Hydrogen from Renewable Power

Technology Outlook for the Energy Transition

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Power Sector Transformation Strategies
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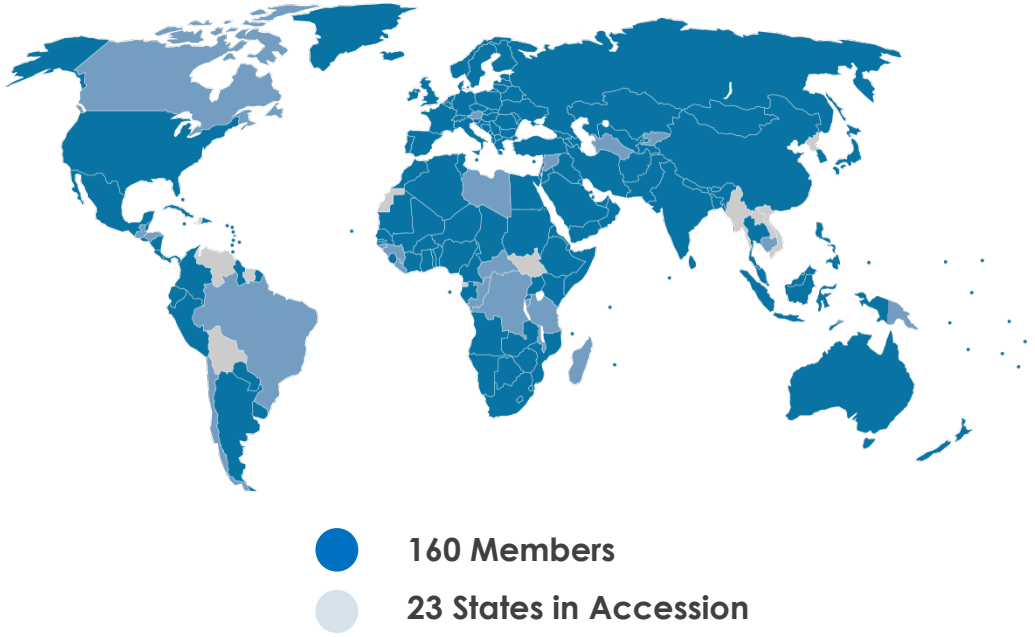
About IRENA

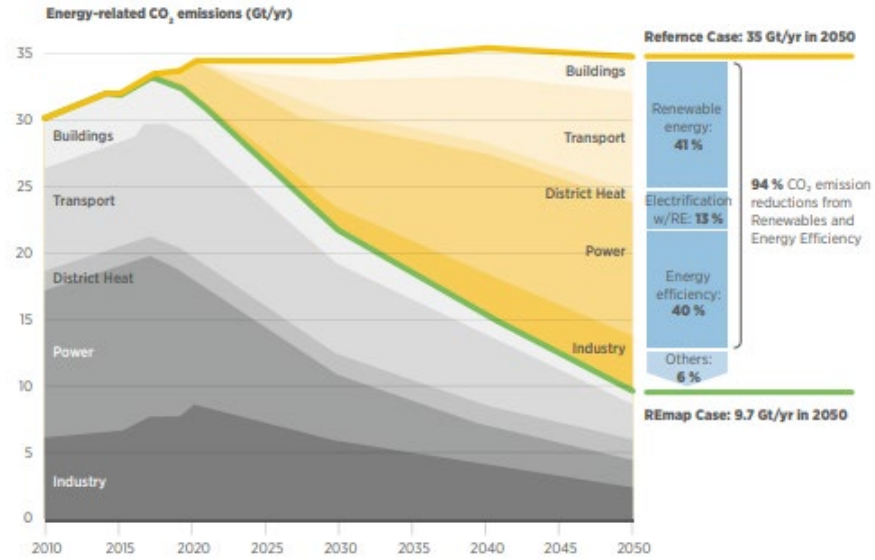
- Inter-governmental agency established in 2011
- Headquarters in Abu Dhabi, UAE
- IRENA Innovation and Technology Centre – Bonn, Germany
- Permanent Observer to the United Nations – New York

