IRENA
International Renewable Energy Agency

The Roadmap for Hydrogen in a Geopolitical Context

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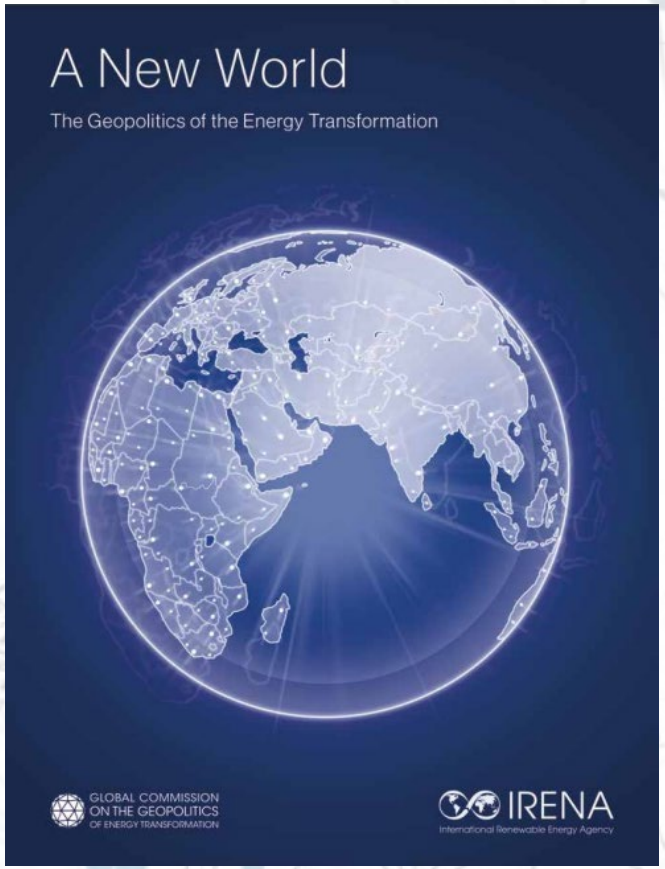
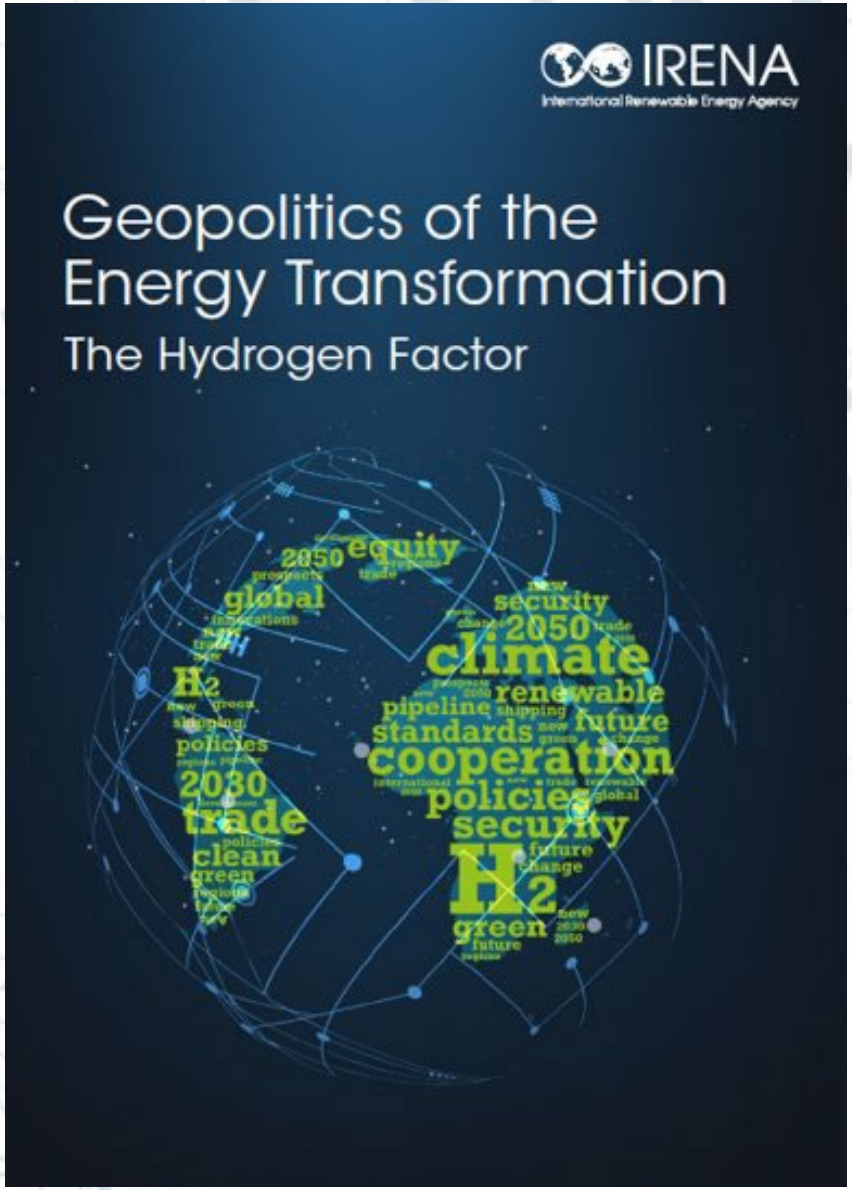
CIEP, 21 February 2022

