

A photograph of an offshore oil rig at sunset. The sun is low on the horizon, creating a bright orange and yellow glow across the sky and reflecting on the dark blue water. The rig's structure is silhouetted against the bright sky. A yellow banner is overlaid on the image, containing the title text.

Global Hydrogen Market Prospects

Synergies with Gas and LNG

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Outline

- Blue vs Green H2
- Natural gas, LNG markets & prospects
- Synergies between gas/LNG and H2
- Opportunities and constraints for H2 transition
- Outlook for H2 in energy mix



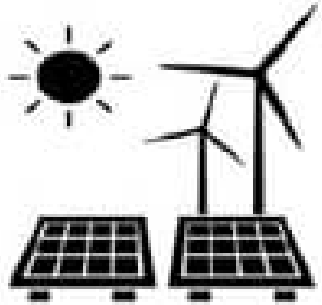
Generation

Conversion

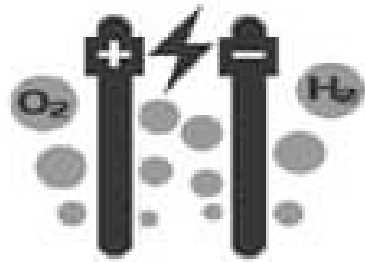
Storage /
Transportation

Application

Green/clean hydrogen

