



# Hydrogen Prospects in WA

## Synergies with Gas and LNG

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John Curtin Institute of Public Policy  
Perth, 13 March 2020



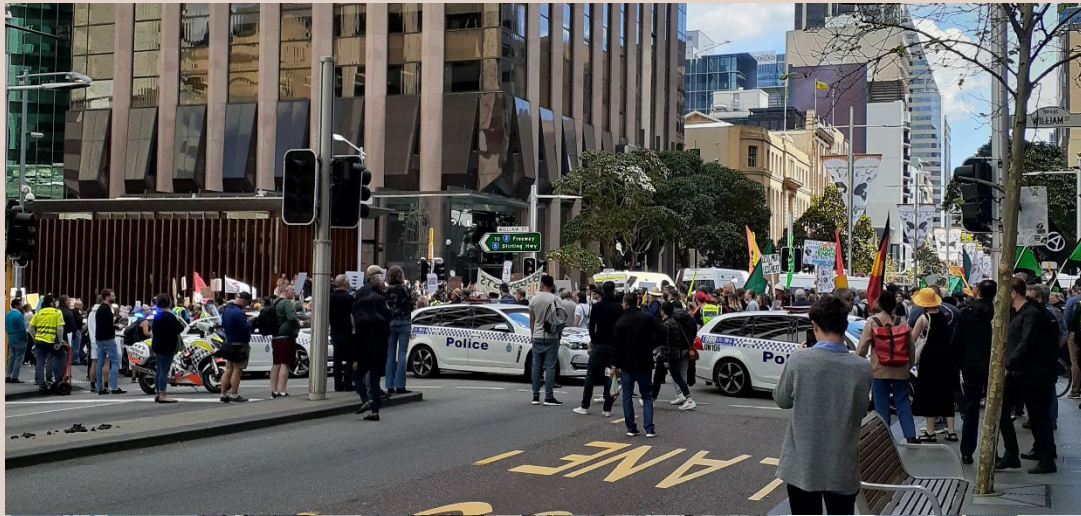
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# Why hydrogen?

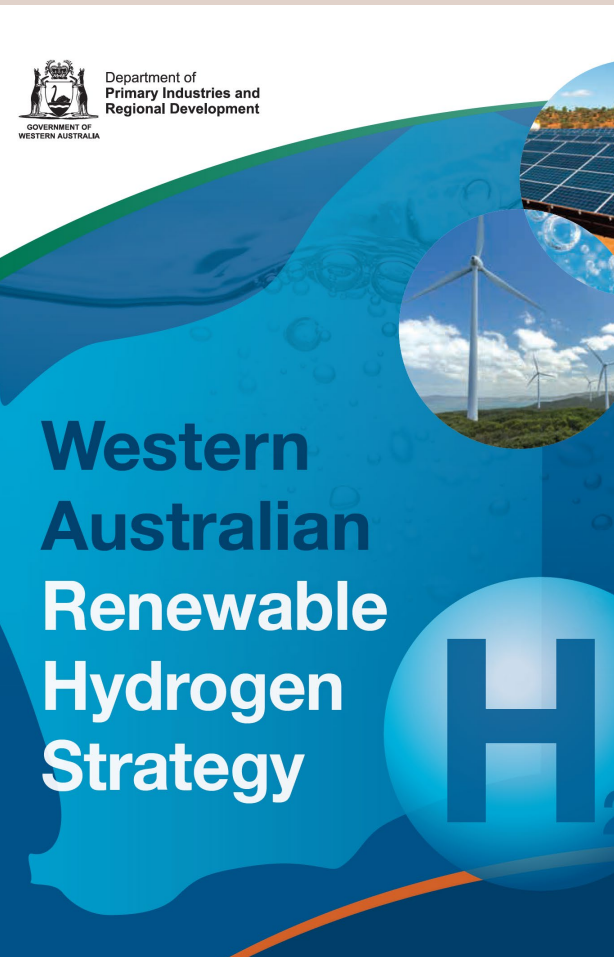
- Abundant, with global potential, including WA & Australia
- Potentially compatible with zero carbon future
- Societal pressure to act on climate change





- Perth, Sept & Oct 2019

# Hydrogen plans in Australia



Department of Primary Industries and Regional Development  
GOVERNMENT OF WESTERN AUSTRALIA

Western Australian Renewable Hydrogen Strategy

H

The cover features a blue background with a large white 'H' in a circle. It includes circular inset images of solar panels and wind turbines.