Geopolitics of the Energy Transformation: The Hydrogen Factor

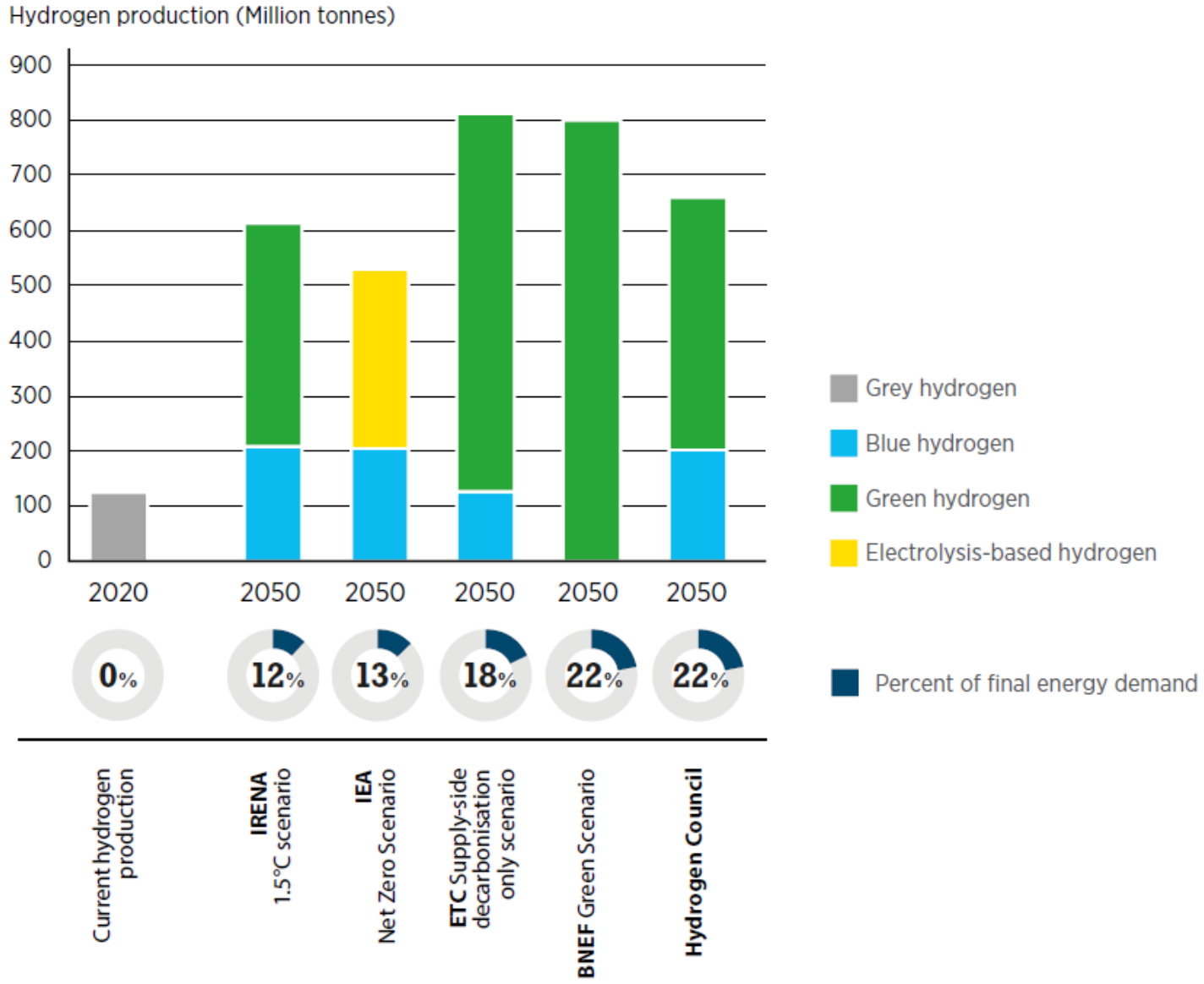




Selected findings

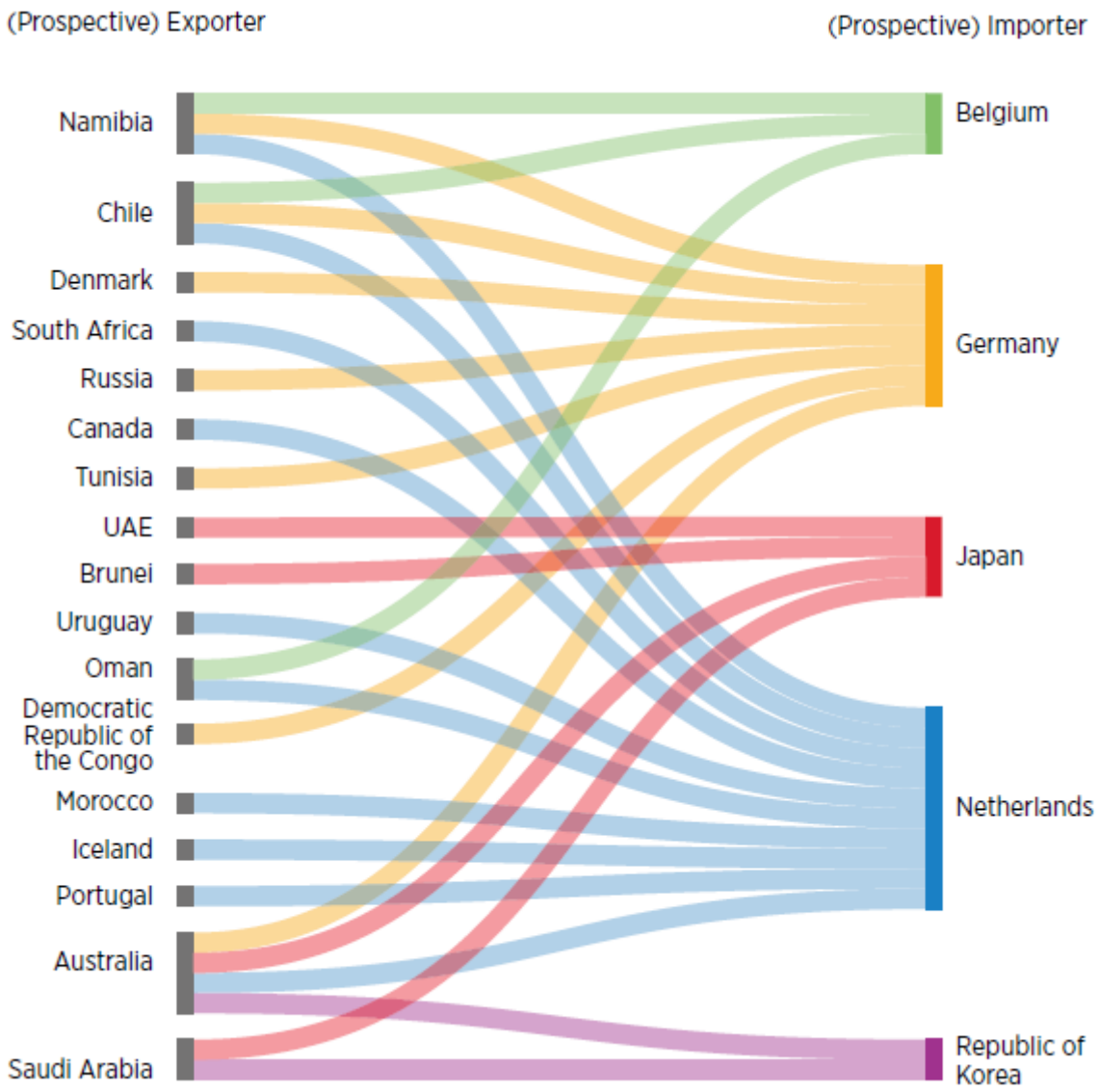
- Hydrogen is part of a much bigger energy transition picture, and its development and deployment strategies should not be considered in isolation.
- Hydrogen trade and investment flows will spawn new patterns of interdependence and bring shifts in bilateral relations.
- Countries with an abundance of low-cost renewable power could become producers of green hydrogen, with commensurate geoeconomic and geopolitical consequences. Hydrogen trade flows are unlikely to become weaponised or cartelised.
- Any form of hydrogen may strengthen energy independence and resilience, but most of the benefits stand to come from green hydrogen.
- International co-operation will be necessary to devise a transparent hydrogen market with coherent standards and norms that contribute to climate change efforts meaningfully.

Converging estimates for global hydrogen demand in 2050

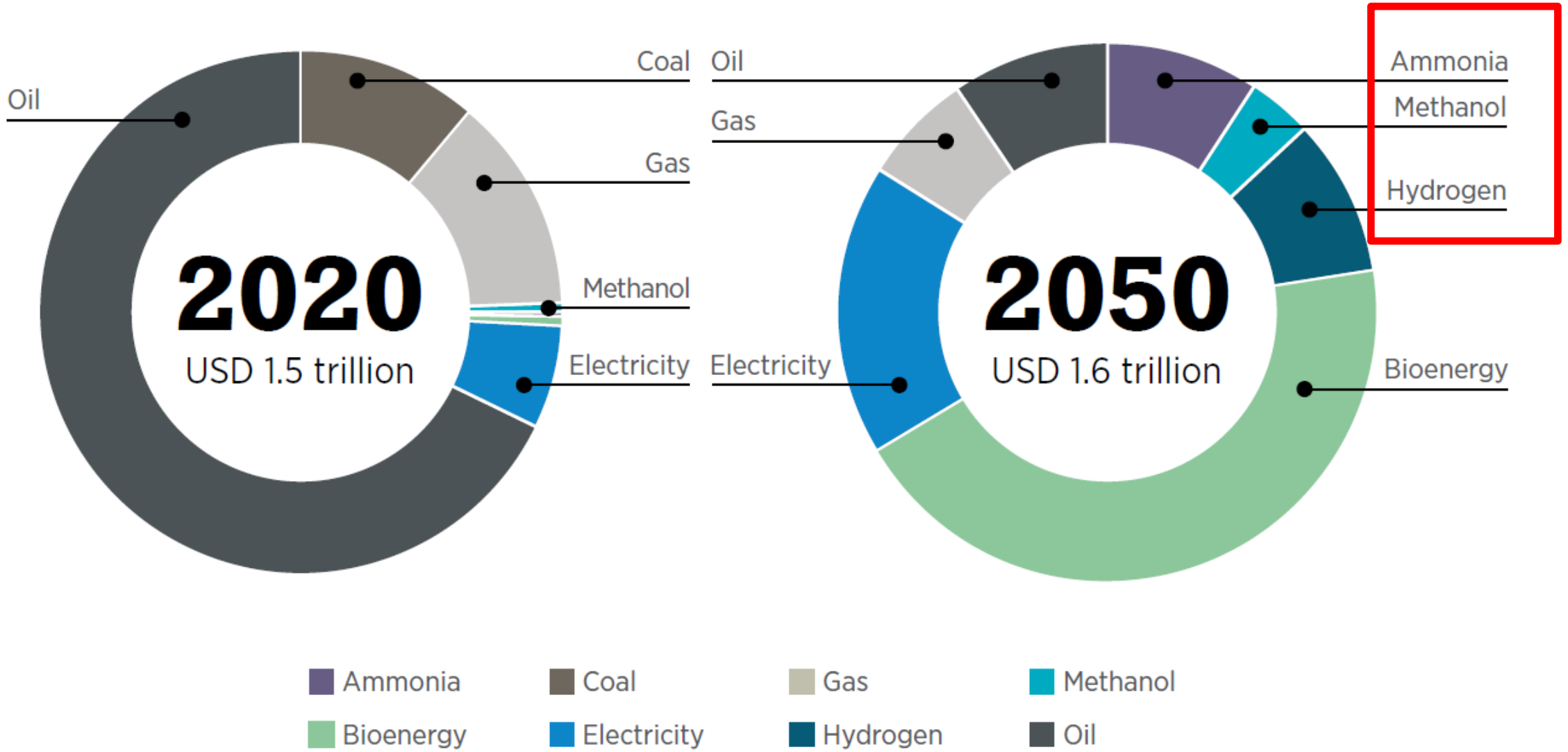


Hydrogen Strategies (October 2021)