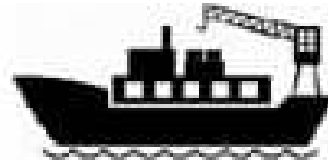


Wind or solar farms generate surplus energy



Electrolysis

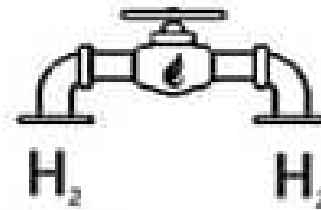
■ **Cost: US\$3-6 / kg**



Liquefied Hydrogen Gas



Natural Gas terminals



Natural Gas pipelines



Fuel cell cars, trains, public transport



Householding, appliances, heating

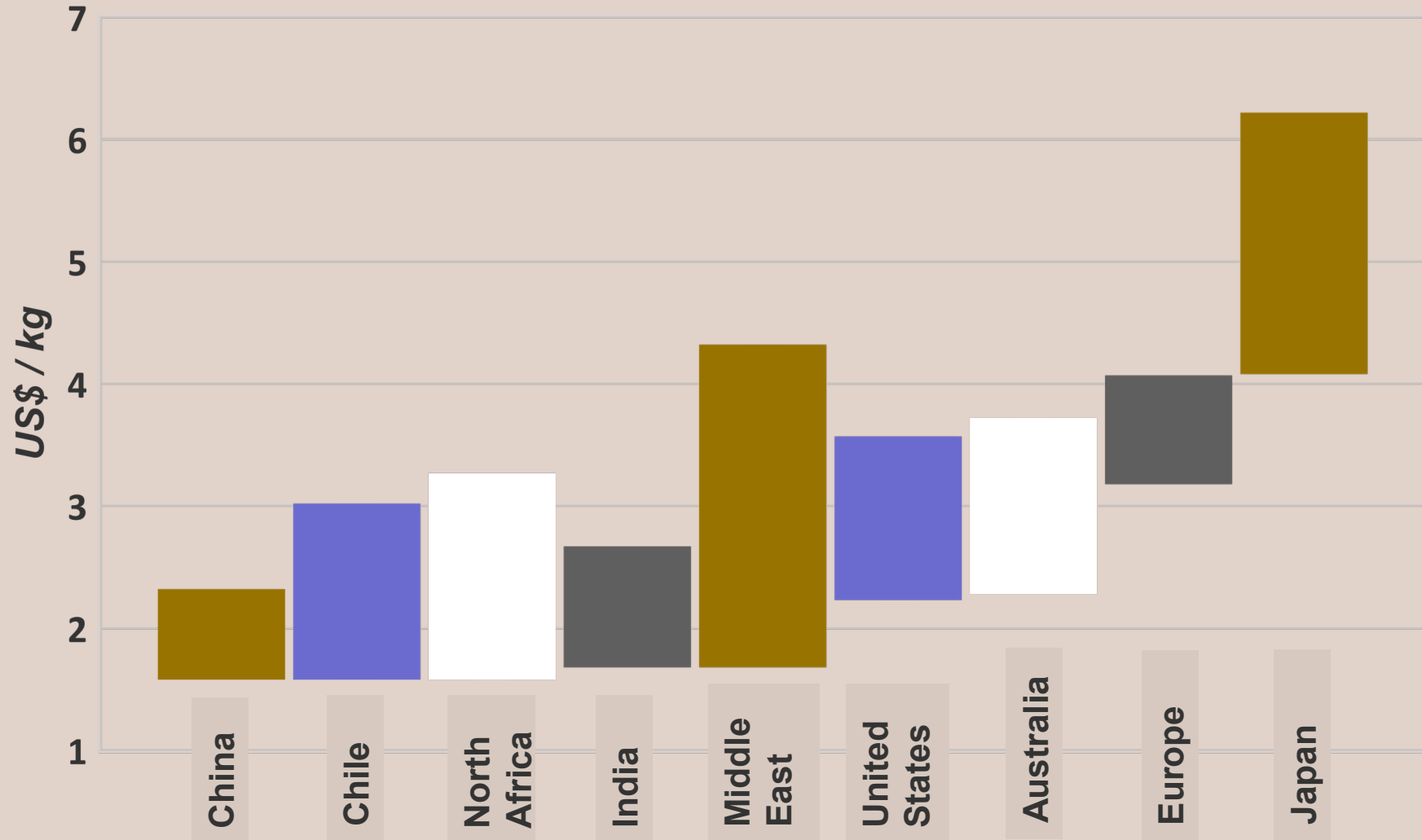


Petrochemicals, steel, refineries



Direct use electricity

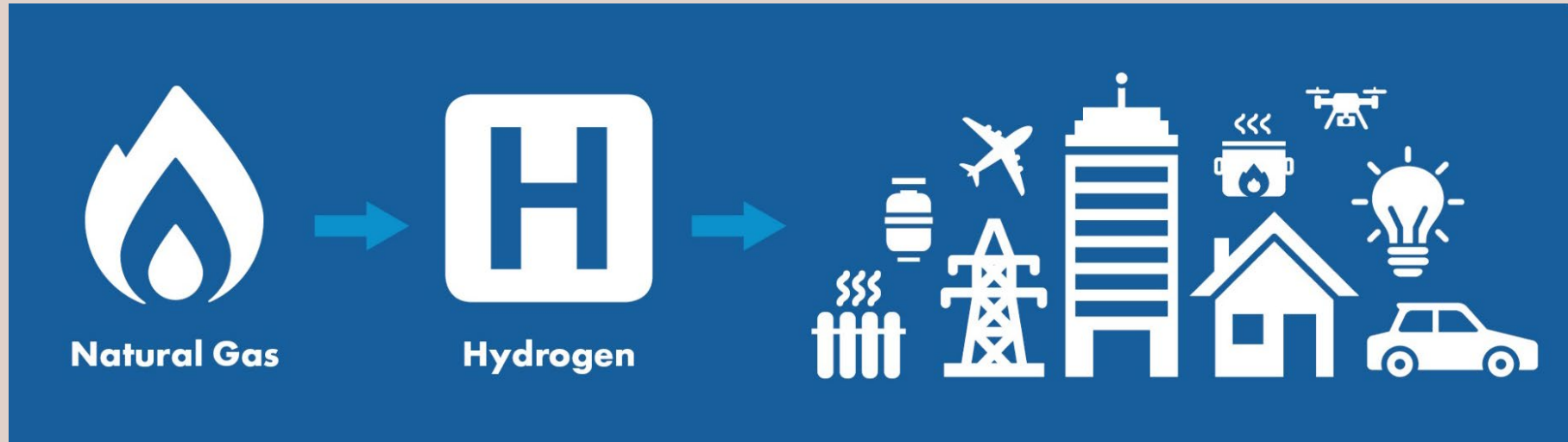
Green hydrogen production costs



■ Source: IEA (2019)

- Short- vs long-term costs, assume rising CO2 prices

Blue hydrogen (sometimes grey)



Steam methane reforming

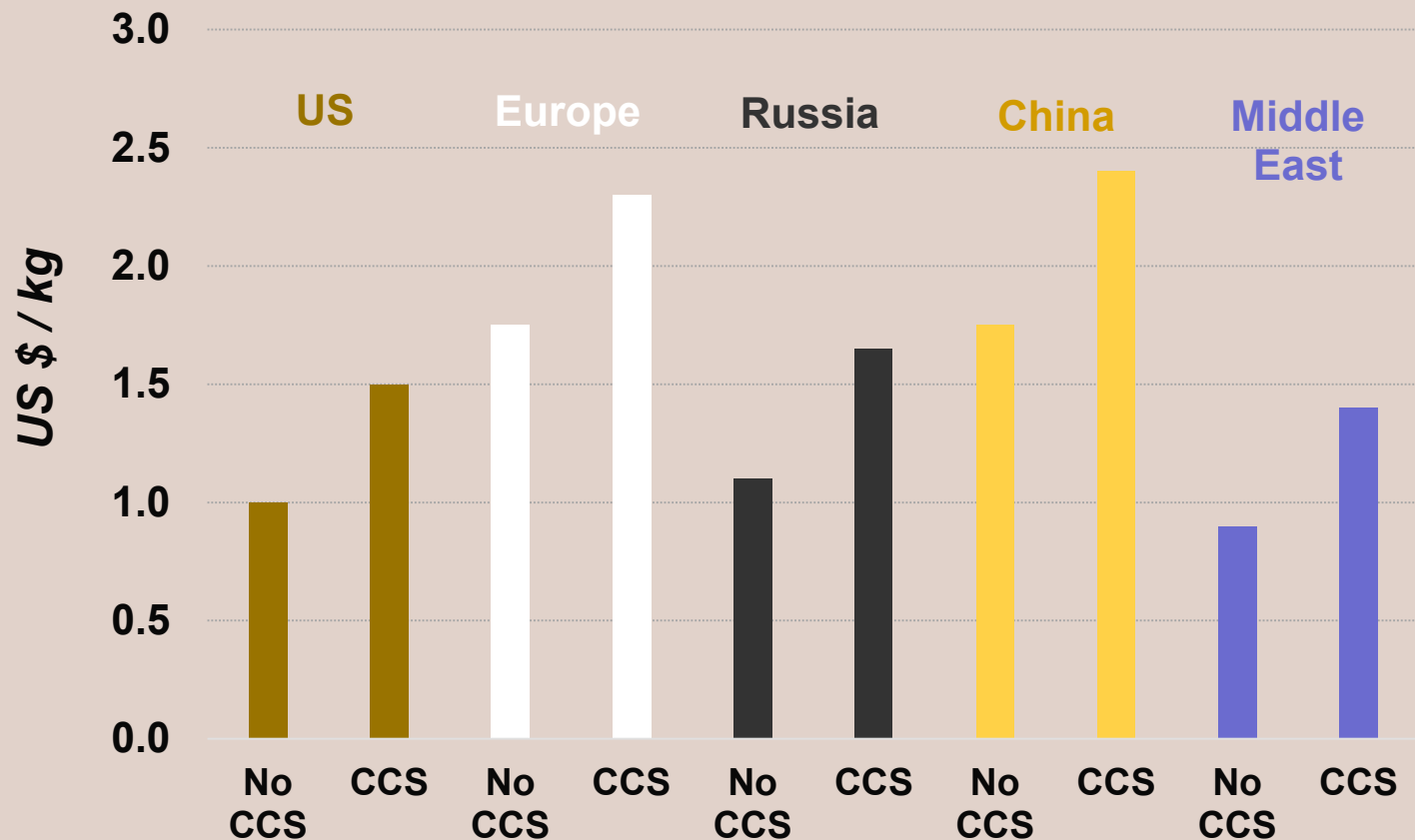
■ **Cost: US\$1-3 / kg**



Partial oxidation

- Source: Energy Information Australia (2019)

