Nuclear Hydrogen Production: A Key Pathway for a Zero Carbon Option

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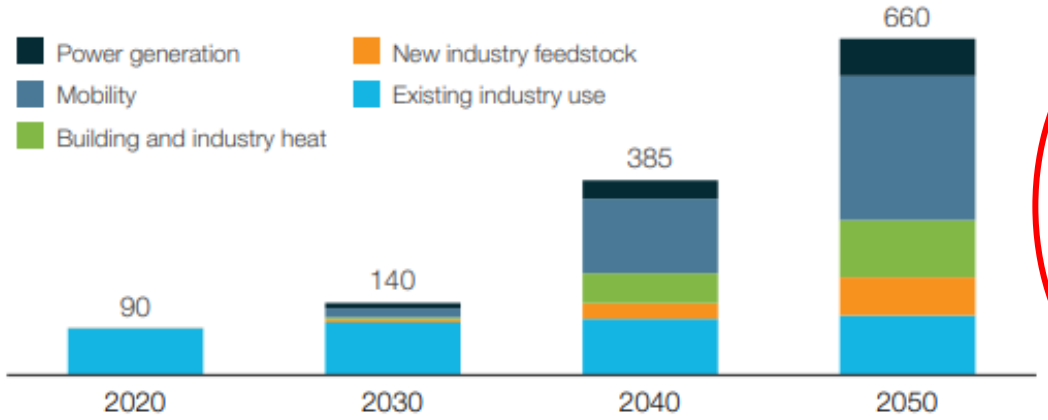
Hydrogen as a Vector of Decarbonization

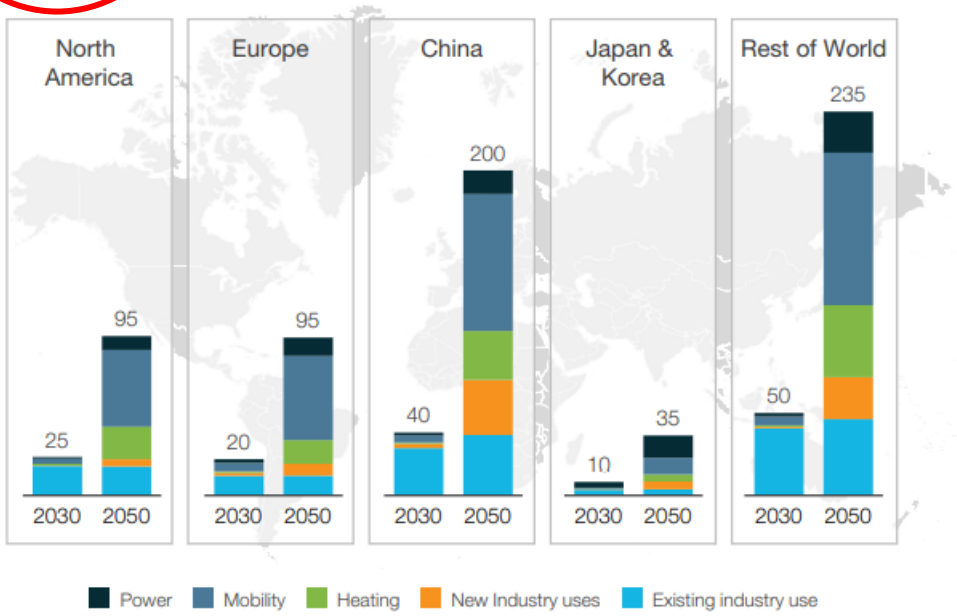


660 MT
hydrogen required p.a. in 2050 for net-zero

22%
of global final energy demand[1]

Hydrogen End-Use Demand by Segment (MT H2/yr)

Hydrogen End-Use Demand by Region (MT H2/yr)



Source: Hydrogen Council & McKinsey – Hydrogen for Net Zero

Clean Hydrogen Demand by Mid-Century is Aggressive!