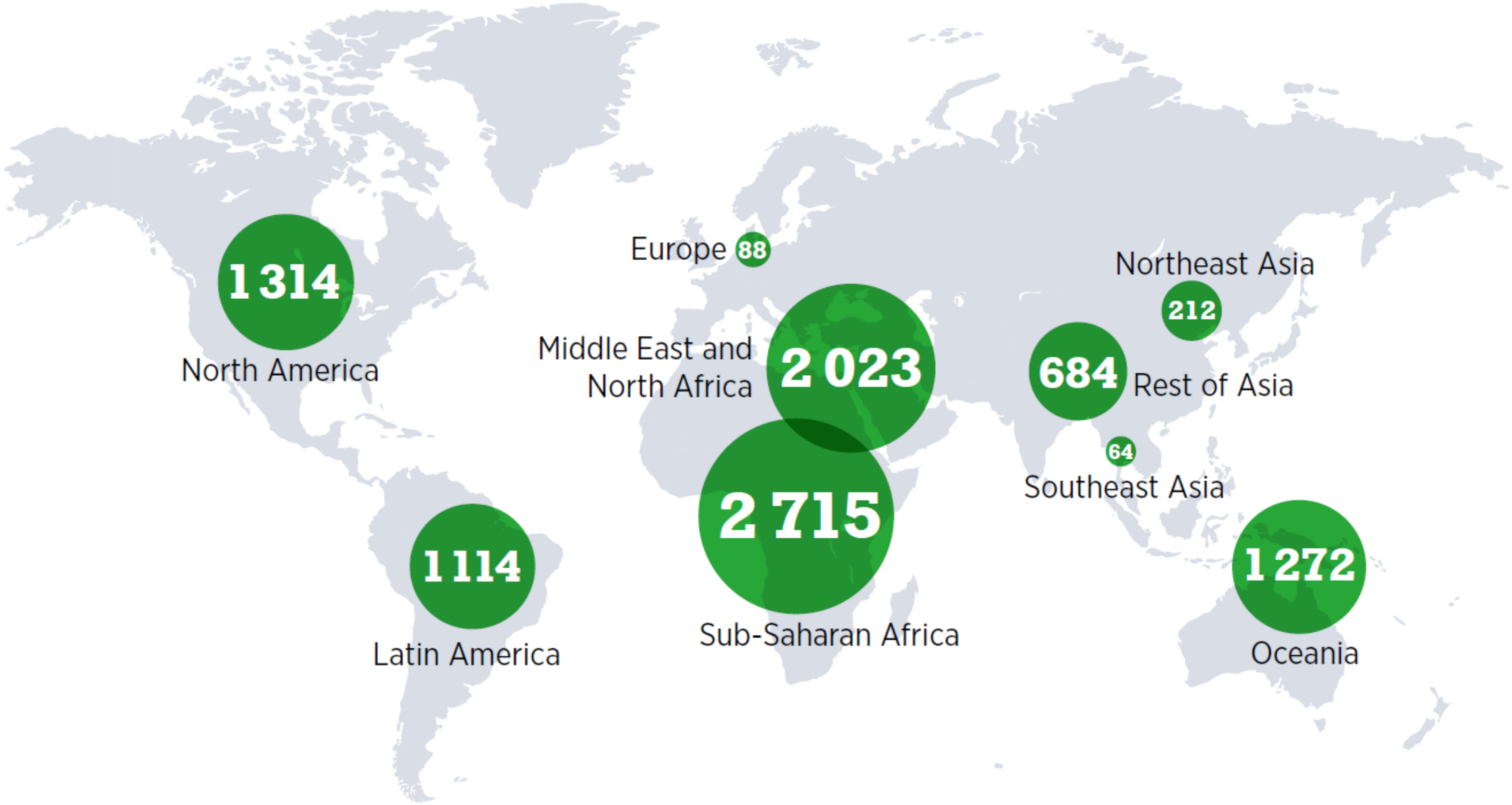
Selected country bilateral trade agreements and MOUs (November 2021)



Shifts in the value of trade in energy commodities, 2020 to 2050
20% hydrogen and its energy derivatives



Technical potential for producing green hydrogen under USD 1.5/kg by 2050, in EJ



Green hydrogen is key for more VRE integration

How to **integrate high shares of variable renewable electricity** in the power system, while maintaining the reliability, security and affordability of the power grid?

Green hydrogen to:

- Provide additional flexibility for VRE integration
- Enable decarbonisation of hard-to-abate sectors
- Tap into global remote high quality renewables resources and thus raise energy security
- Circumvent grid expansion bottlenecks
- Capture a larger share of energy end-use markets (aviation, shipping, steel etc)

Growing commitment to develop green hydrogen

Over 30 UN Energy Compacts for green hydrogen from governments, subnational governments, intergovernmental organizations, private sector companies and coalitions

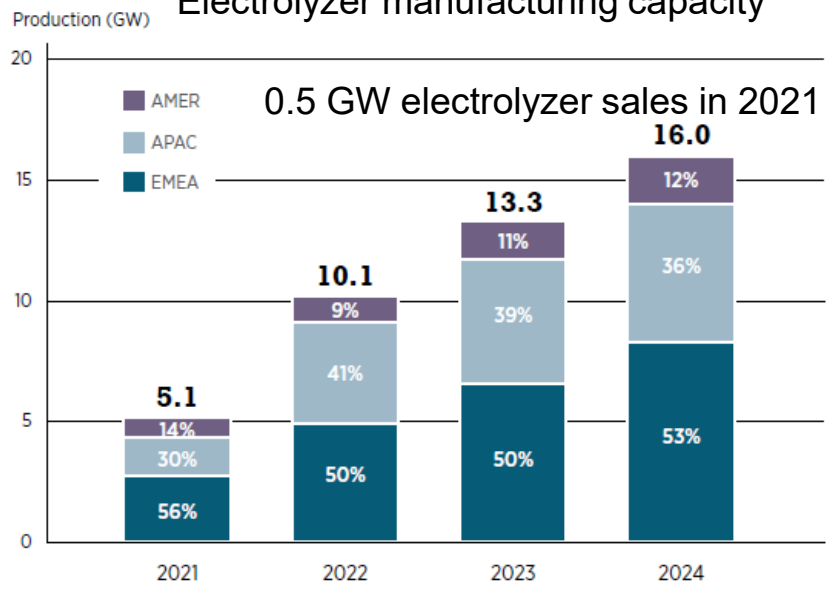
268 GW new renewable capacity by 2030 - more than total new renewable energy capacity added in 2020)

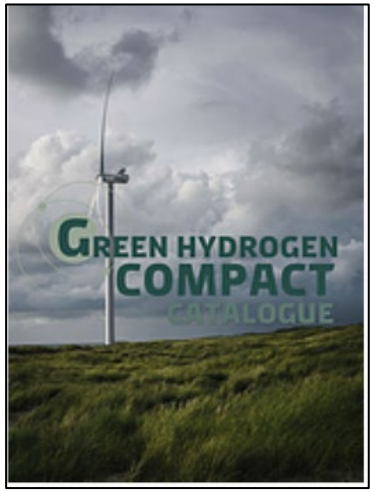
129 GW of new electrolyser capacity by 2030