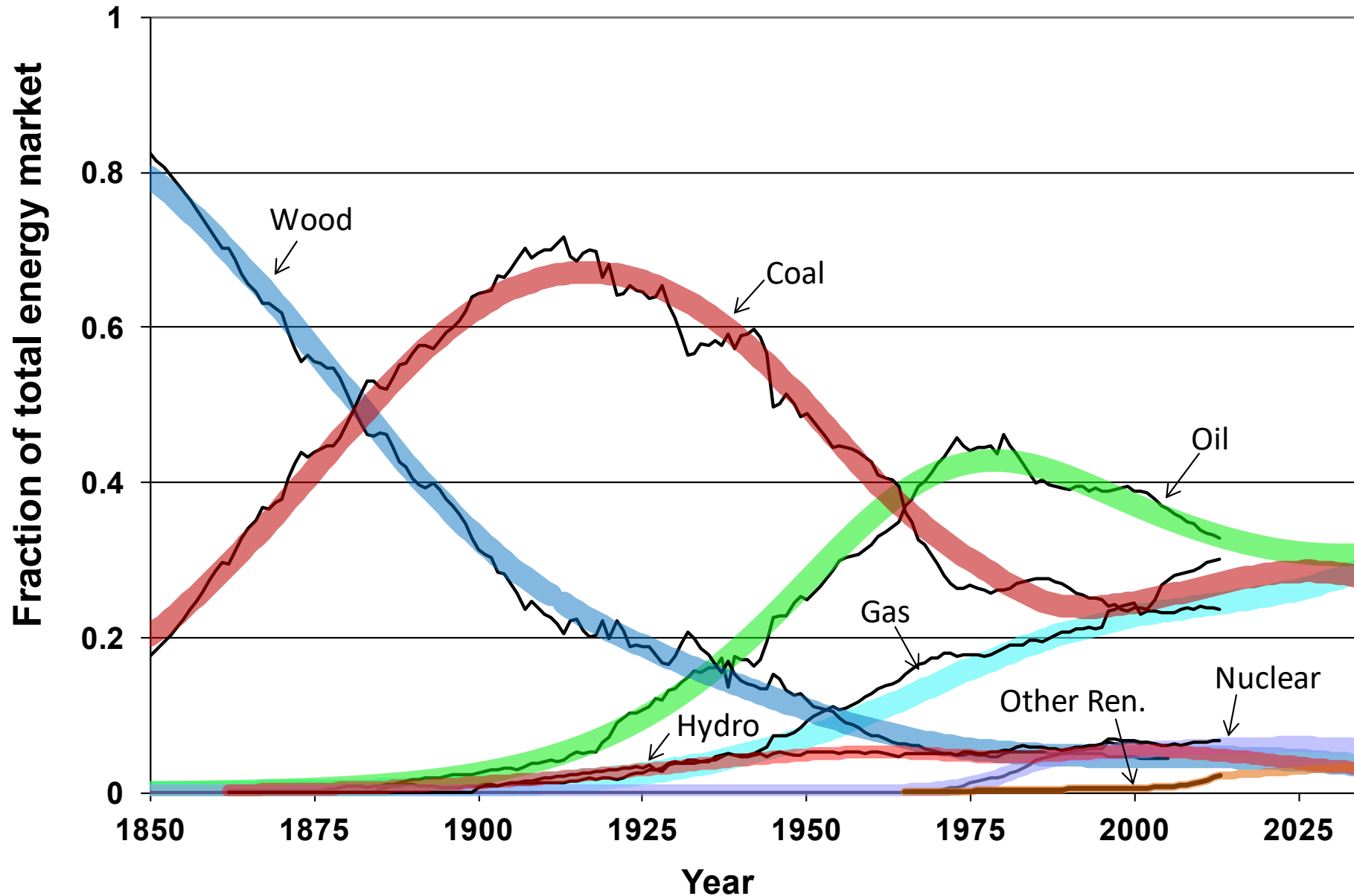
Blue/grey hydrogen production costs



■ Source:
IEA (2019)

- Price of natural gas accounts for about 50% of costs

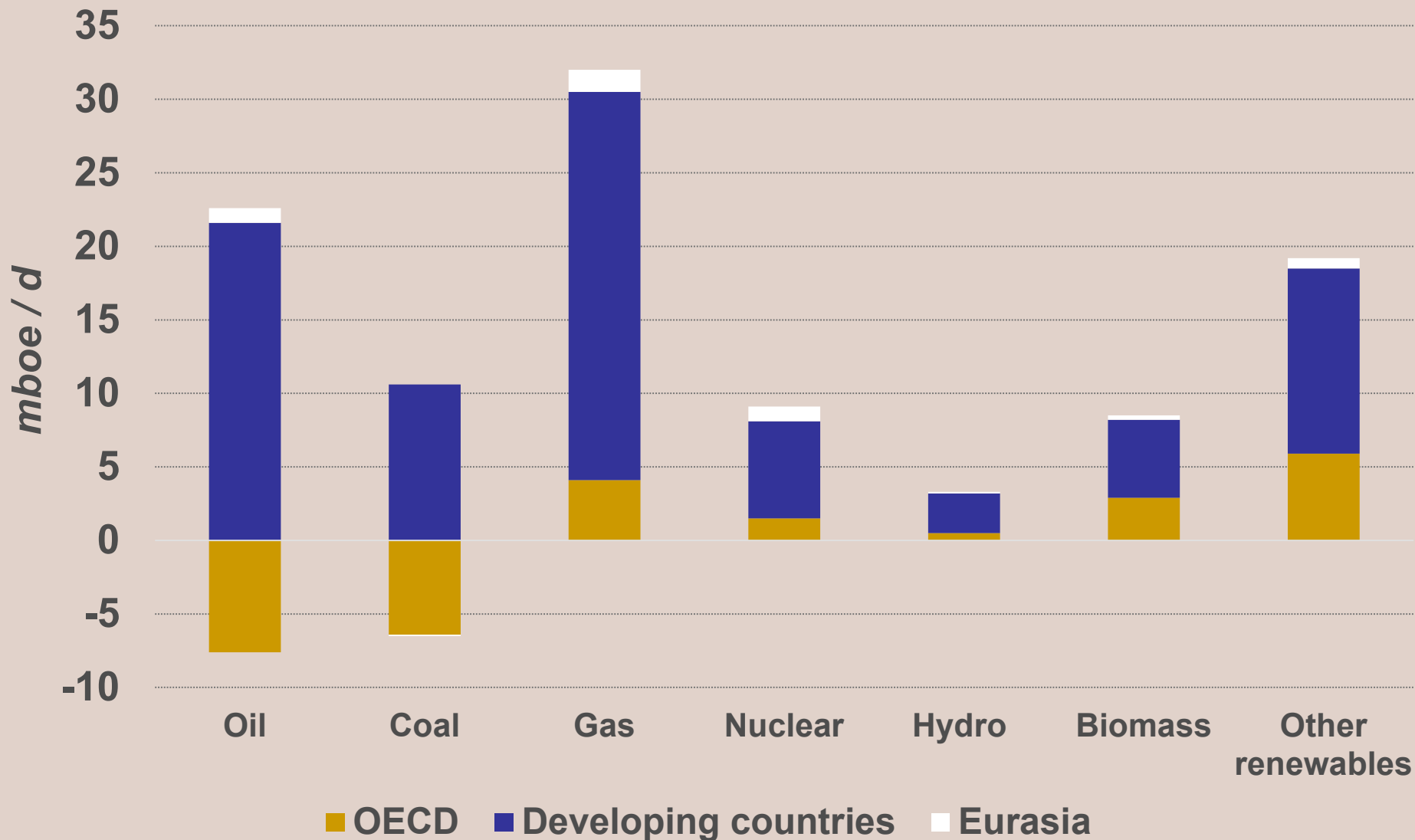
Primary energy mix (1850 - 2035)