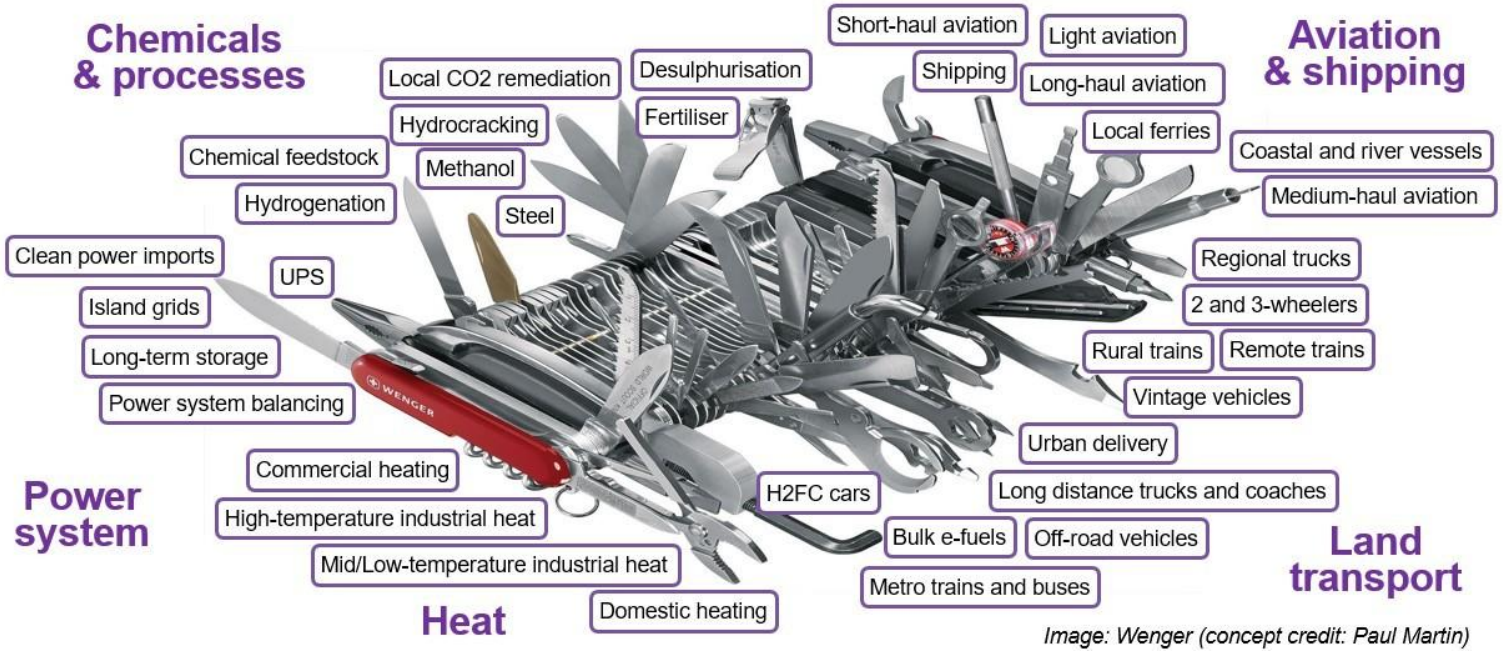


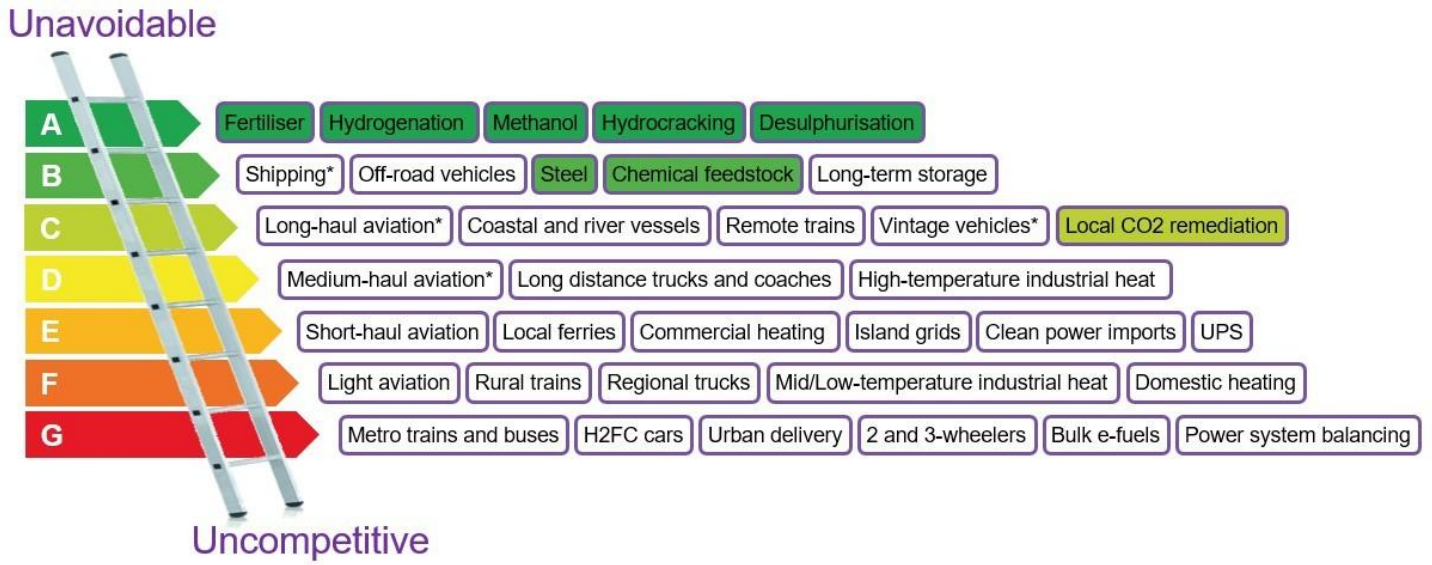
Image: Wenger (concept credit: Paul Martin)