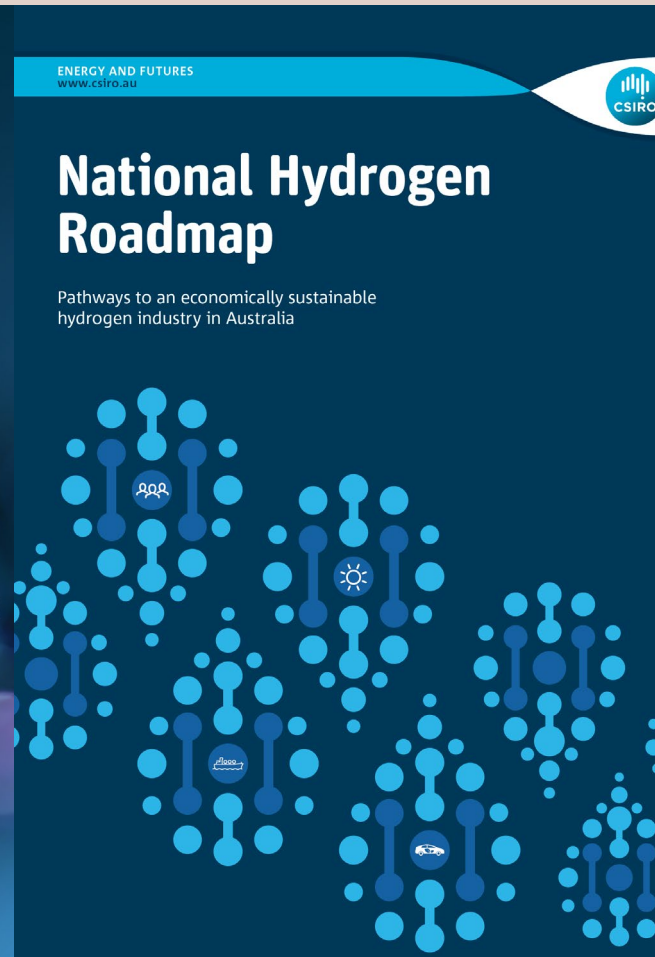


COAG Energy Council

AUSTRALIA'S NATIONAL HYDROGEN STRATEGY

H<sub>2</sub>

The cover features a central 'H<sub>2</sub>' molecule surrounded by a network of icons representing various hydrogen applications and production methods.