- Low prices extend gas use for longer time period

■ Source: Aguilera and Aguilera, Mineral Economics (2018)

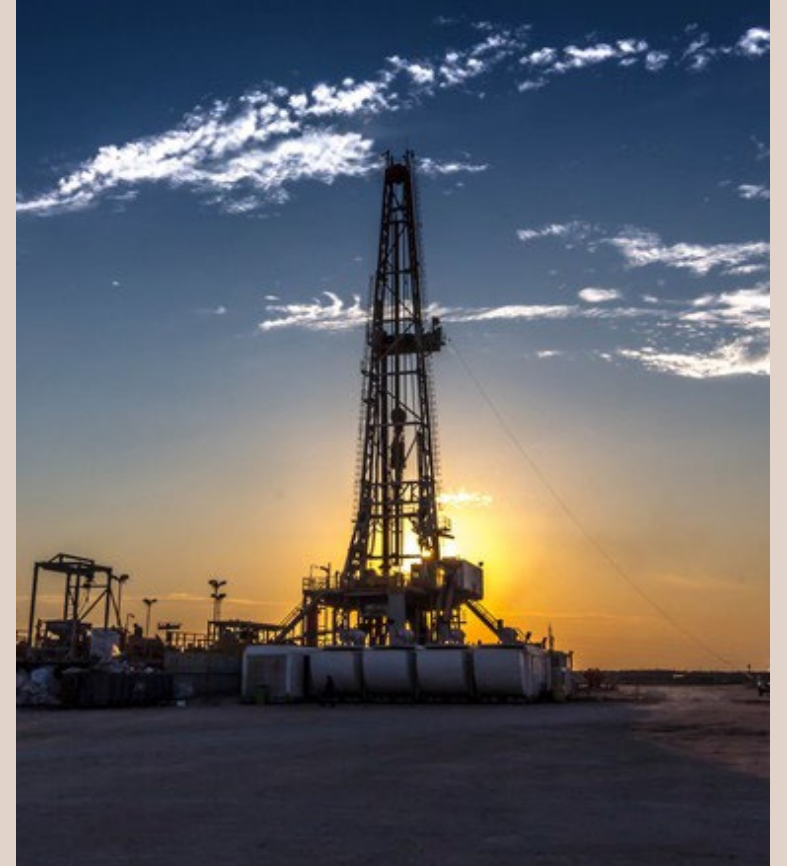
Energy demand growth; fuel type & region (2015 - 2040)



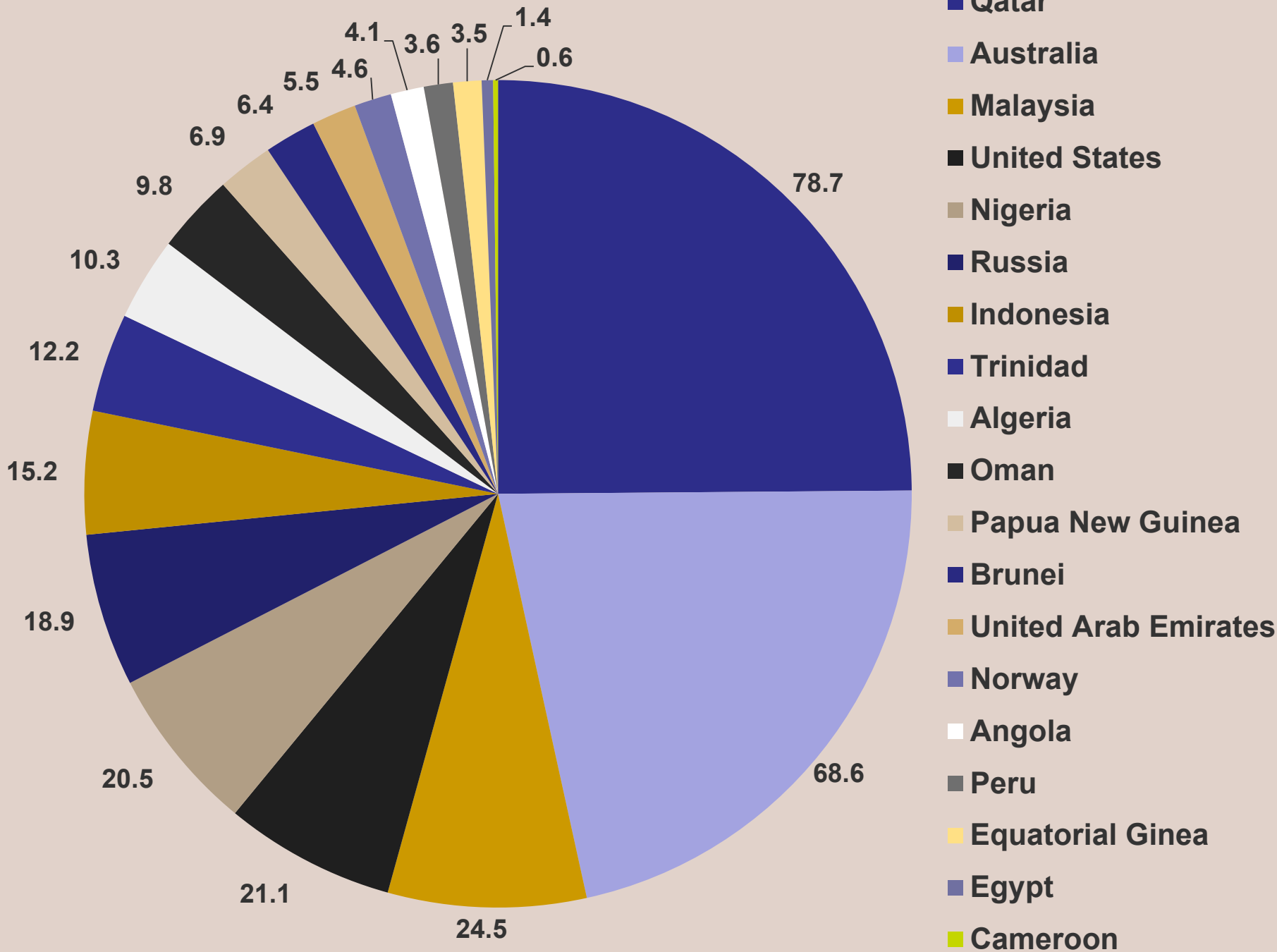
- Demand led by developing Asia
- Gas fastest growing energy source