Potential uses of hydrogen

More likely uses of hydrogen (one view)

Clean Hydrogen Ladder: Chemicals & processes

Liebreich Associates



** Via ammonia or e-fuel rather than H2 gas or liquid*

Source: Liebreich Associates (concept credit: Adrian Hiel/Energy Cities)

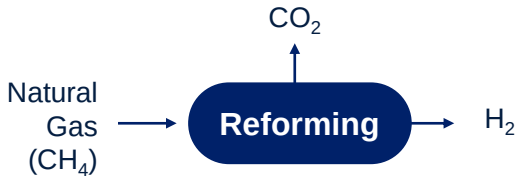
Steam Methane Reforming

(95% of H_2 production today)

OIL, COAL, NATURAL GAS

Carbon Intensive

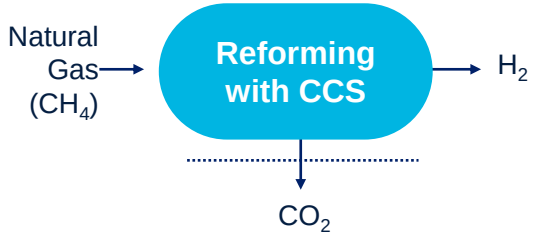
H2 produced at oil refineries = 10.5 tons CO_2 per ton of H_2



Steam Methane Reforming + CCUS

OIL, COAL, NATURAL GAS

Low Carbon, but more expensive



Electrolysis + Zero-Carbon Source

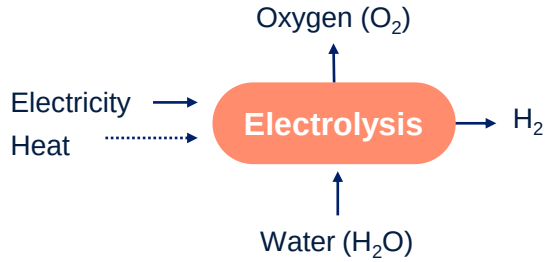
RENEWABLES

Zero Carbon, but currently more expensive

Geographic Limitations

NUCLEAR

Zero Carbon, can be economically competitive due to baseload production + H2 production efficiencies



Largest Cost Components of Electrolytic Hydrogen

Electricity Costs (50%+ of production costs)

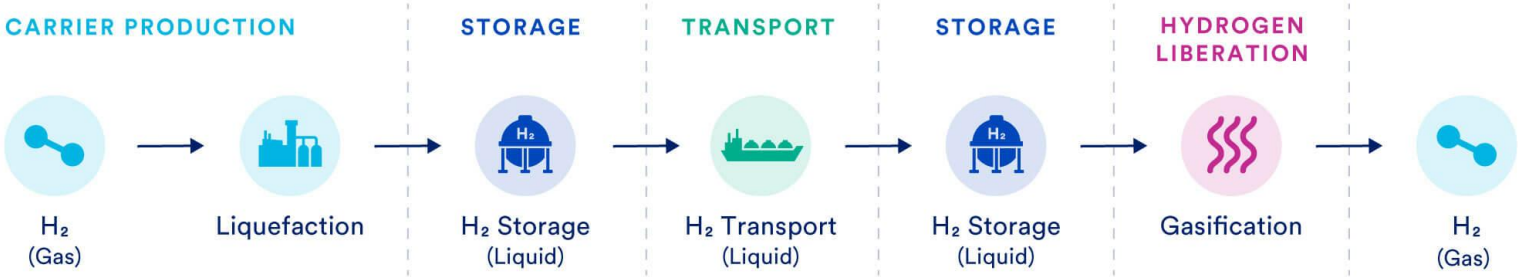
CAPEX (electrolyzer, civil construction, connection facilities)