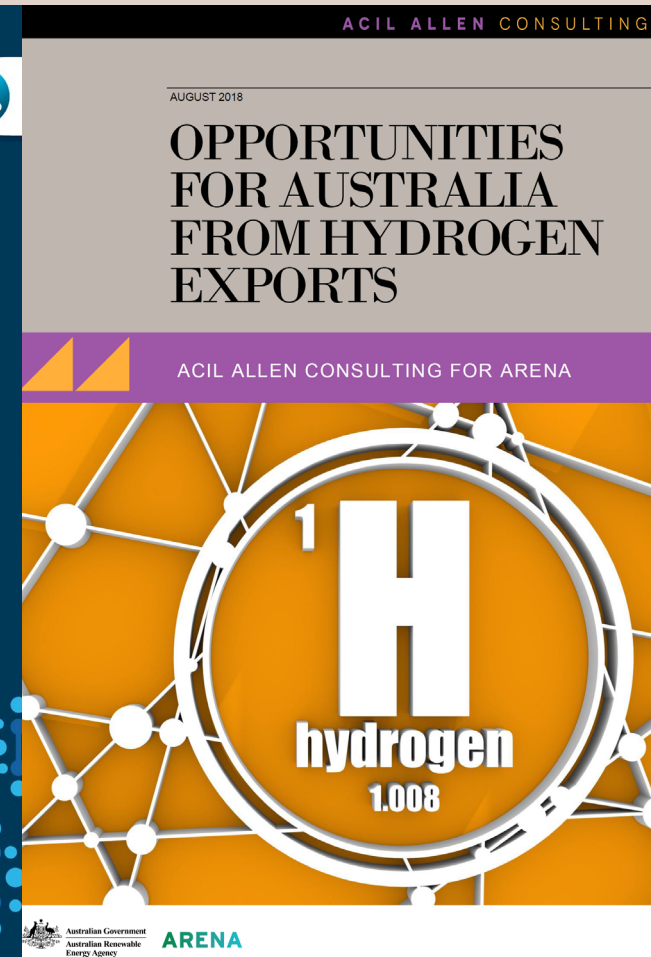
ENERGY AND FUTURES  
www.csiro.au

CSIRO

National Hydrogen Roadmap

Pathways to an economically sustainable hydrogen industry in Australia

The cover features a blue background with a network of white and blue dots and lines, representing a roadmap or network.



ACIL ALLEN CONSULTING

AUGUST 2018

OPPORTUNITIES FOR AUSTRALIA FROM HYDROGEN EXPORTS

ACIL ALLEN CONSULTING FOR ARENA

1 H hydrogen 1.008

Australian Government  
Australian Renewable Energy Agency

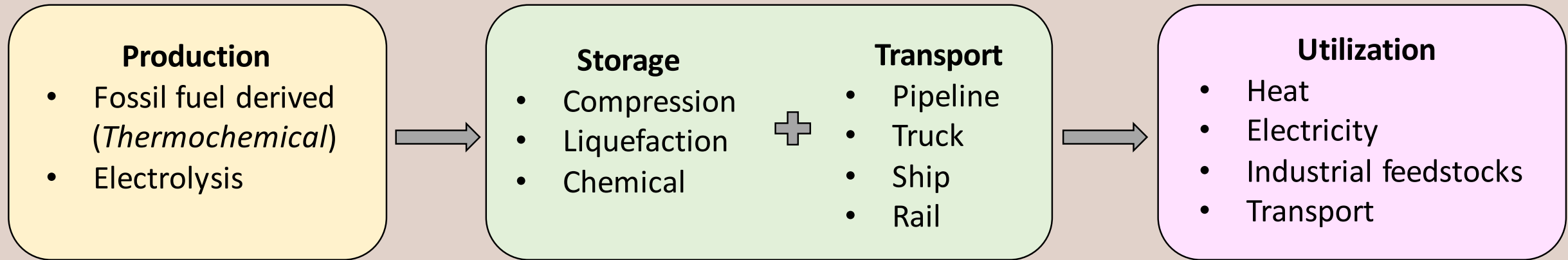
ARENA

The cover features a large white 'H' in a circle with '1' above it and 'hydrogen 1.008' below it, set against a blue background with a network of white dots and lines.

# Outline

- Hydrogen supply chain and applications
- Blue vs Green H2
- Natural gas, LNG markets & prospects
- Synergies between gas/LNG and H2
- Challenges and opportunities for H2 transition
- Outlook for H2 in energy mix