26 MT green hydrogen annual production by 2030

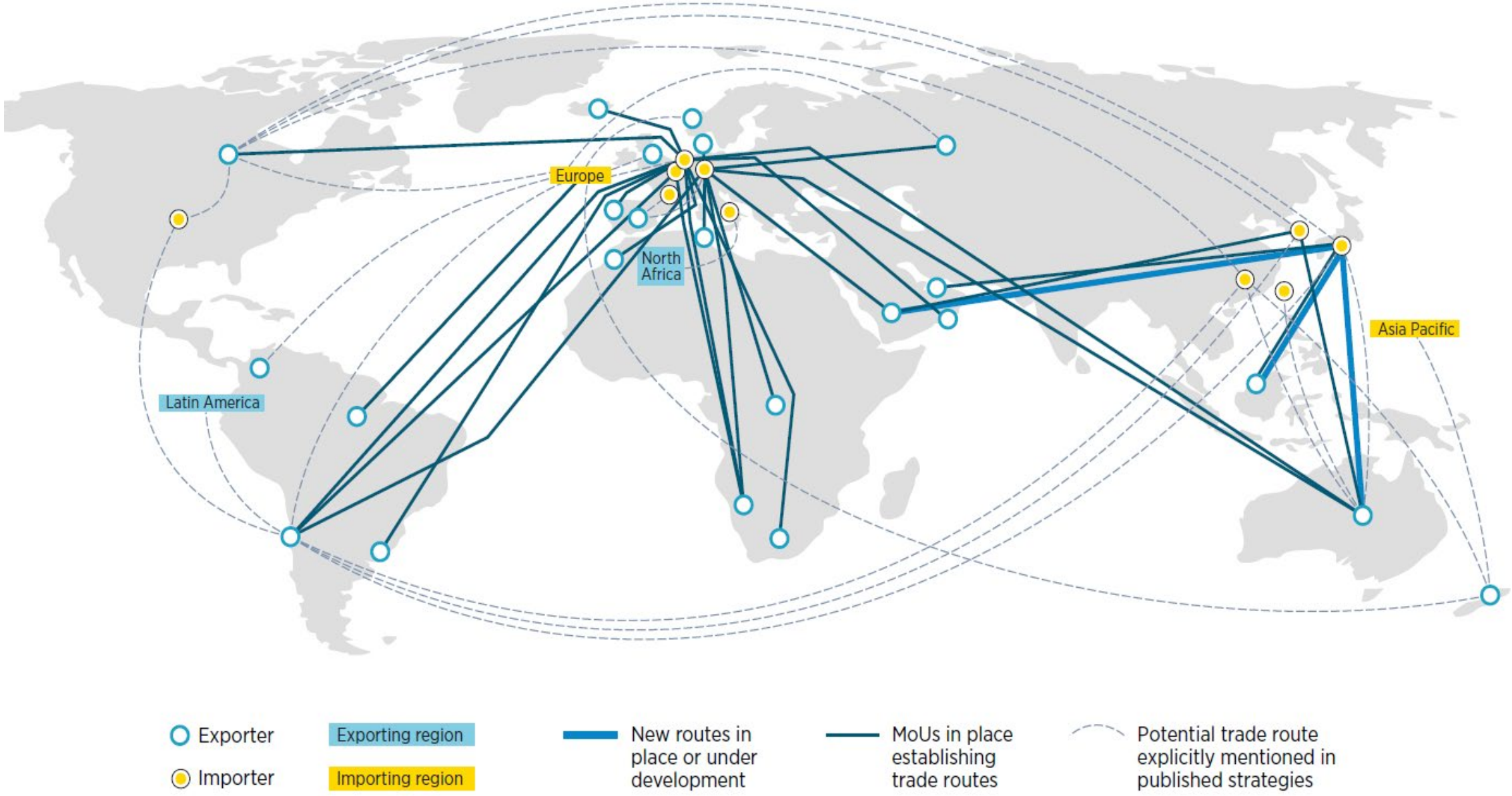
Electrolyzer needs: 350 GW in 2030, 5 000 GW in 2050

Electrolyzer manufacturing capacity

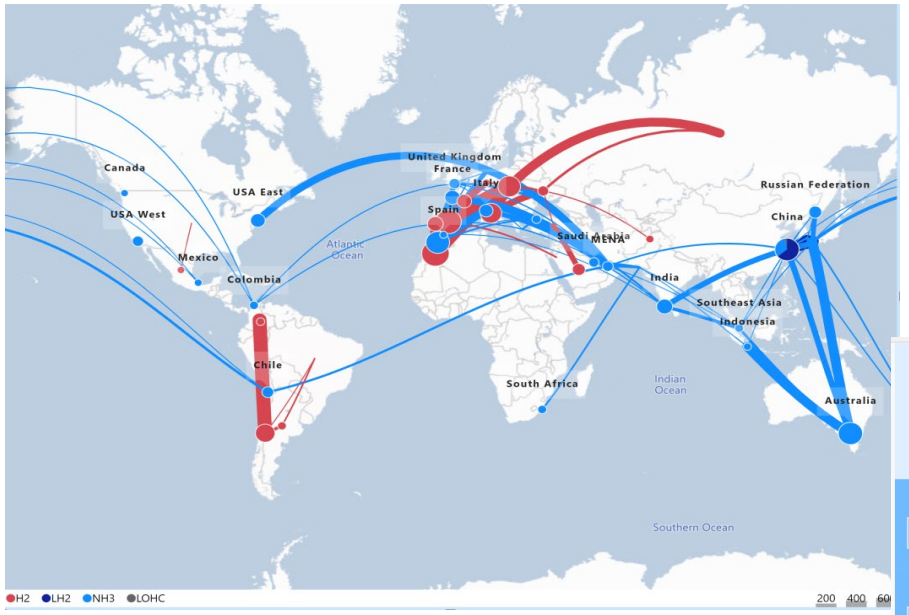




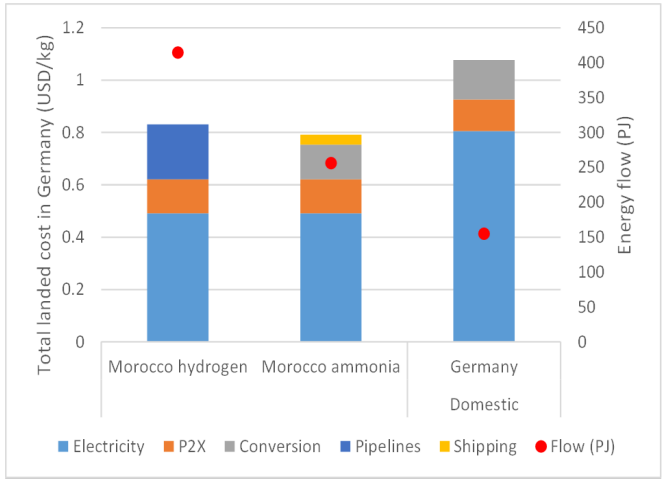
An expanding network of hydrogen trade routes, plans and agreements