Storage

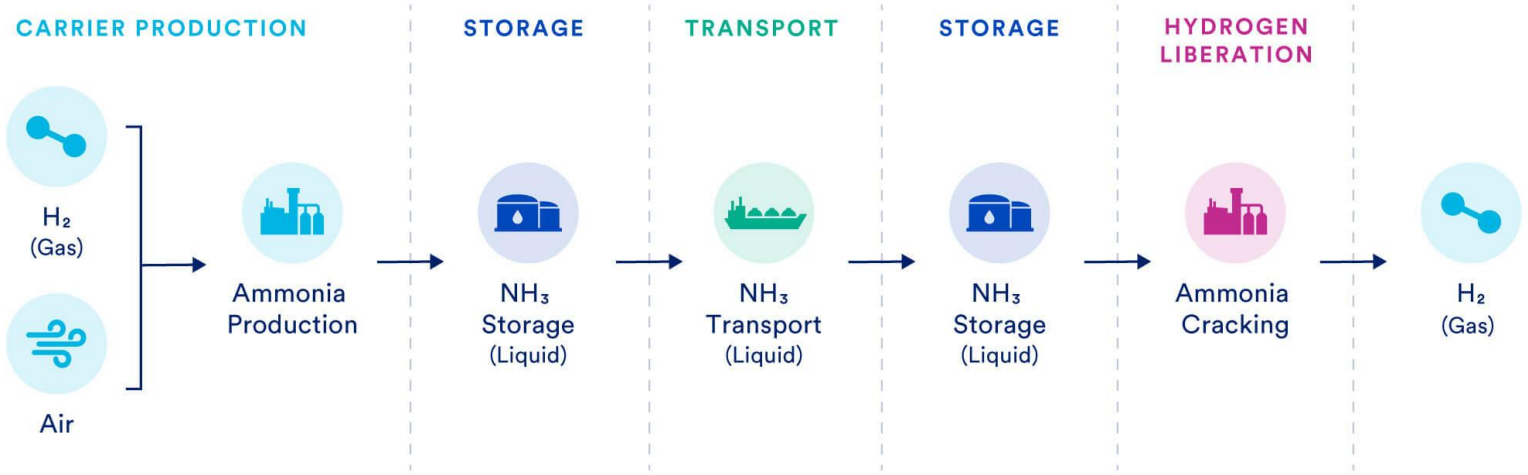
Transportation

The Hydrogen Transportation Challenge

Hydrogen Value Chain – Liquid Hydrogen as a Carrier



Hydrogen Value Chain – Ammonia as a Hydrogen Carrier