# Hydrogen value chain

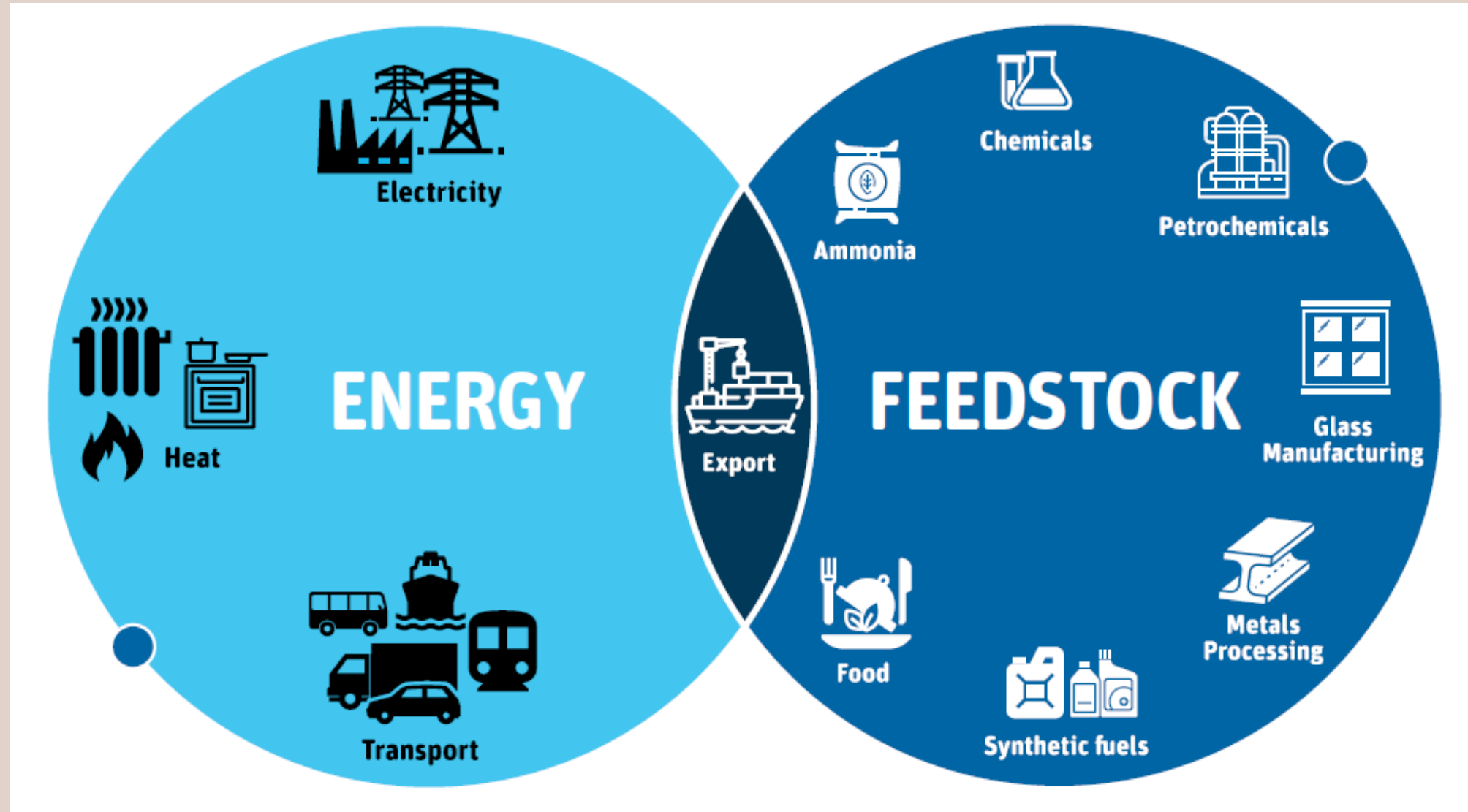


■ Source: adapted from CSIRO (2018)

- H2 produced using various sources
- Several H2 transport methods
- Application in many end use sectors

# Hydrogen applications

- H2 useful as energy source or feedstock



- Source: CSIRO (2018)