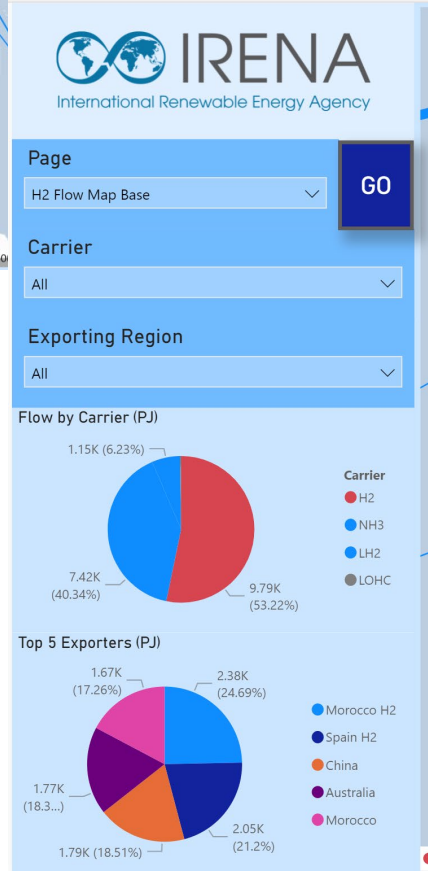


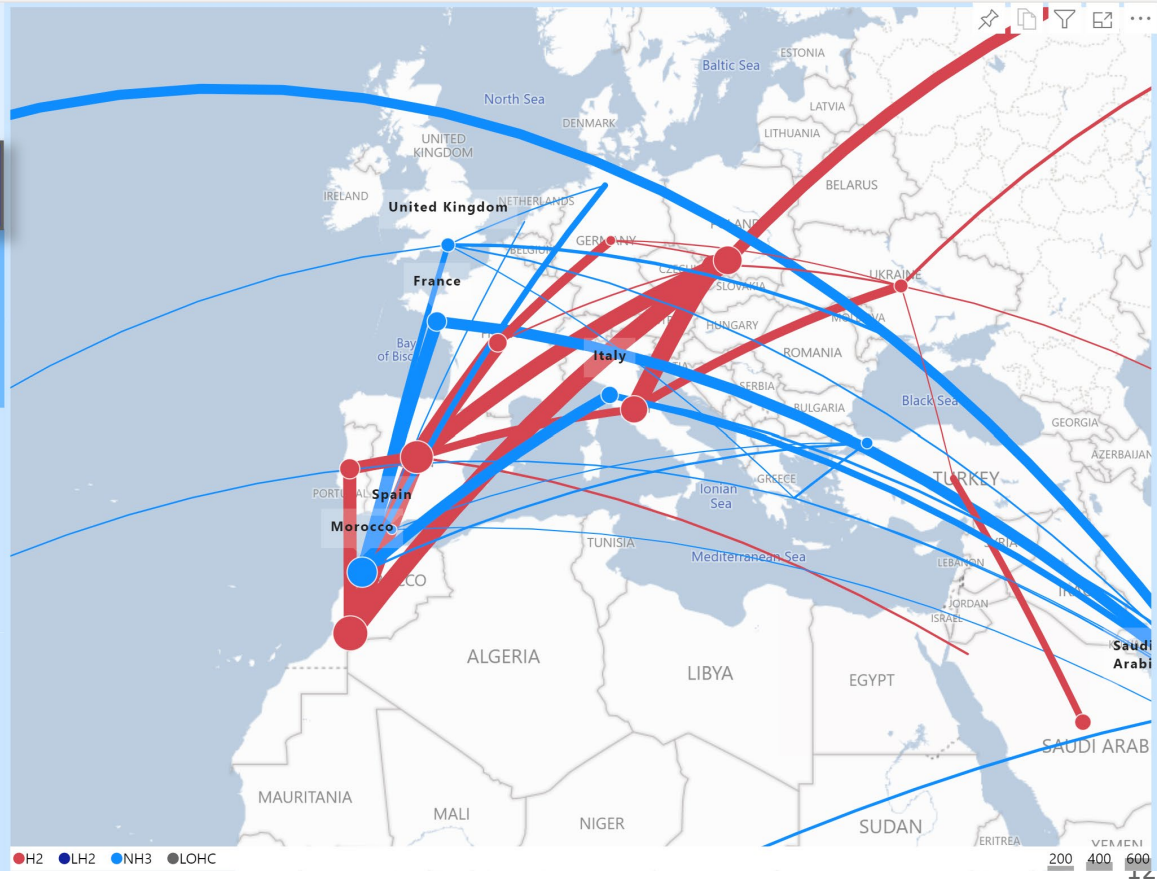
Global trade of hydrogen and ammonia



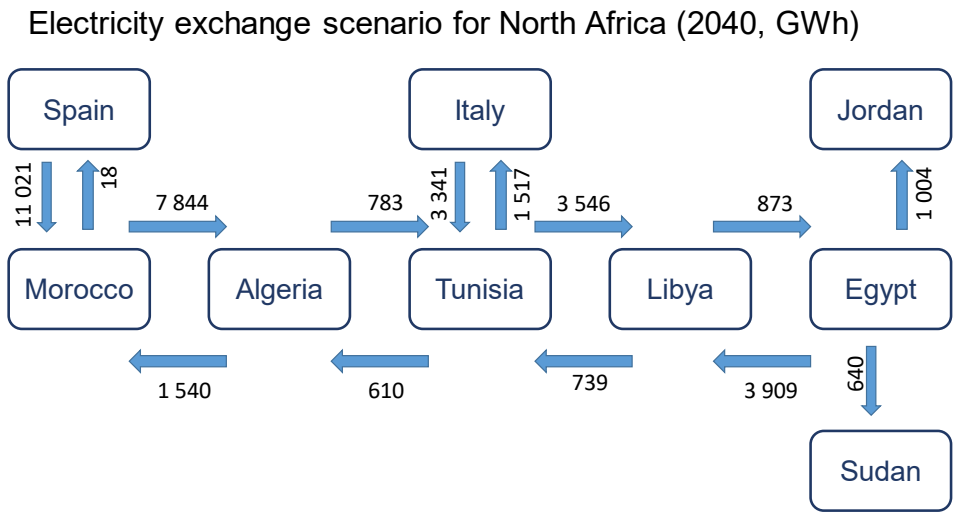
Comparison of landed cost of hydrogen from Morocco to Germany in 2050 (H2 pipelines vs ammonia)