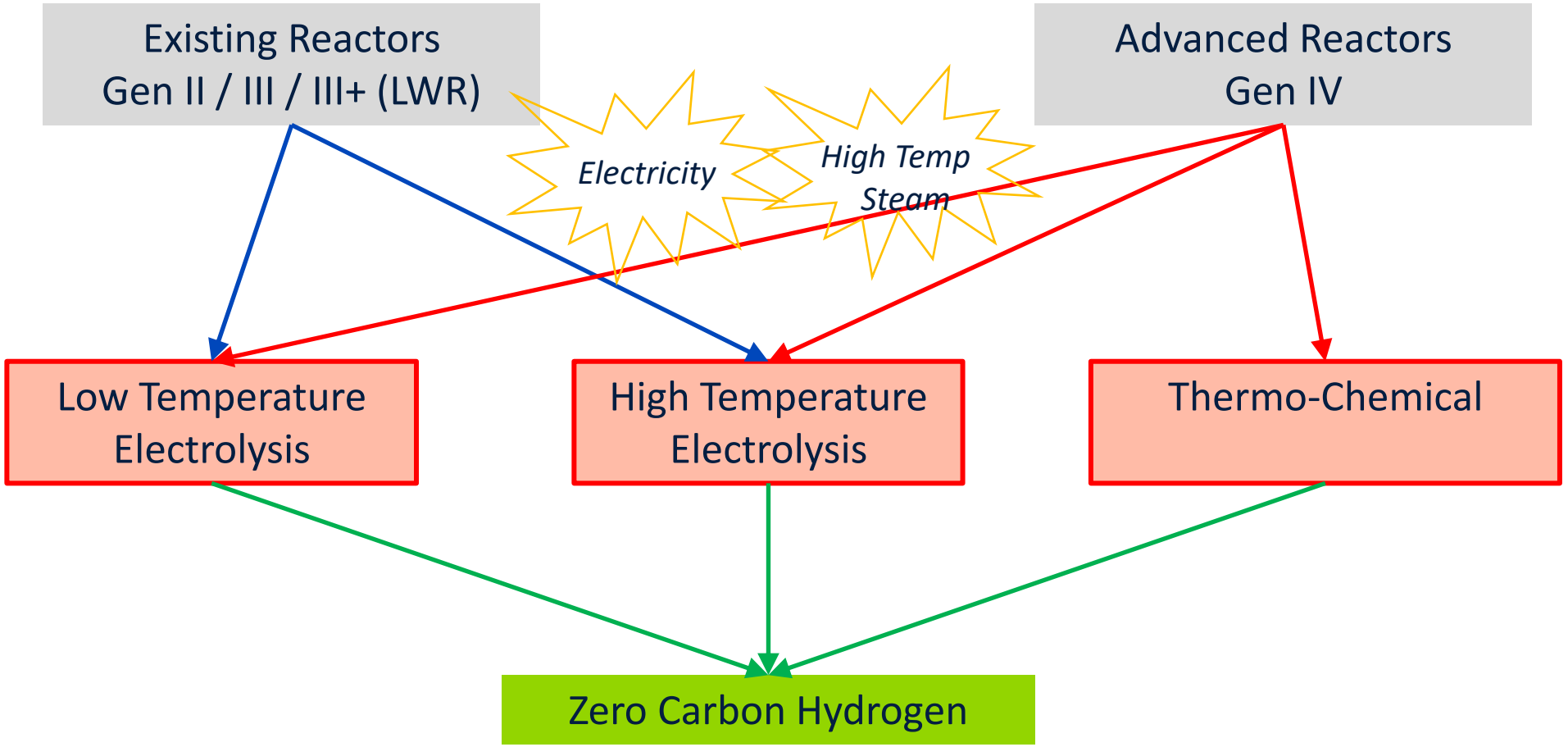
Transportation Methods:

- Trucking
- Pipeline
- Conversion to Alternative Carrier (e.g. ammonia)

Source: https://www.catf.us/resource/techno-economic-realities-long-distance-hydrogen-transport/