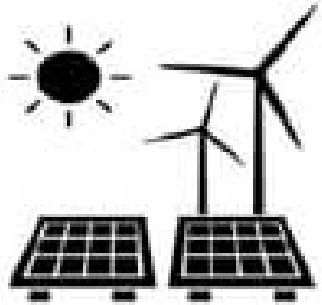
Generation

Conversion

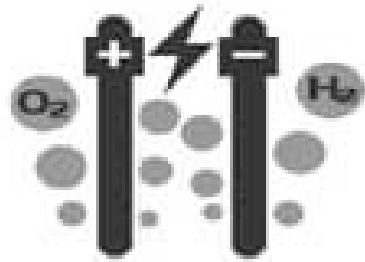
Storage /  
Transportation

Application

# Green/clean hydrogen



Wind or solar farms generate surplus energy

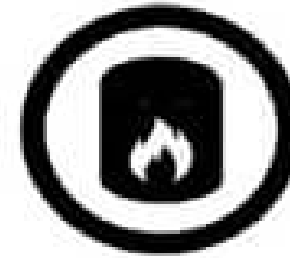


Electrolysis

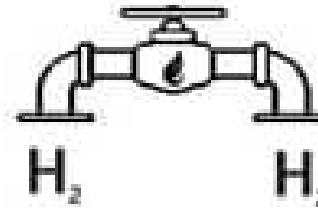
■ **Cost: US\$3-6 / kg**



Liquefied Hydrogen Gas



Natural Gas terminals



Natural Gas pipelines



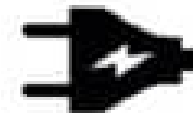
Fuel cell cars, trains, public transport