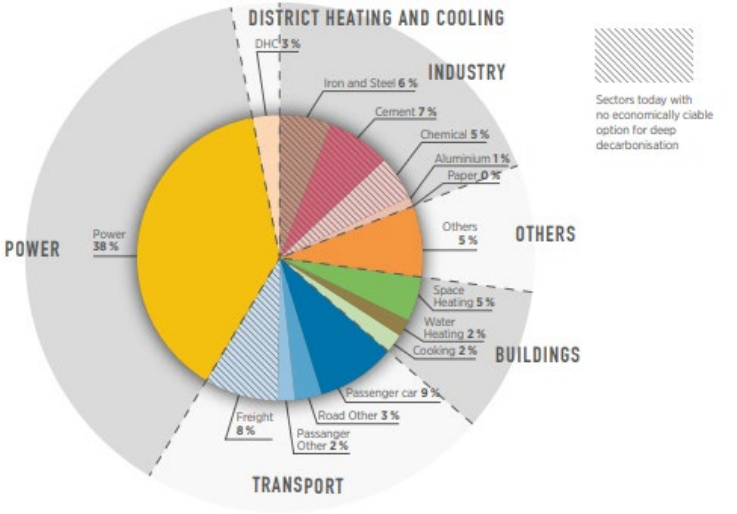


Mandate: Assist countries to accelerate renewable energy deployment

Context: the Global Energy Transformation

- ✓ Paris Agreement: Average global temperature to **“well below 2 degrees”**
- ✓ **No economically viable options** to decarbonize one third of energy-related emissions (Mostly from the energy-intensive industry sectors and freight transport).
- ✓ **Hydrogen could be the “missing link”**: supply renewable energy to sectors for which electrification is otherwise difficult, such as transport, industry and processes that require high-grade heat

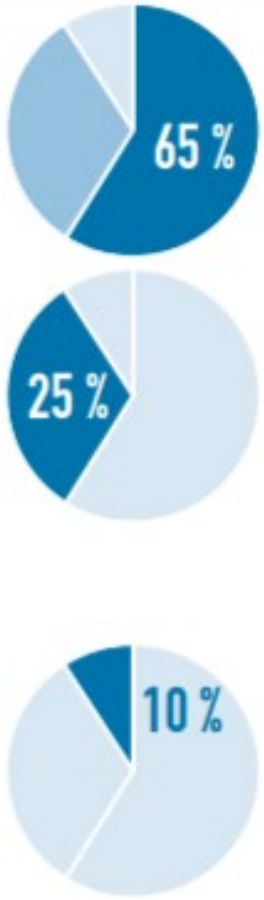




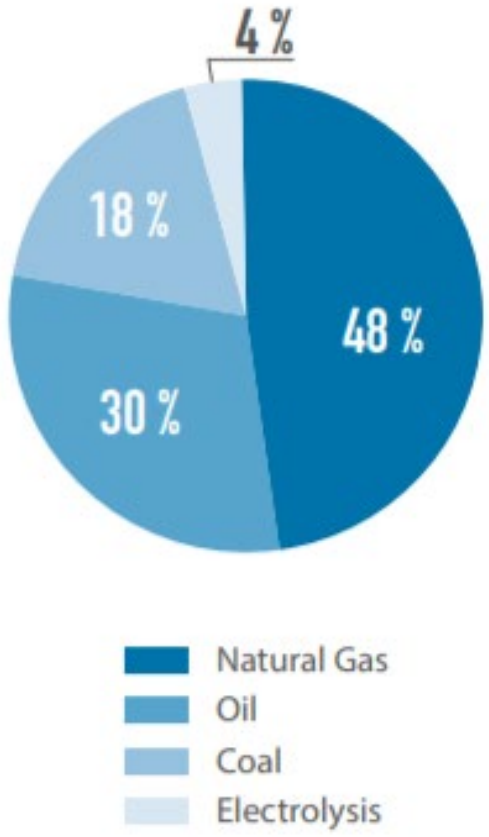
Global Hydrogen Demand and Production Sources

INDUSTRY SECTOR	KEY APPLICATIONS
CHEMICAL	• Ammonia • Polymers • Resins
REFINING	• Hydrocracking • Hydrotreating
IRON & STEEL	• Annealing • Blanketing gas • Forming gas
GENERAL INDUSTRY	• Semiconductor • Propellant fuel • Glass production • Hydrogenation of fats • Cooling of generators