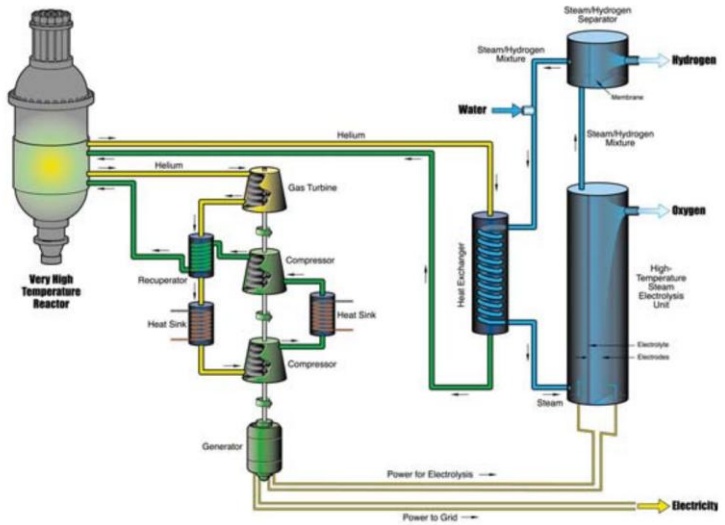
Hydrogen Production via Nuclear Energy

Many Pathways to Zero Carbon Hydrogen



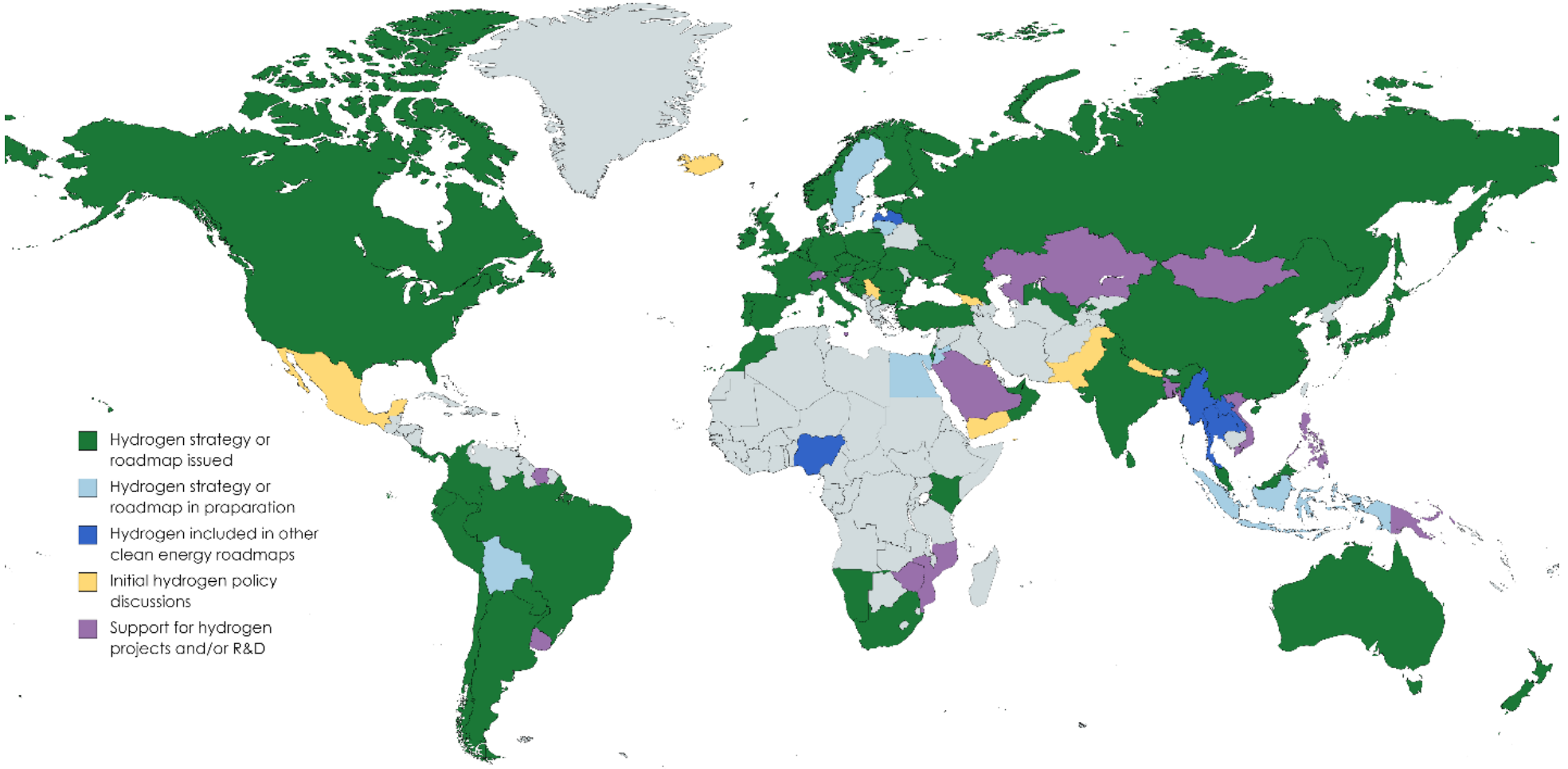
SMRs and Hydrogen Production

- Zero emissions generation (electricity and high temperature steam)
- Firm, reliable, high-capacity Factor
- Energy dense, less physical footprint/land required
- Can support multiple pathways to produce H2
- Extreme weather resistant, 365/24/7, not dependent on seasonal impacts
- Advanced Reactors/SMRs can offer unique advantages for hydrogen production
  - Higher temperatures (pairing with SOEC)
  - Ability to be co-located with hydrogen end-use



Policy Landscape

- As of today, 53 countries and the EU have issued hydrogen policies, strategies or roadmaps.
- Many of these include nuclear hydrogen production, but more work to be done.



Thank you

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