Householding, appliances, heating



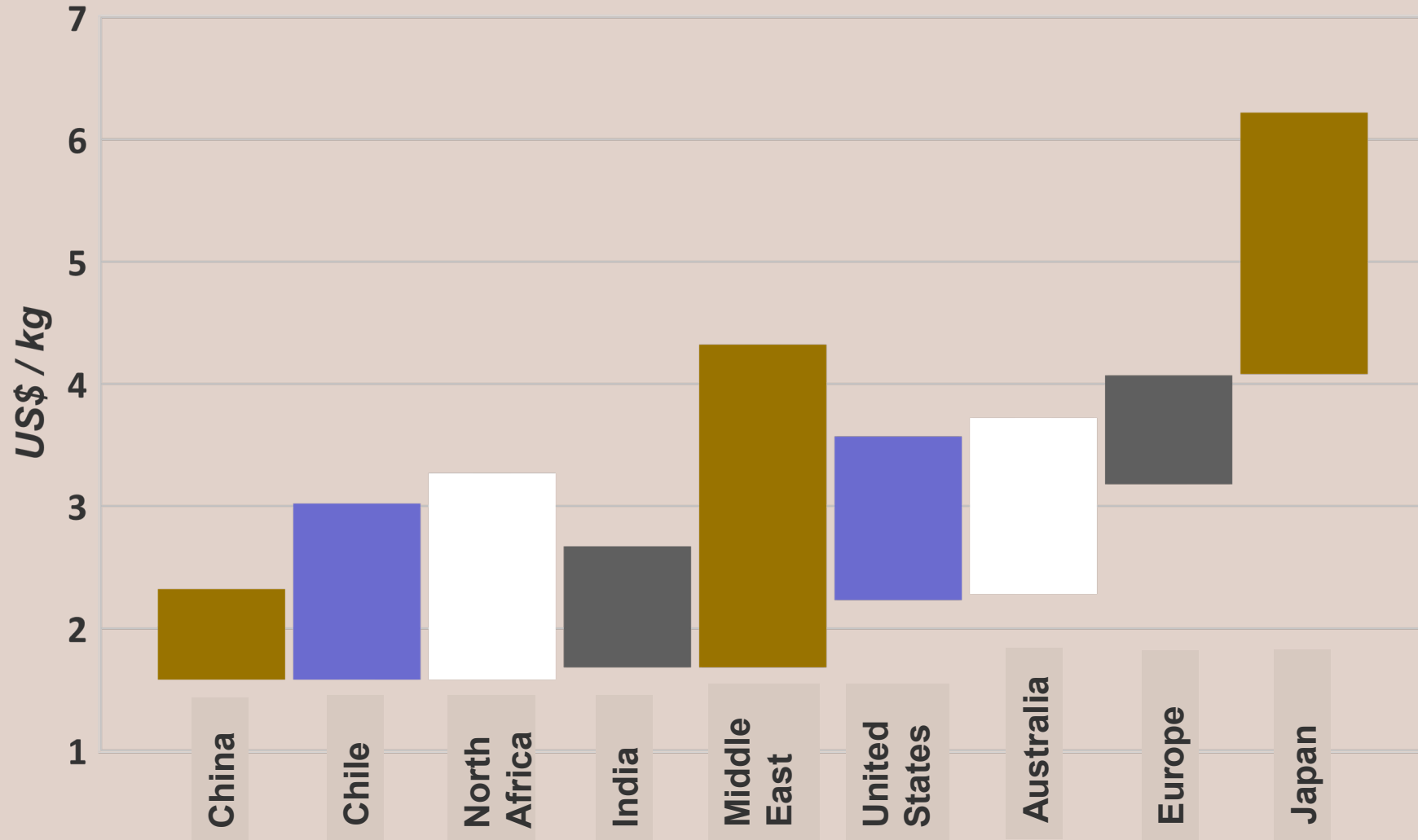
Petrochemicals, steel, refineries



Direct use electricity



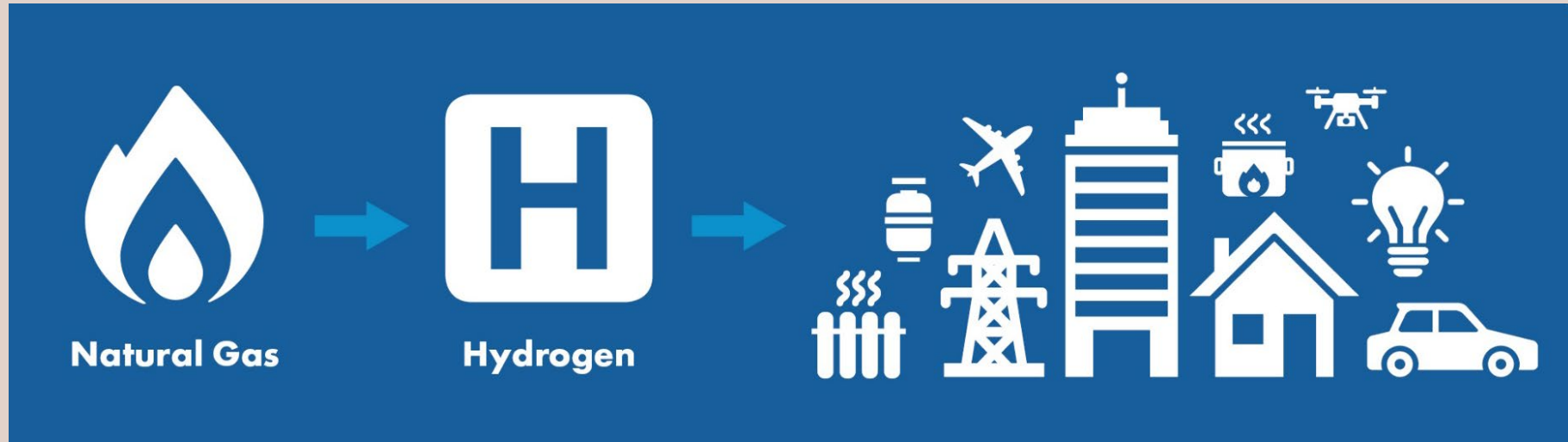