H2 links with natural gas: a valuable bridge

- Blue hydrogen
 - Domestic gas for H2 production, for consumption or export
- Gas pipeline networks can:
 - Supply gas as feedstock for H2
 - Be converted for H2 transport



LNG exports (2018), mtpa



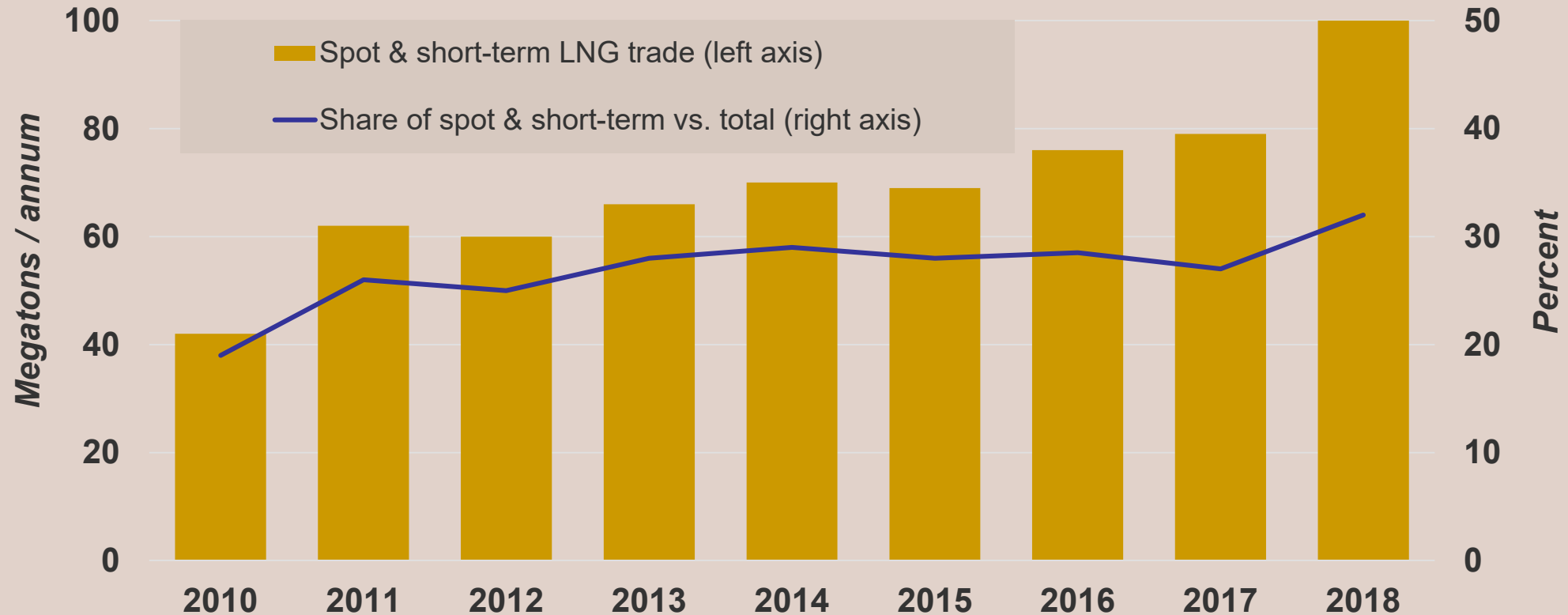
Source: International Gas Union (2019)

H2 links with LNG

- Export LNG for H2 production abroad
- Some LNG infrastructure works with H2
 - But liquid H2 colder than LNG
- Transferrable expertise and skills
 - Industry, academia, government
- Market structures
 - Short term vs. long term