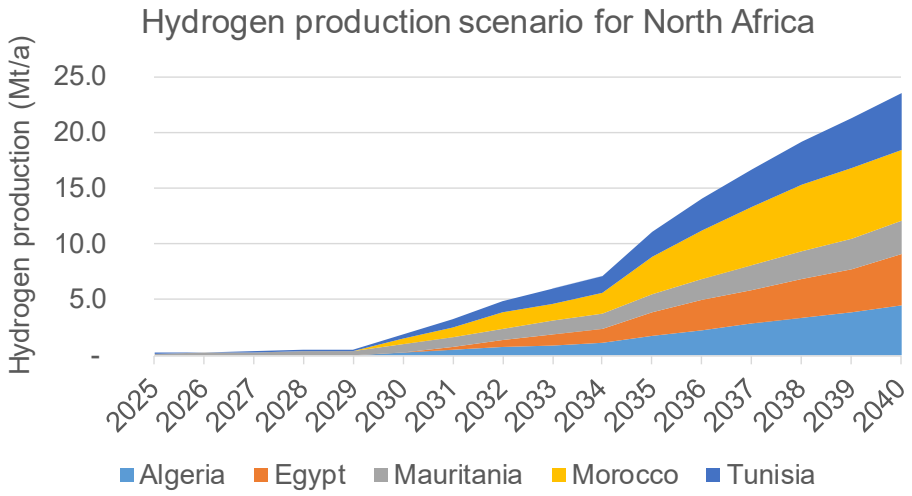


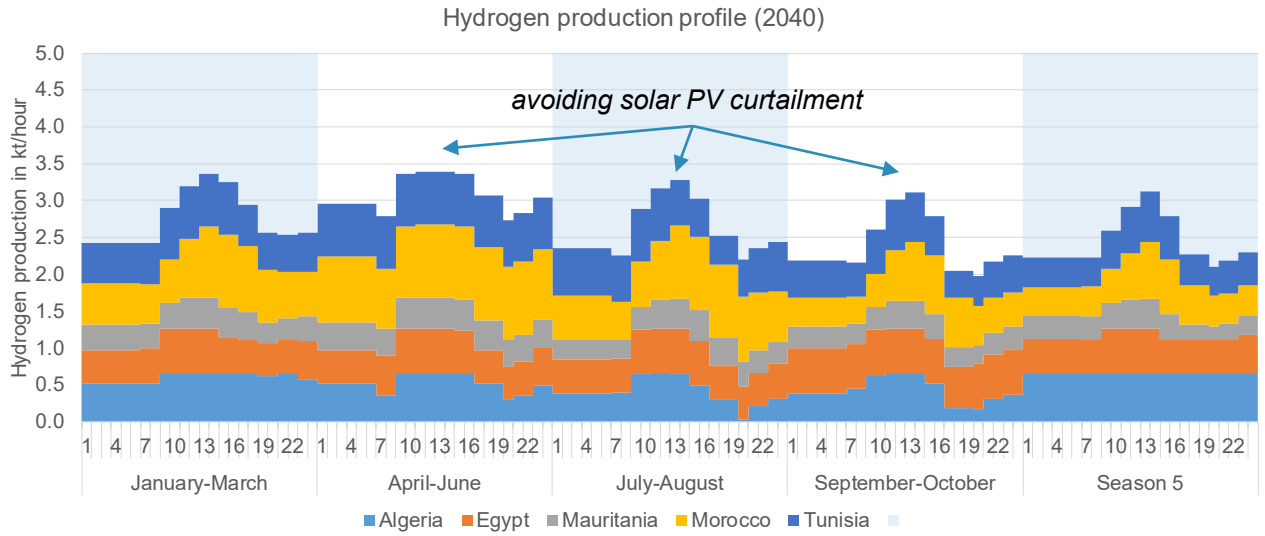


Green hydrogen, VRE and regional trade: North Africa analysis

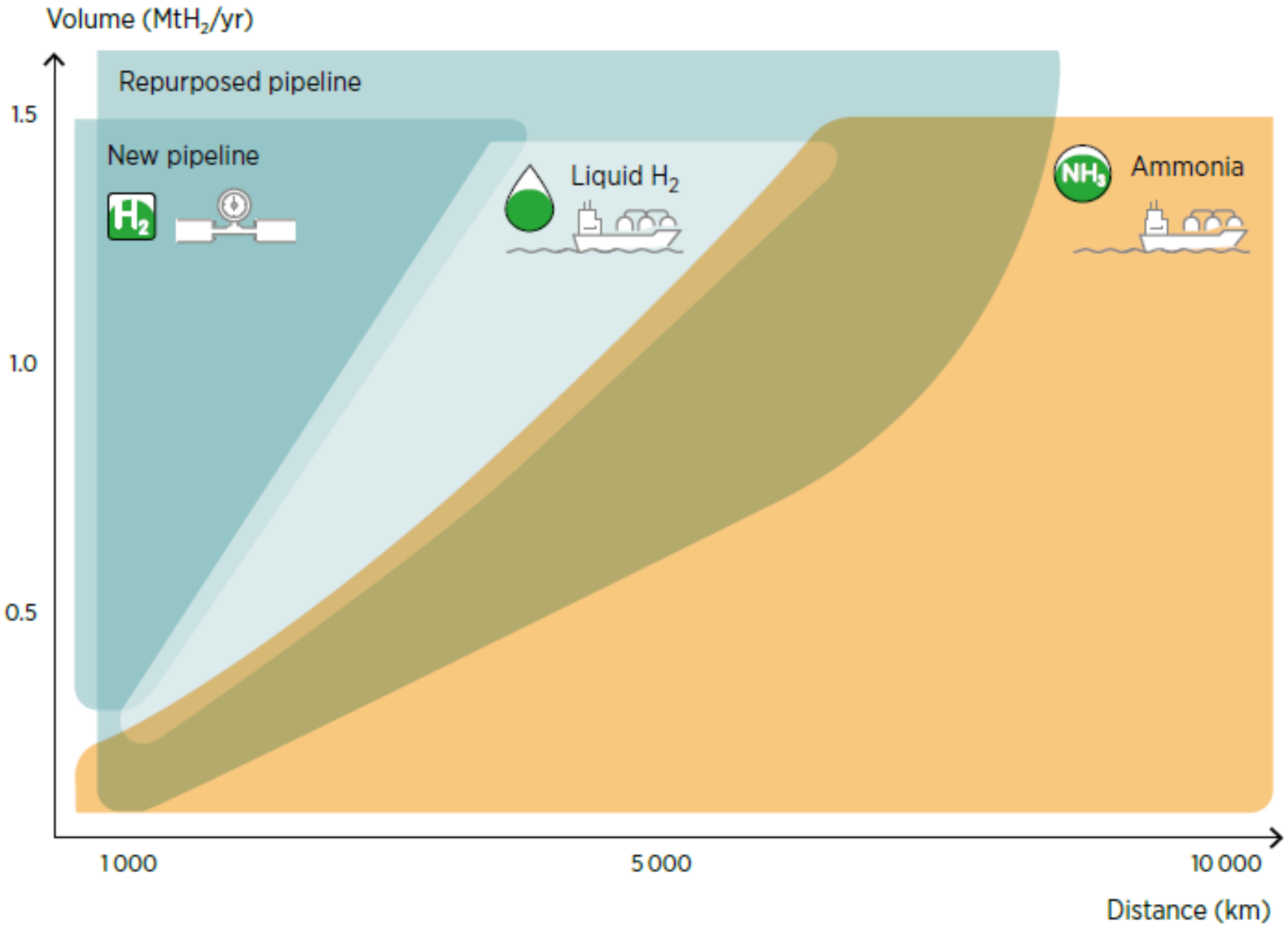


- Latest IRENA analysis underlines **potential role for North African green hydrogen production** for export
- Potential to **lower power generation costs** in North Africa & leverage VRE deployment
- **Important synergies** between
  - Regional trade North Africa & Europe ;
  - VRE and battery storage deployment ;
  - VRE and green hydrogen production for EU market

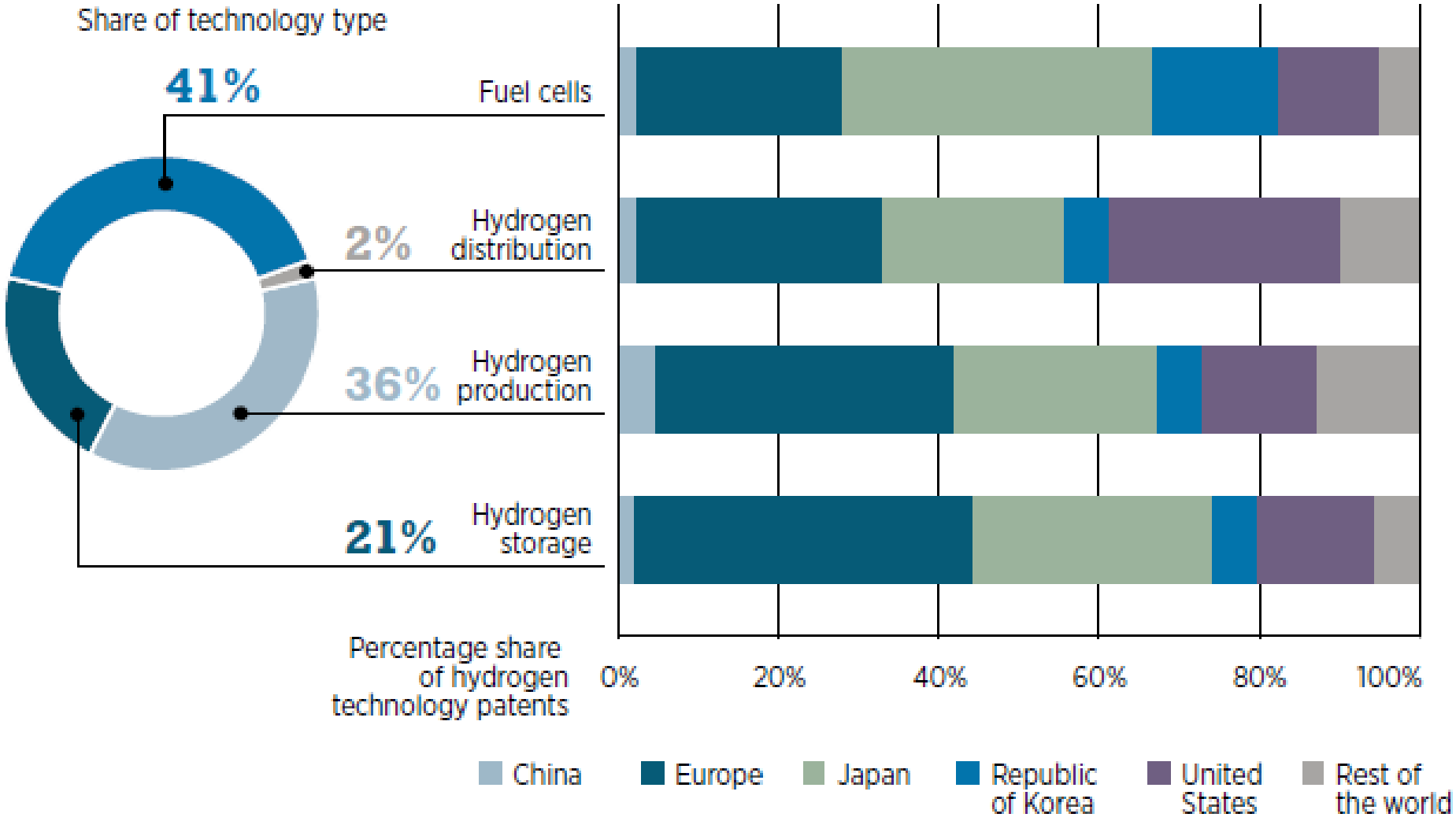




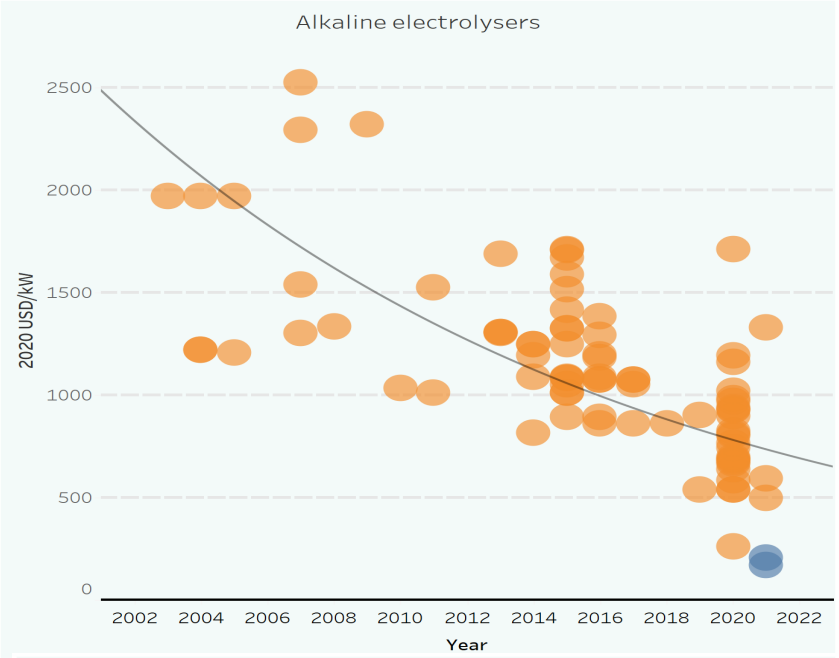
Cost efficiency of transport options when considering volume and distance
Pipelines and ammonia dominate