# Green hydrogen production costs



■ 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**

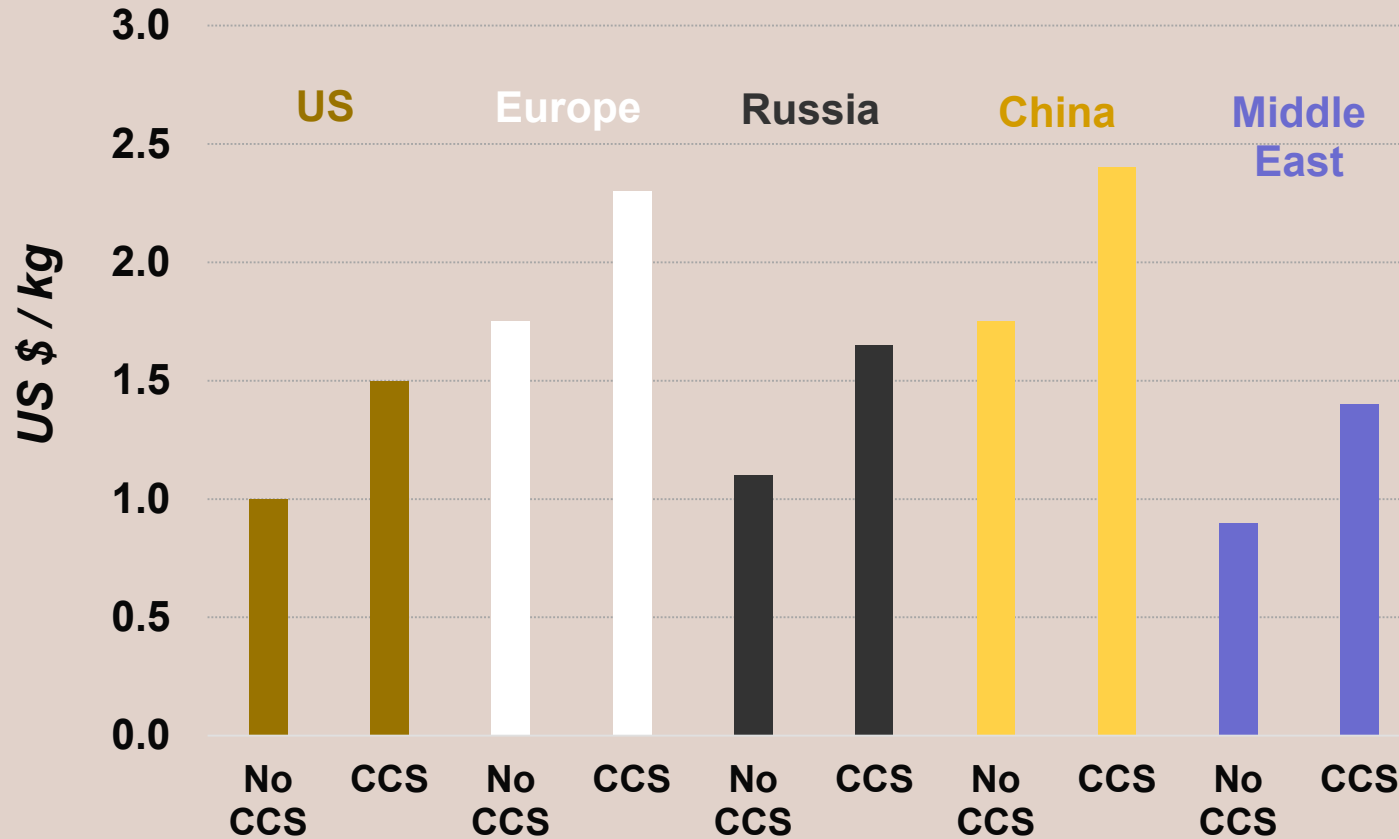
- Source: Energy Information Australia (2019)