PERCENTAGE OF GLOBAL H_2 DEMAND



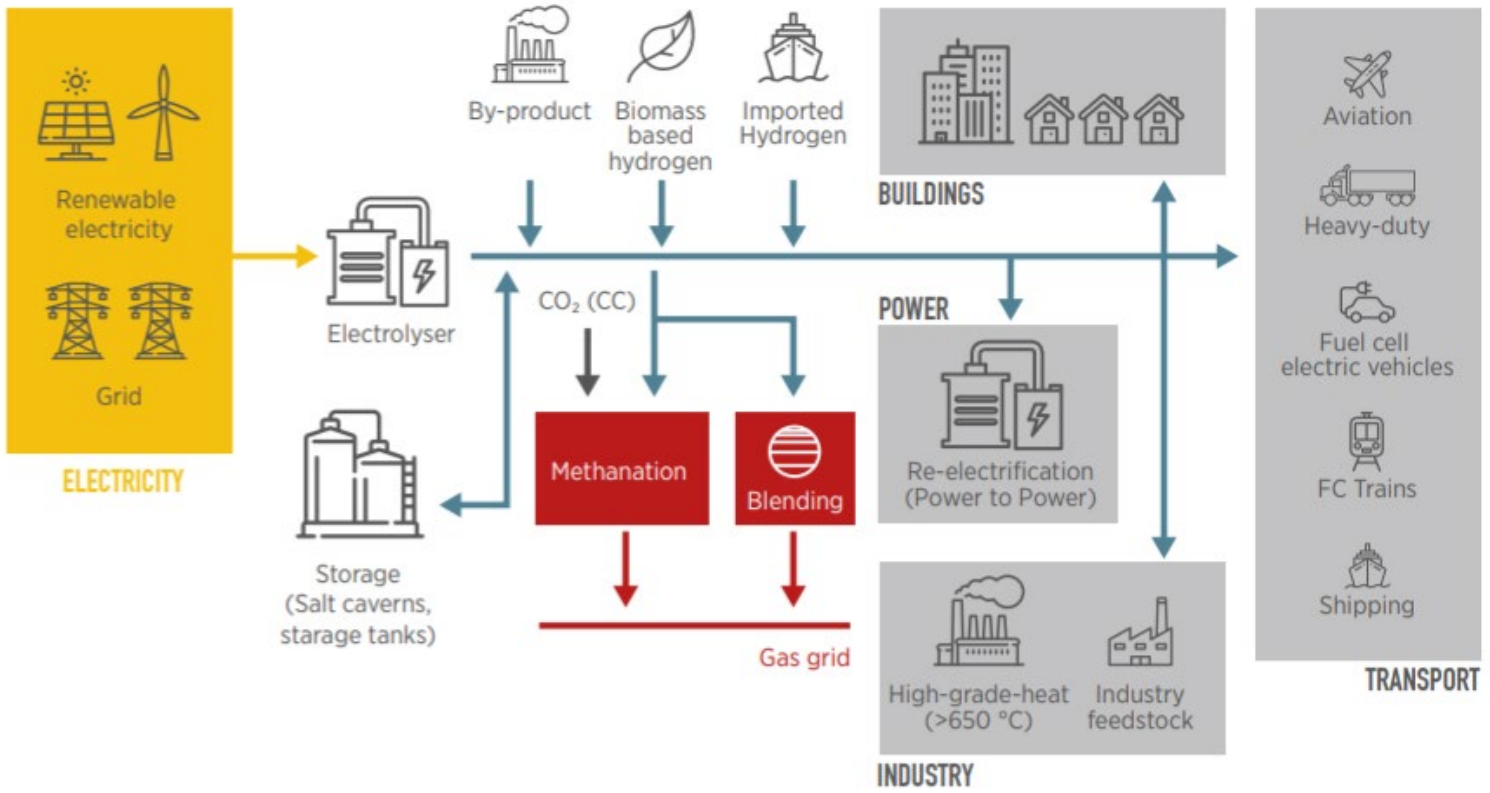
HYDROGEN SOURCES



Hydrogen in the energy transition

Hydrogen and electricity, as energy carriers, are complementary in a world dominated by renewable energy

- ✓ **Decarbonising Transport:**
  - ✓ FCEVs: performances of conventional vehicles
  - ✓ FCEVs are complementary to BEVs in decarbonising road transport
- ✓ **Decarbonising Industry:**
  - ✓ Replace fossil-fuel produced hydrogen
  - ✓ Replace fossil-fuel based feedstocks
- ✓ **Decarbonising the gas grid:**
  - ✓ Take advantage of low electricity prices
  - ✓ Provide seasonal storage for solar and w
  - ✓ Provide grid services from electrolysers



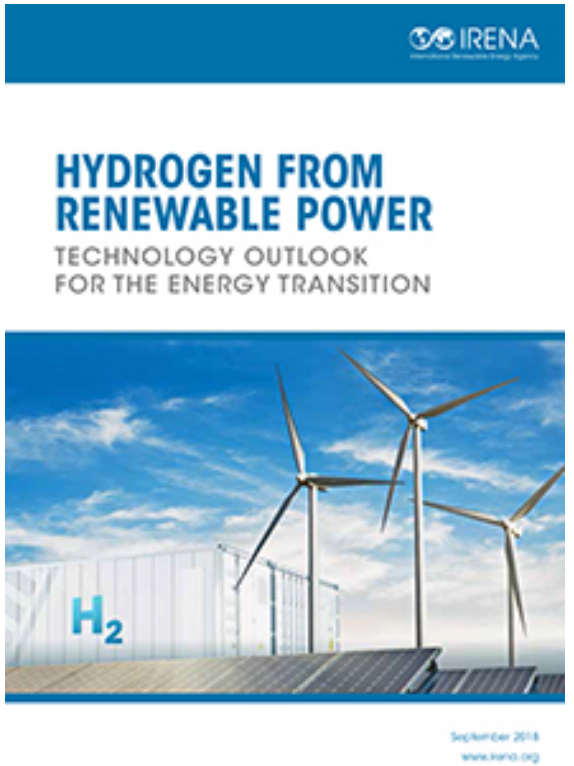
Challenges and enablers for scaling-up production of hydrogen from renewable power