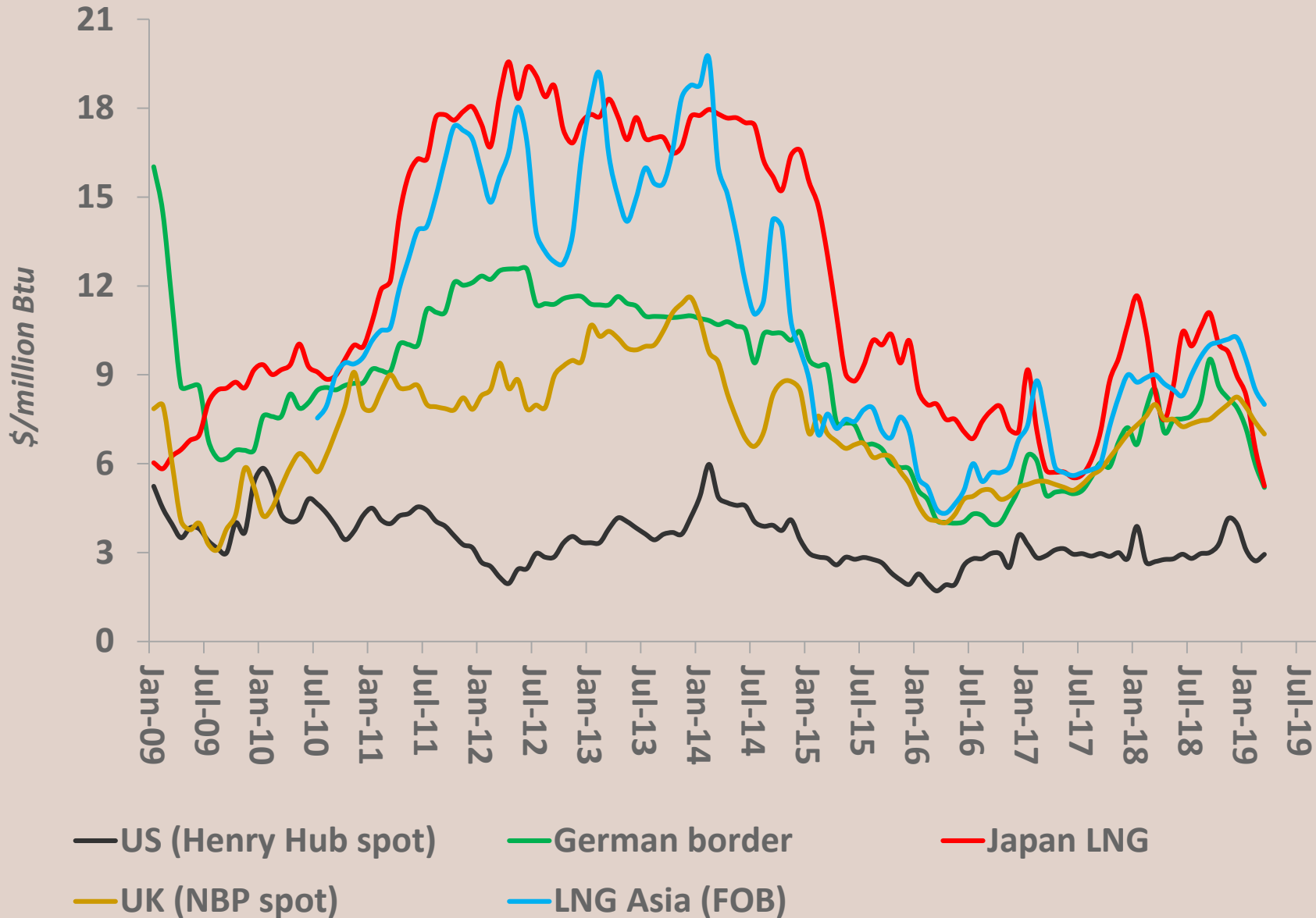
Spot and short-term vs. total LNG trade



■ Source: GIIGNL (2019)

- Gas-on-gas pricing growing with global LNG trade
- But progress is gradual

Natural gas price developments



- Regional prices diverged as shale gas supply & oil price rose
- Divergence narrowed with low oil price & expanded global gas trade

■ Source: IMF, Cedigaz

With low prices, LNG industry bringing costs down

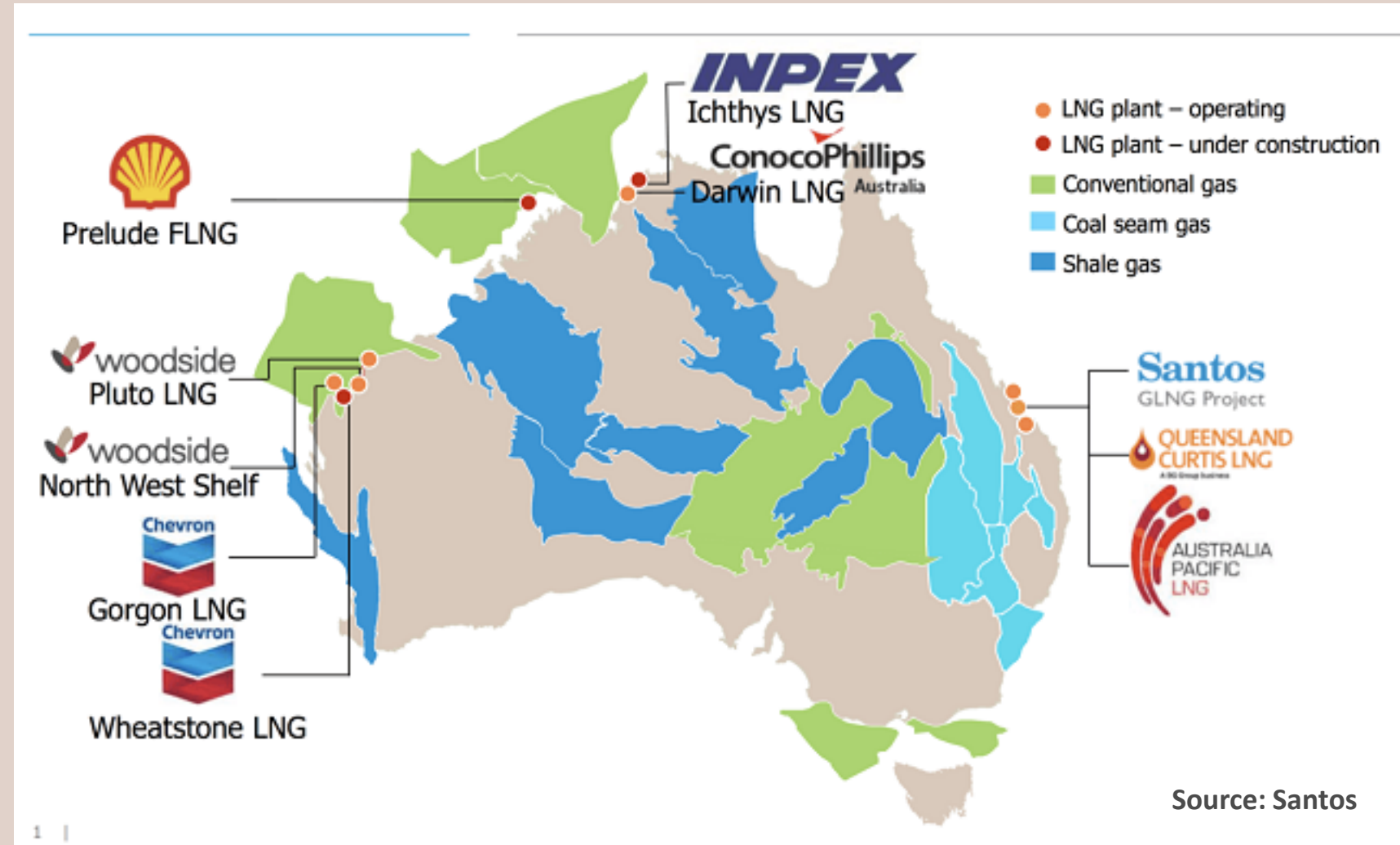
- Improved productivity and operational efficiencies
- Better planning, cooperation, standardisation, simple construction, floating LNG
- On consumption side, floating LNG enables poor countries to increase gas use
- Lessons applicable to H2