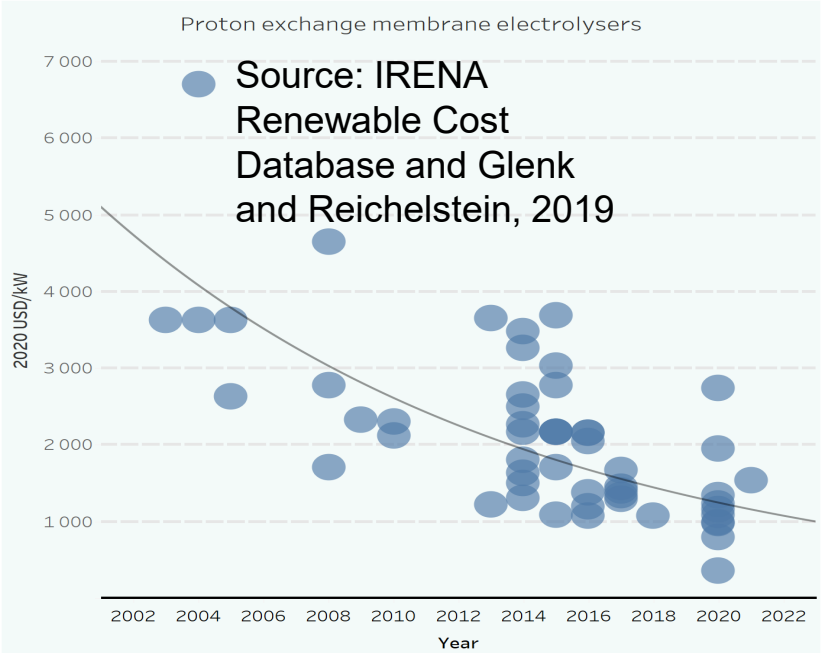


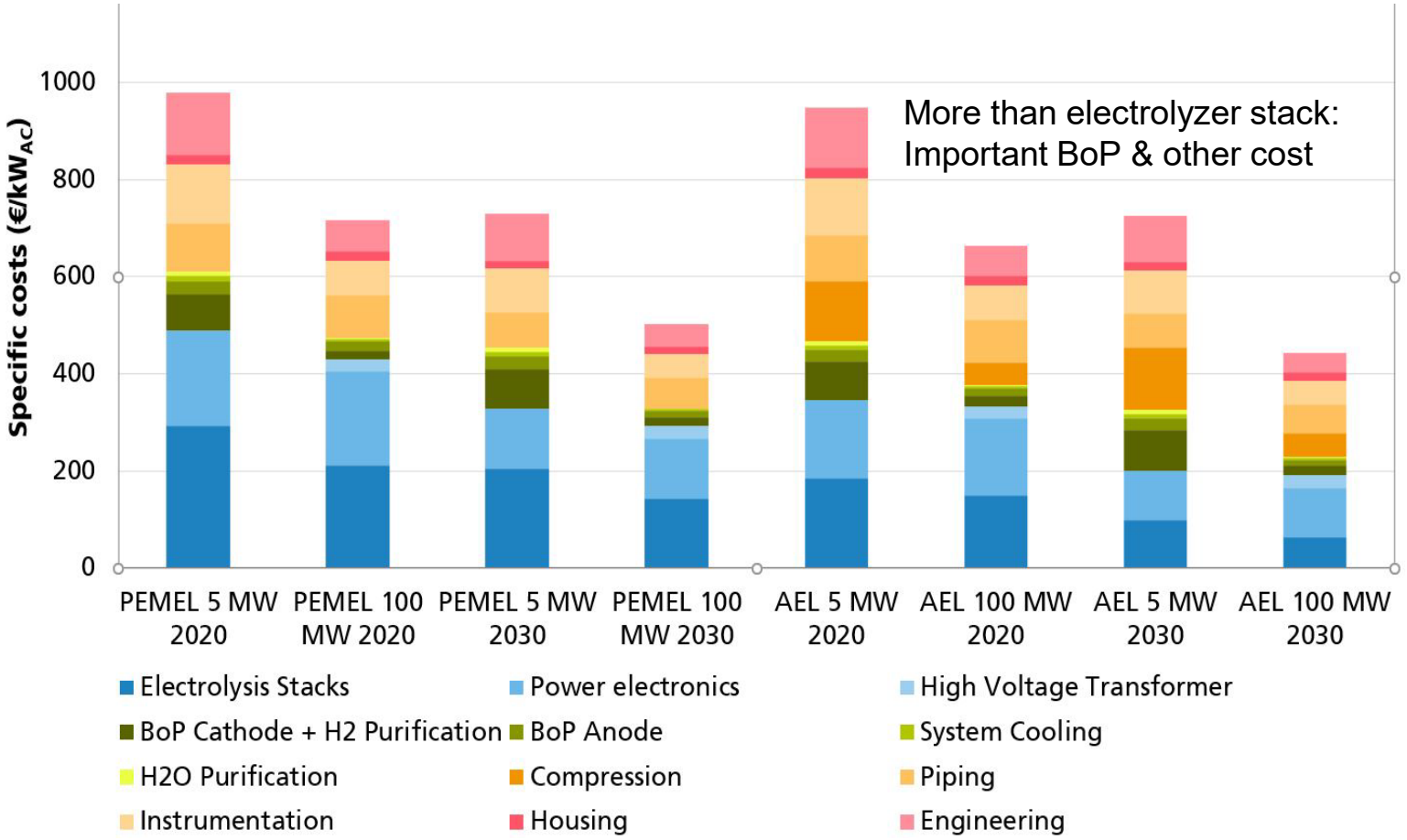
Geographic distribution of hydrogen-related patent families, 2010-2020



Elctrolyser cost trends – 800-1200 USD/kW today, USD 500-600 by 2030



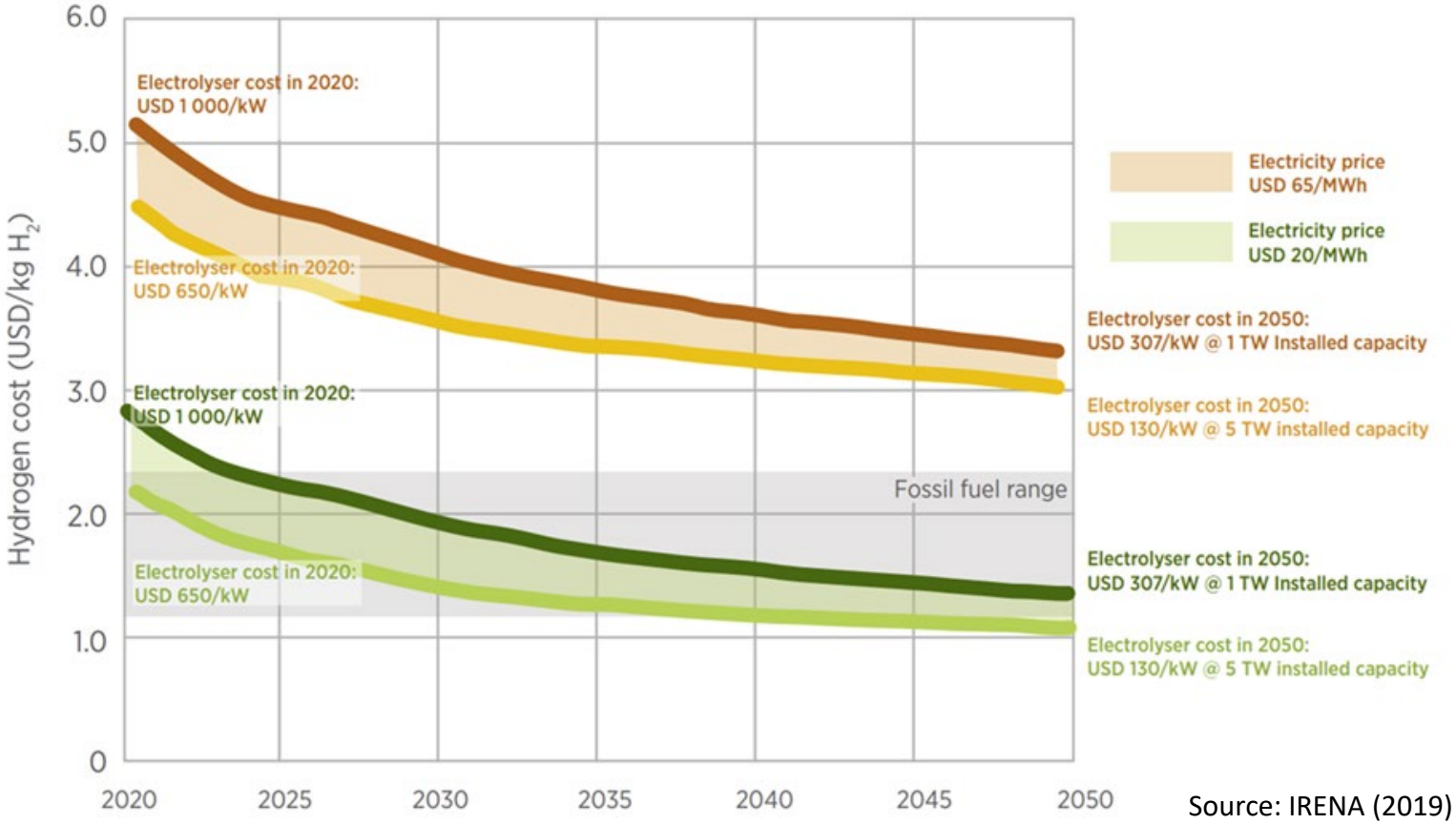




Source: FhG ISE, 2022

Hydrogen production costs
Electricity cost will be key

Green hydrogen will become cheaper than blue hydrogen



Source: IRENA (2019)