IRENA
International Renewable Energy Agency

	Electricity system	Green H_2 production	Conditioning and logistics	Distribution	End use
Key Challenges	Electricity prices				**Transport** - Initial high costs and low volume - Investment and technology risk perception - Need for dedicated refuelling infrastructure (HRS)
	Difficulty to monetise electrolyser flexibility				**Industry** - High green hydrogen price vs. fossil-based hydrogen - Hydrogen for high temperature heat significantly more expensive than current fuels
			Technology scale-up		**Natural gas grid** - Hydrogen cost vs. natural gas - Blending limits (technical)
Enabling measures	Facilitate access to low-cost renewable electricity		Promote market uptake de-risking/insurance instruments ("take or pay")		**Transport** - Market pull regulations (zero-emission zones, emission standards, etc.) - Market push instruments (CAPEX subsidy, tax rebates, etc.) Infrastructure: Long-term supporting policy for hydrogen giving visibility for industrial actors, investment subsidies for HRS
	Partial exemptions of grid charges, taxes and levies for electrolysers*				**Industry** - Carbon pricing - Sectorial mandates (emission, RE content, etc.)
	Create a level playing field for flexibility services to unlock access fo electrolysers				**Natural gas grid** - Feed-in tariff - Carbon pricing - Harmonized blending limits
Recognising hydrogen's role in energy transition					

*Provided that they run in system beneficial mode

Source: Adapted from HINICIO (2016).



https://irena.org/energytransition/Power-Sector-Transformation/Hydrogen-from-Renewable-Power


IRENA INNOVATION WEEK 2018
ELECTRIFICATION
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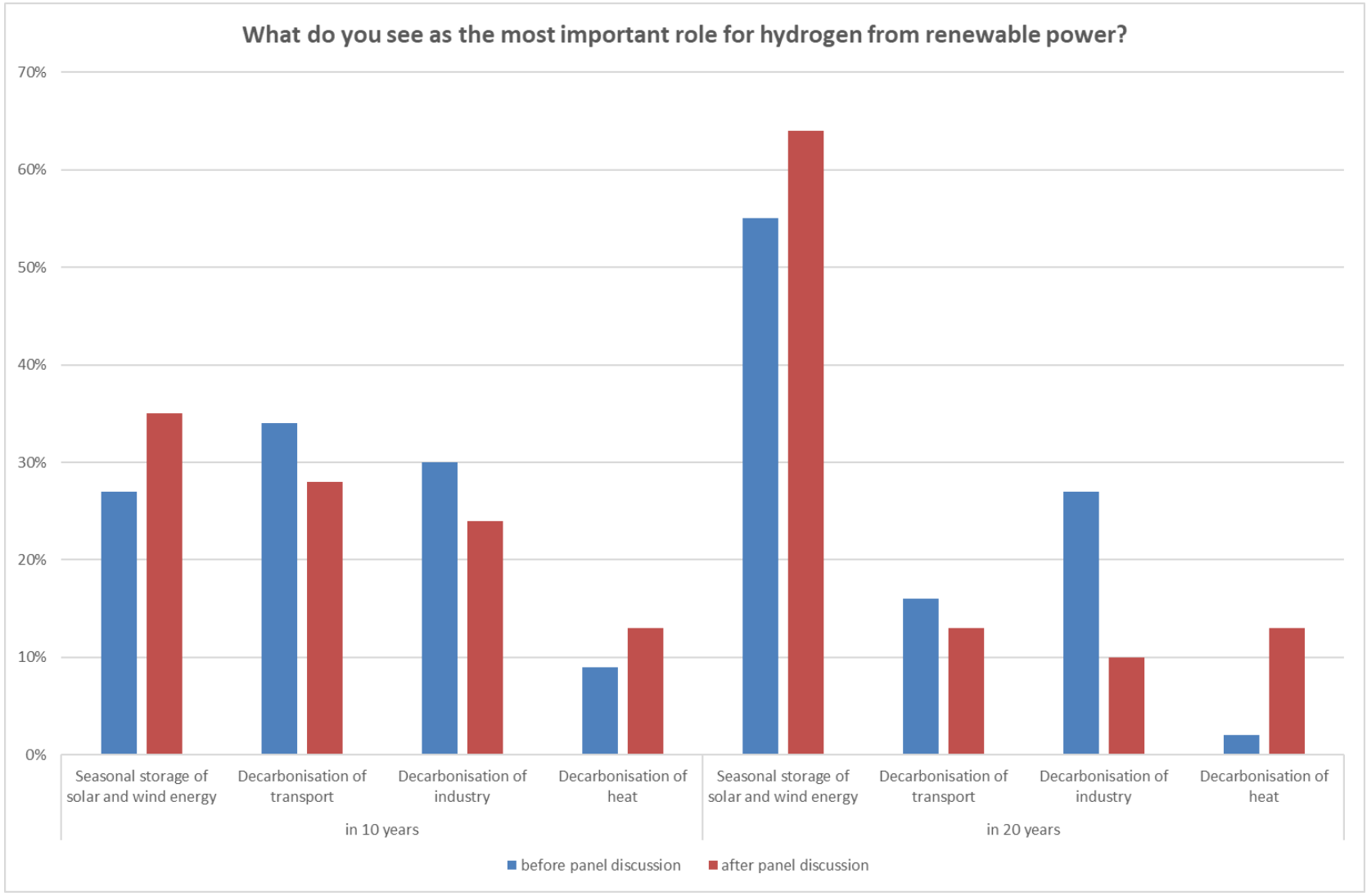
Feedback from IRENA Innovation Week participants
Role of hydrogen from renewable power