Source: Shell

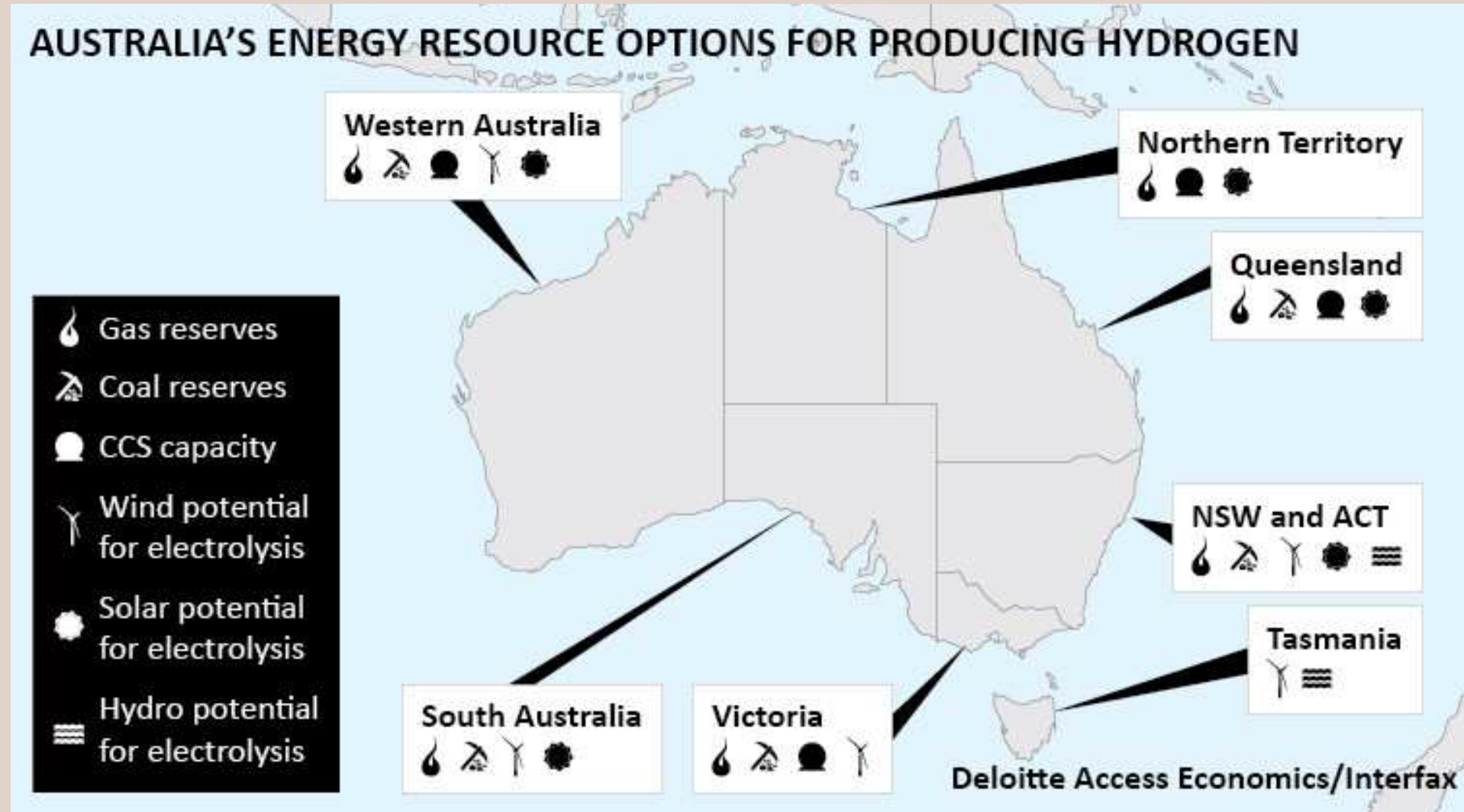
Australia: \$200 billion investment in LNG projects

- By 2020, Australia to export 85 mtpa of LNG
- Proximity to Asia makes ideal destination for exports (low shipping costs)
- Plans to leverage LNG experience for H2 development



Australian hydrogen potential

- H2 potential throughout Australia
 - Blue, grey, green, brown
- Natural gas to H2 favours WA



Hydrogen development obstacles

- Demand
 - Sufficient H2 demand?
- Supply
 - Commercially competitive H2?
- Infrastructure & logistics
 - Sufficient storage & delivery?
- Uncertainty
 - Policy, technology, economics?
- Transition
 - Sizeable share in energy mix?