Today:

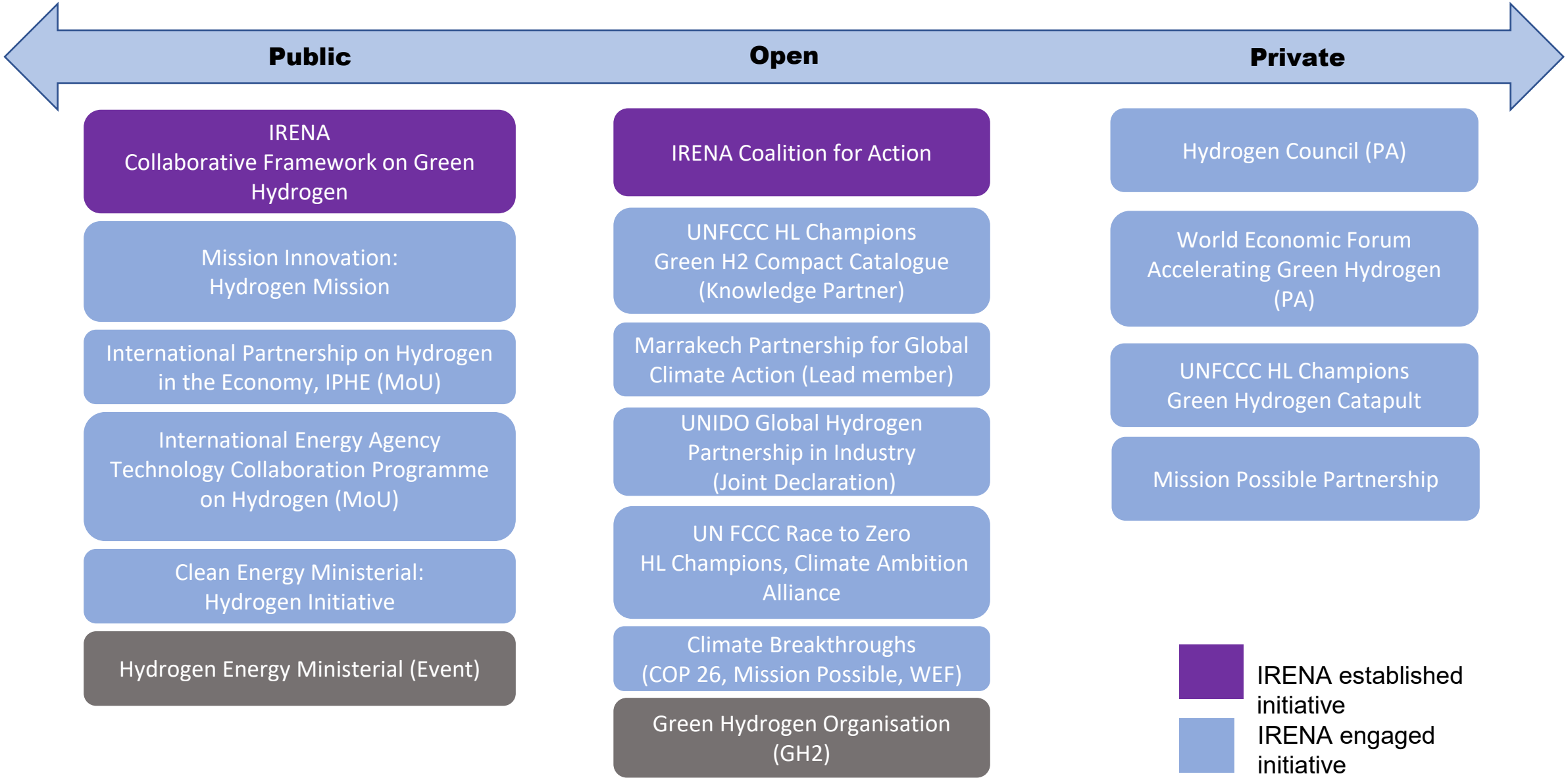
- 98% grey hydrogen supply
- 1% of all hydrogen supply is green and 1% is blue
- <1 GW installed electrolyser capacity
- More than 200 GW pipeline of electrolyser projects

2050 (1.5C scenario):

- Electrolyser system costs may drop to 200 USD/kW in 2050
- Electrolyser efficiency may improve to 45 kWh/kg
- >600 Mt clean hydrogen demand, 2/3 green

Key assumptions electrolyser: Electricity price USD 20/MWh. Efficiency at nominal capacity: 65% in 2020 and 76% in 2050, Electrolyser investment cost (2020): USD 650-1000/kW (USD 130-307/kW as a result of 1-5 TW of capacity deployed by 2050).

Growing collaboration globally across public and private sectors



IRENA's hydrogen work programme

UN Energy Compacts for green hydrogen (Catalogue)

Geopolitics of hydrogen (new report)

Hydrogen **trade perspectives** (upcoming report series)

Collaborative Framework on Green Hydrogen and Geopolitics

Collaboration with WEF on **enabling frameworks** for green hydrogen

Collaboration with Ammonia Energy Association on Innovation Outlook for **Green Ammonia**

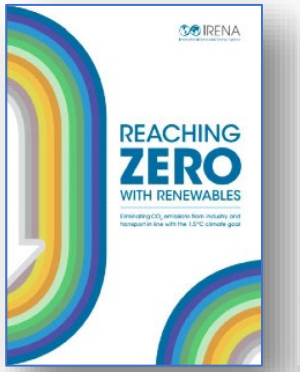
Hydrogen **policy** briefs

Deep dives into topics; hydrogen in the gas grid, certification & standards, electrolysis cost

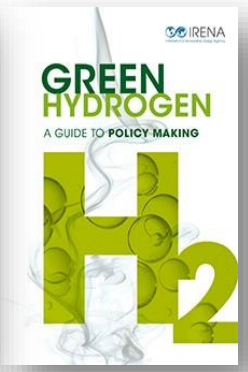
IRENA Hydrogen Policy Day 8 March

WETO 2022 launch end March BETD – hydrogen deepdive

IRENA G7 & G20 Hydrogen activities

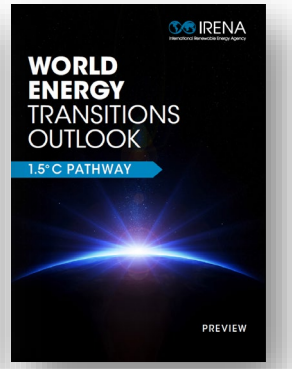


September 2020

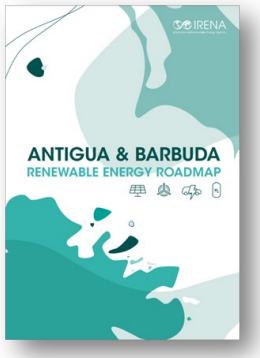


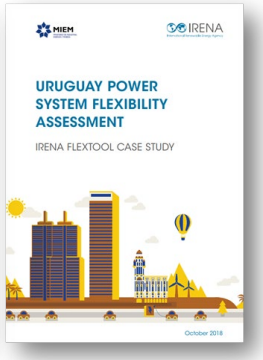
November 2020

December 2020

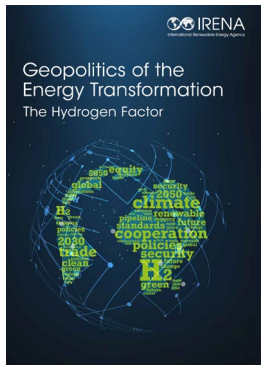


March 2021





Country-specific studies of hydrogen as flexibility option



January 2022

Thank you