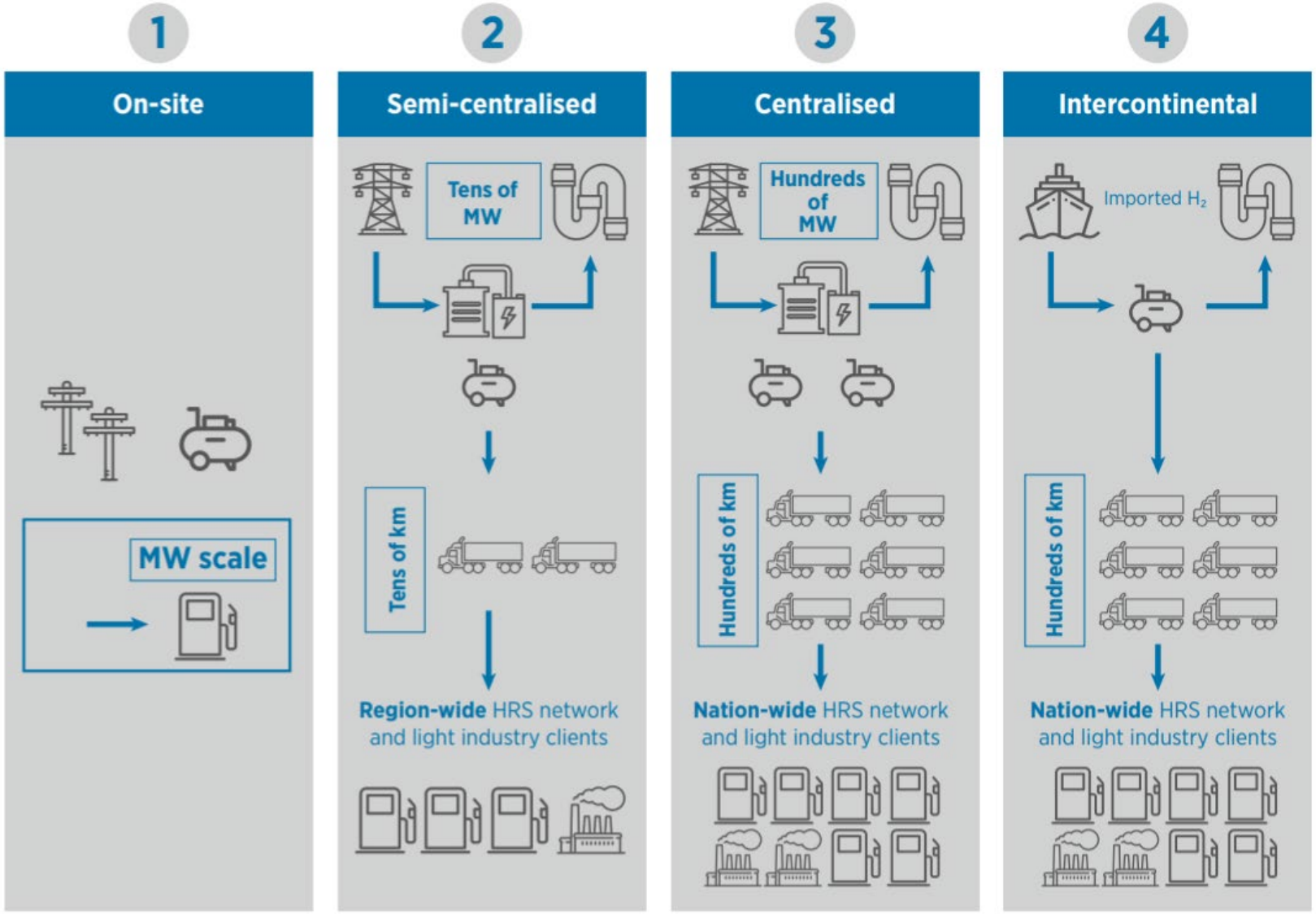
- ✓ Before and after the panel, audience associated hydrogen with **solar and wind integration** in the 20 years