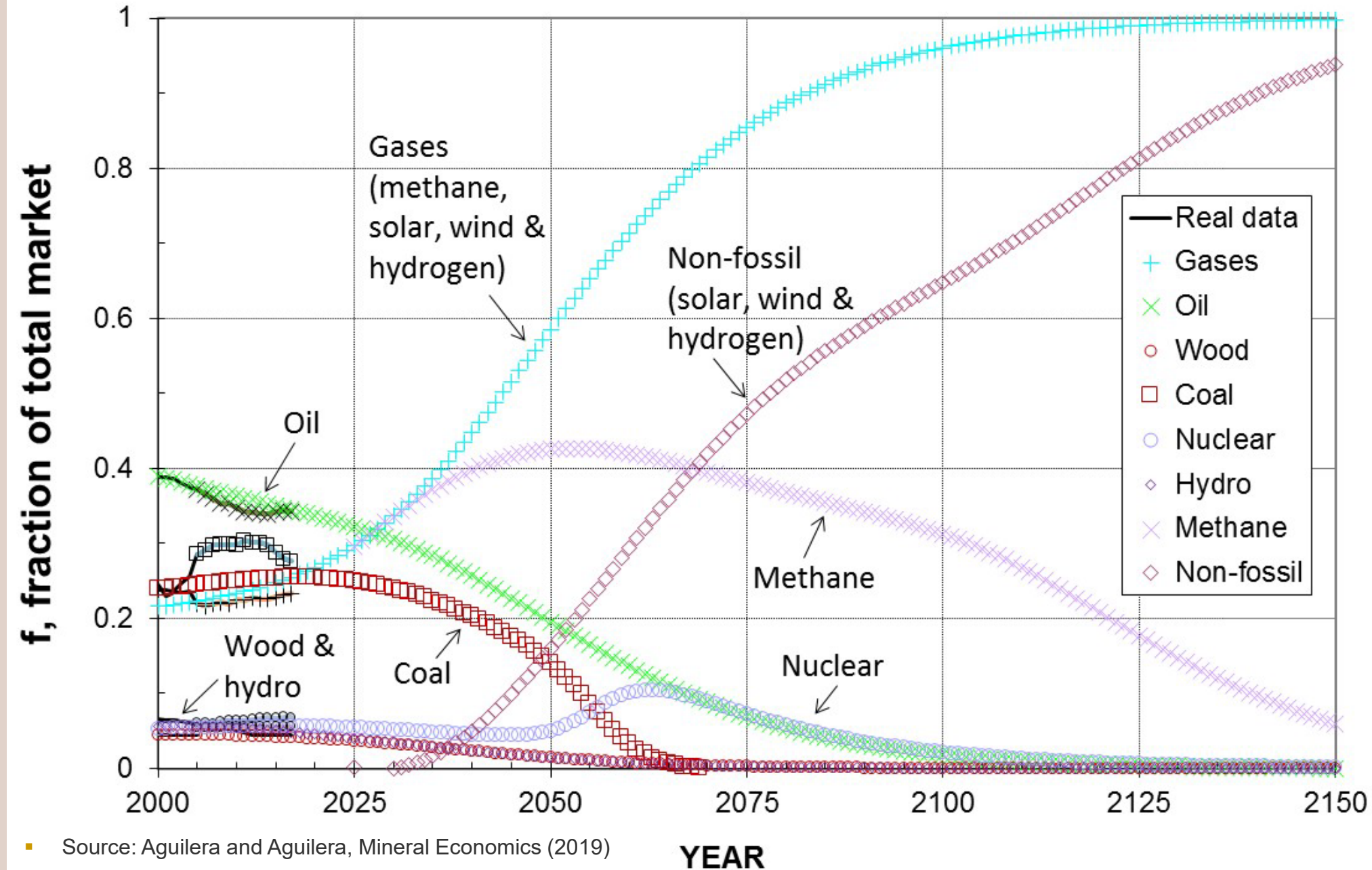


Requirements for increased H2 market share

- Policy support in coming decades
 - Eventual shift from policy- to market-based use
- Benefit from established industries
 - Natural gas, LNG & renewables
- Cost reduction
 - Versus fossil fuels & renewable sources
- Learning by doing at regional scale
 - Regional approaches based on natural strengths



Primary Energy Mix (2000 - 2150)



- Natural gas share peaks near 2050
- Non-fossil energy, like H₂, leads market 2H 21st century

■ Source: Aguilera and Aguilera, Mineral Economics (2019)



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Conclusions

- Hydrogen transition takes time
- Policy and technical advance are key
- Utilize gas and LNG links
- H2 as part of energy mix portfolio
- Expect experimentation period



Thank you!

Questions?

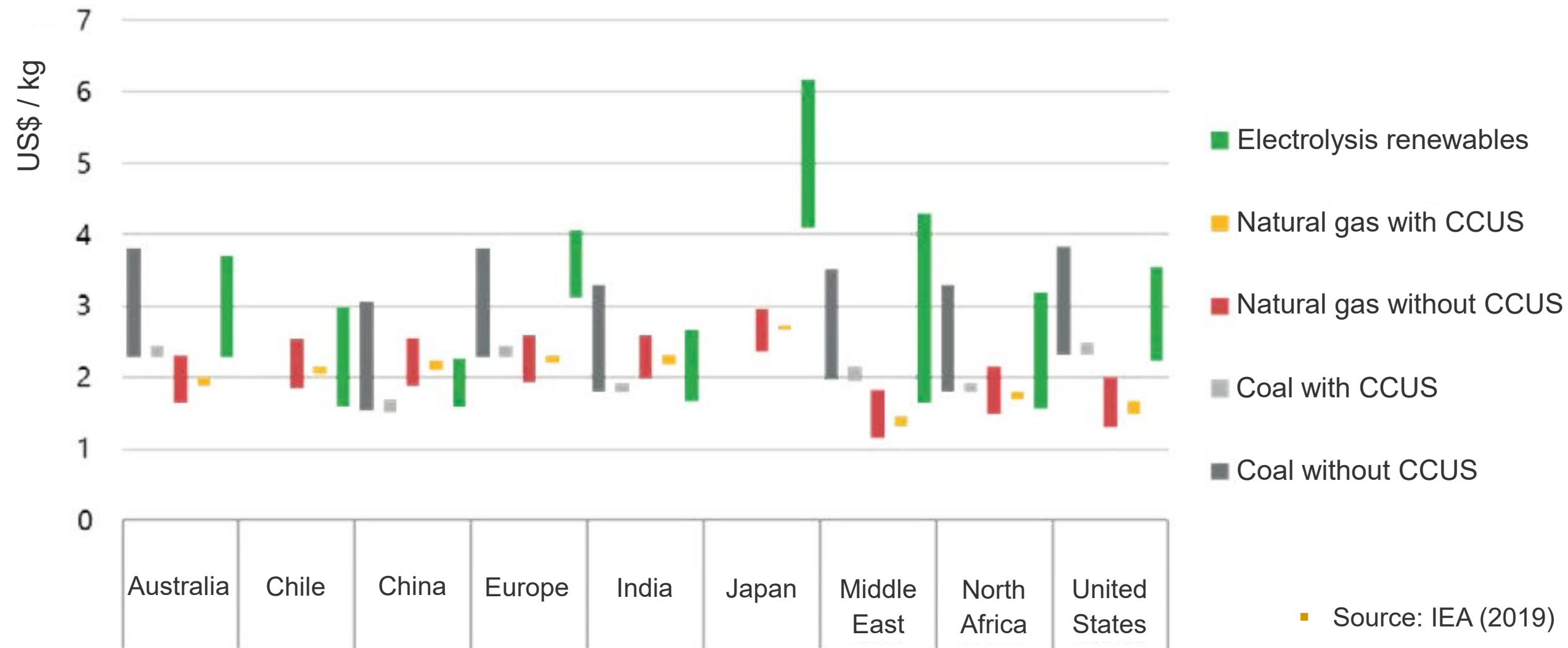
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Hydrogen costs around the world



■ Bars represent short- vs long-term costs, assume rising CO2 prices