytic hydrogen production

Electrolytic hydrogen production cost at different full load hours



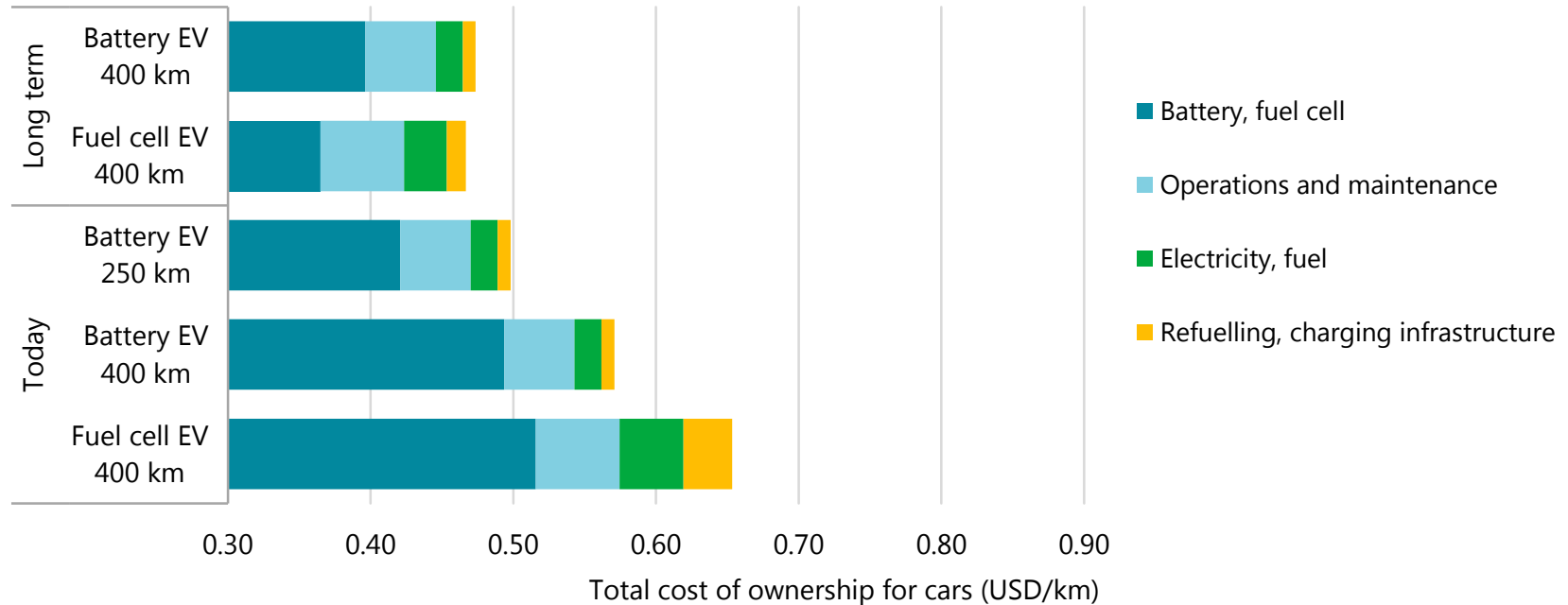
Mid-load operation of electrolyzers achieves the lowest hydrogen costs, balancing CAPEX, OPEX, and electricity costs.

Hydrogen routes for steel production are emerging, but expensive



The hydrogen-based DRI-EAF route is between 10% and 90% more costly than its natural gas-based counterpart, and is highly sensitive to the cost of electricity.

Which cars will win the low carbon race?



Total costs of ownership could break even with EVs at 400 km drive range. Prospects for fuel cell cars depend on cost reductions in fuel cells and storage tanks, and the utilisation of stations.

Four key opportunities for scaling up hydrogen to 2030