- ✓ People shifted **from industry towards heat in 20 years**, probably appreciating better that competitiveness in industry is not easy

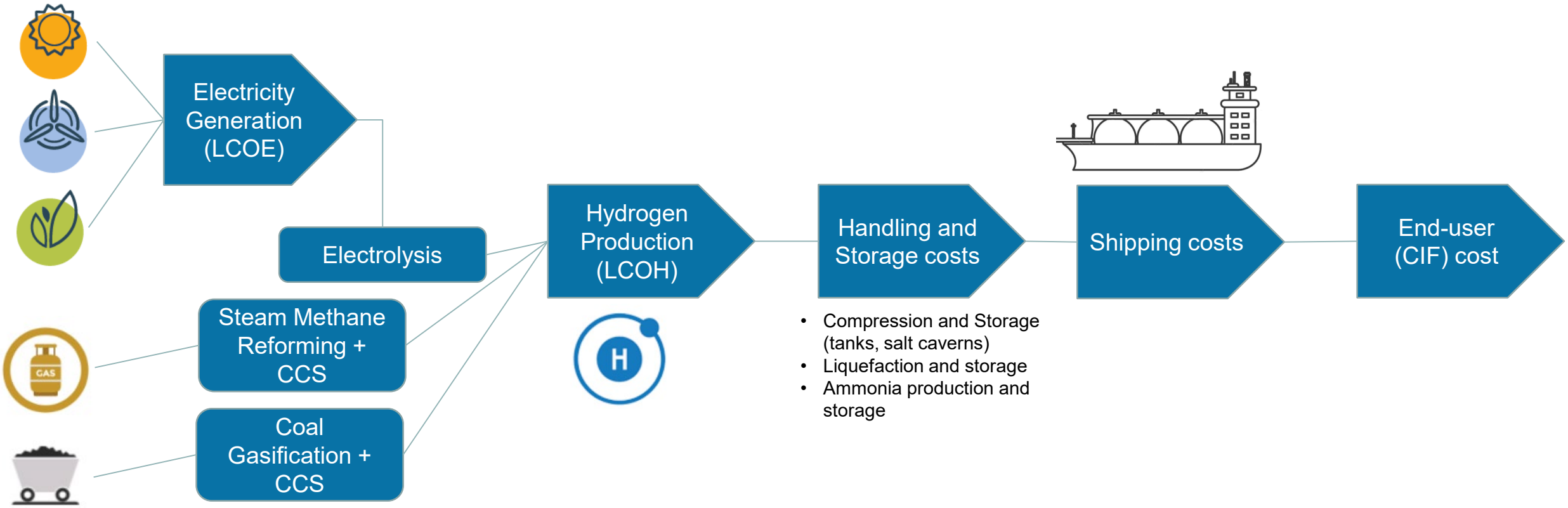
- ✓ Before the panel, audience associated hydrogen more with **transport** than RE in 10 years
  - ✓ **After** the panel, opinion shifted more towards **solar and wind integration**



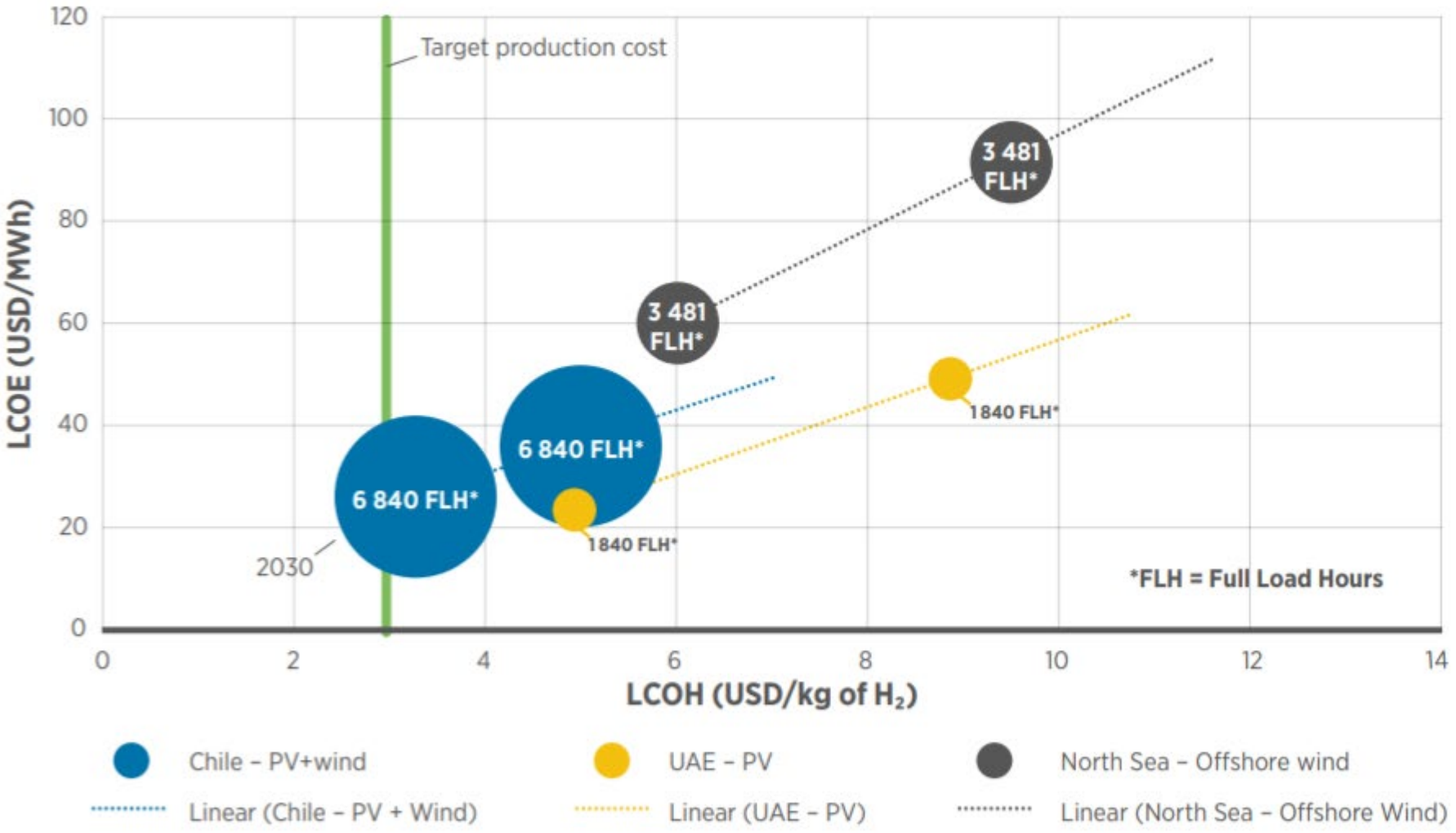
Supply chain options for hydrogen production and supply



Hydrogen Supply Chain: Renewables, Coal and Natural Gas



Hydrogen cost from renewable electricity



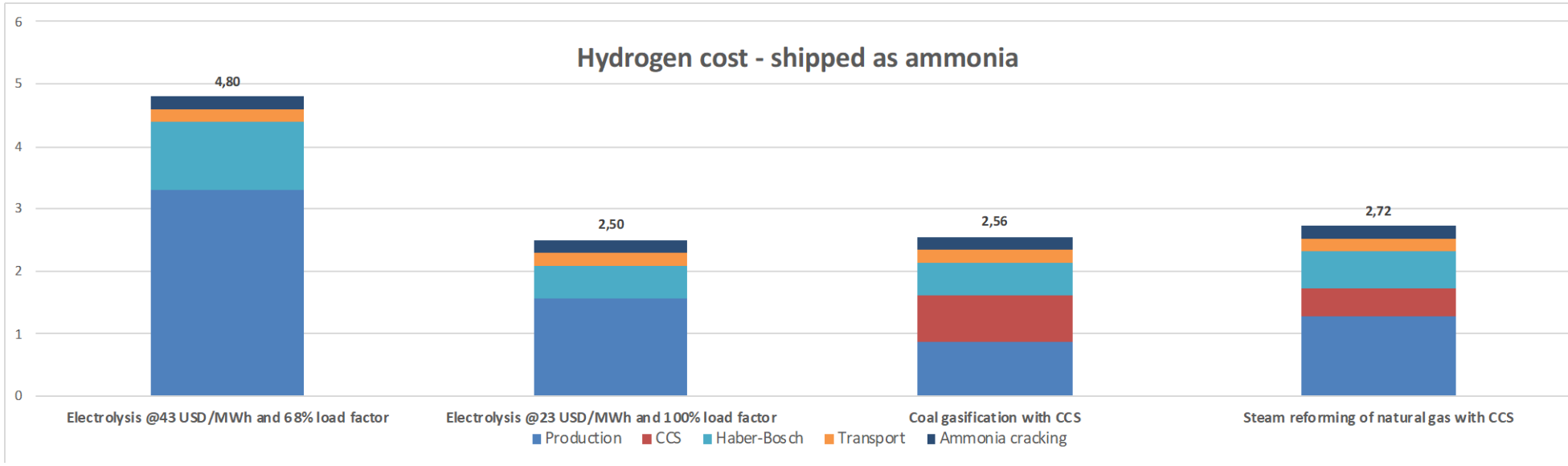
Hydrogen: Total Costs (production, storage and shipping)

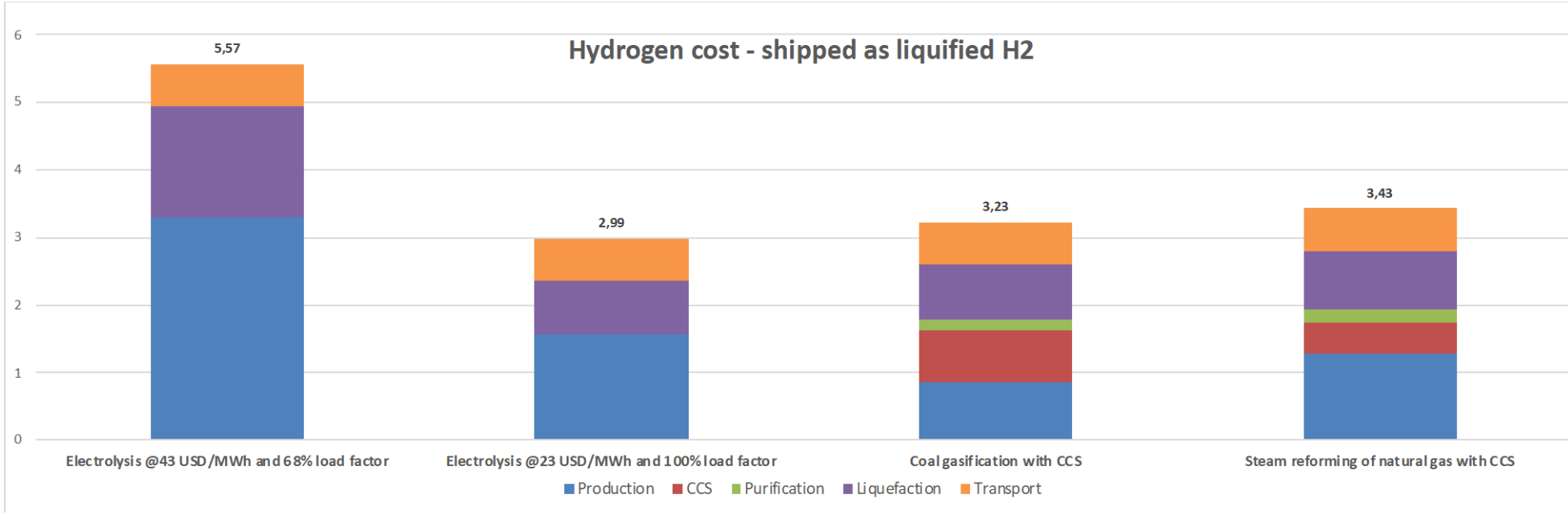
Australia -> Japan (USD/Kg H2)

- Wind + PV today: 43 USD/MWh and 6,000 h/year
- Best case electrolysis from RE: 23 USD/MWh and 8,000 h/year
- Natural gas price:

  5 USD/million BTU
- Brown coal price:

  2 USD/GJ and 10.3 MJ/kg





Policy Recommendations

- Strengthening economic case for **intercontinental hydrogen trade**, allowing for remote RE resources to supply high demand centres. This helps climate change mitigation as well as energy security

- To date, grey and blue hydrogen are cheaper, but **green hydrogen is in a good path to become the best economic choice in the future**, coupled with best renewable energy resources

- **Dedicated renewable plants seem more promising in the long term**. Electrolyzers connected to the grid and running only when prices are low risk to have insufficient operating hours, although can be located closer to demand and save on significant logistic costs

- There are still **uncertainties regarding applications.** Asia seems to be keen to hydrogen use mostly in **transport**, while **industrial applications** are considered in several regions: opportunities for oil and gas exporters

- **Ammonia** offers the immediate prospect of decarbonising the ammonia market and fertilizer industry as a first step, before hydrogen demand scales up in end uses

- The **steel industry** seems particularly promising, based on newer processes such as DRI: export commodities produced using hydrogen from renewable power rather than hydrogen itself

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