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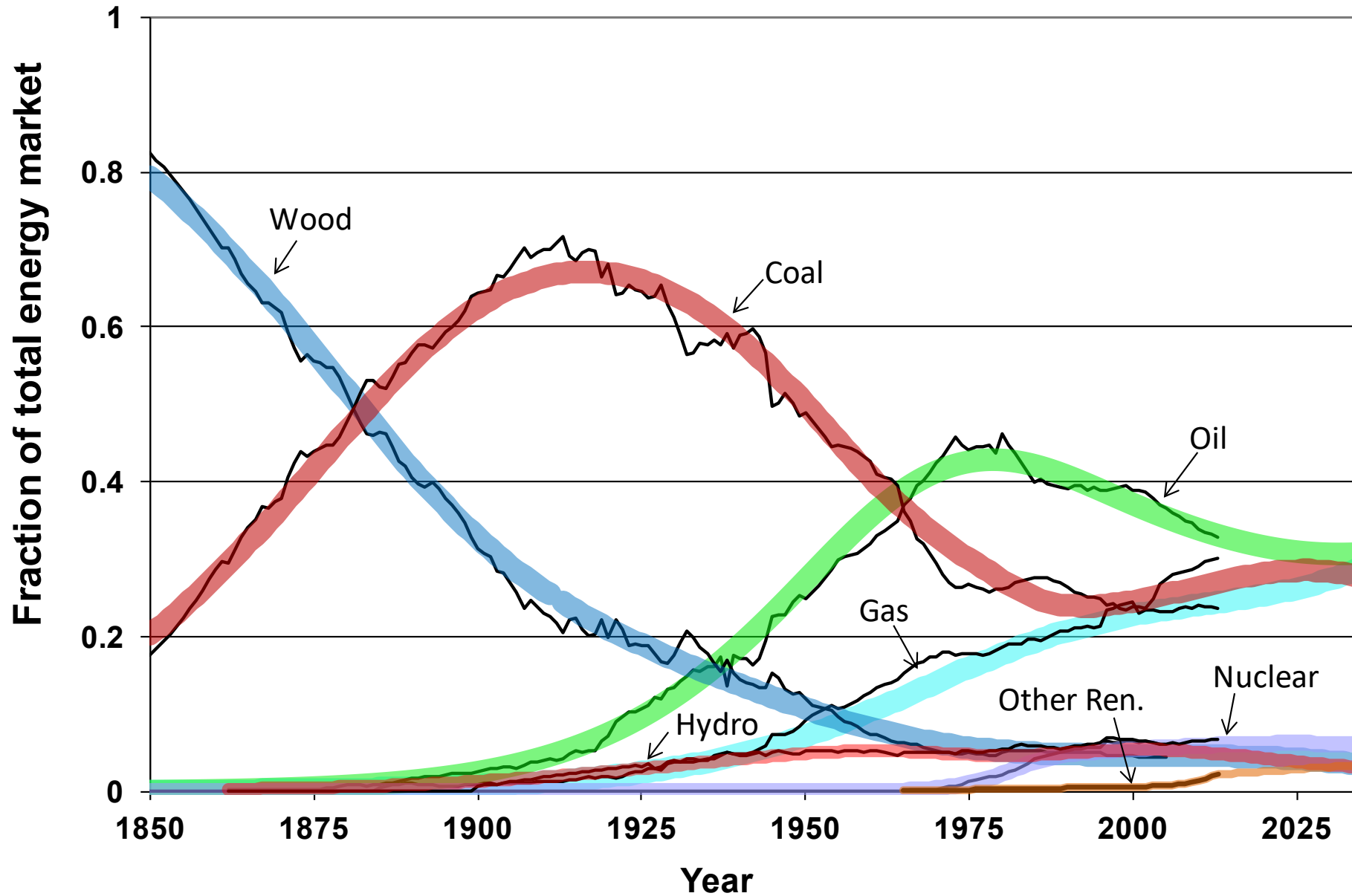
# Blue/grey hydrogen production costs



■ Source: IEA (2019)

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

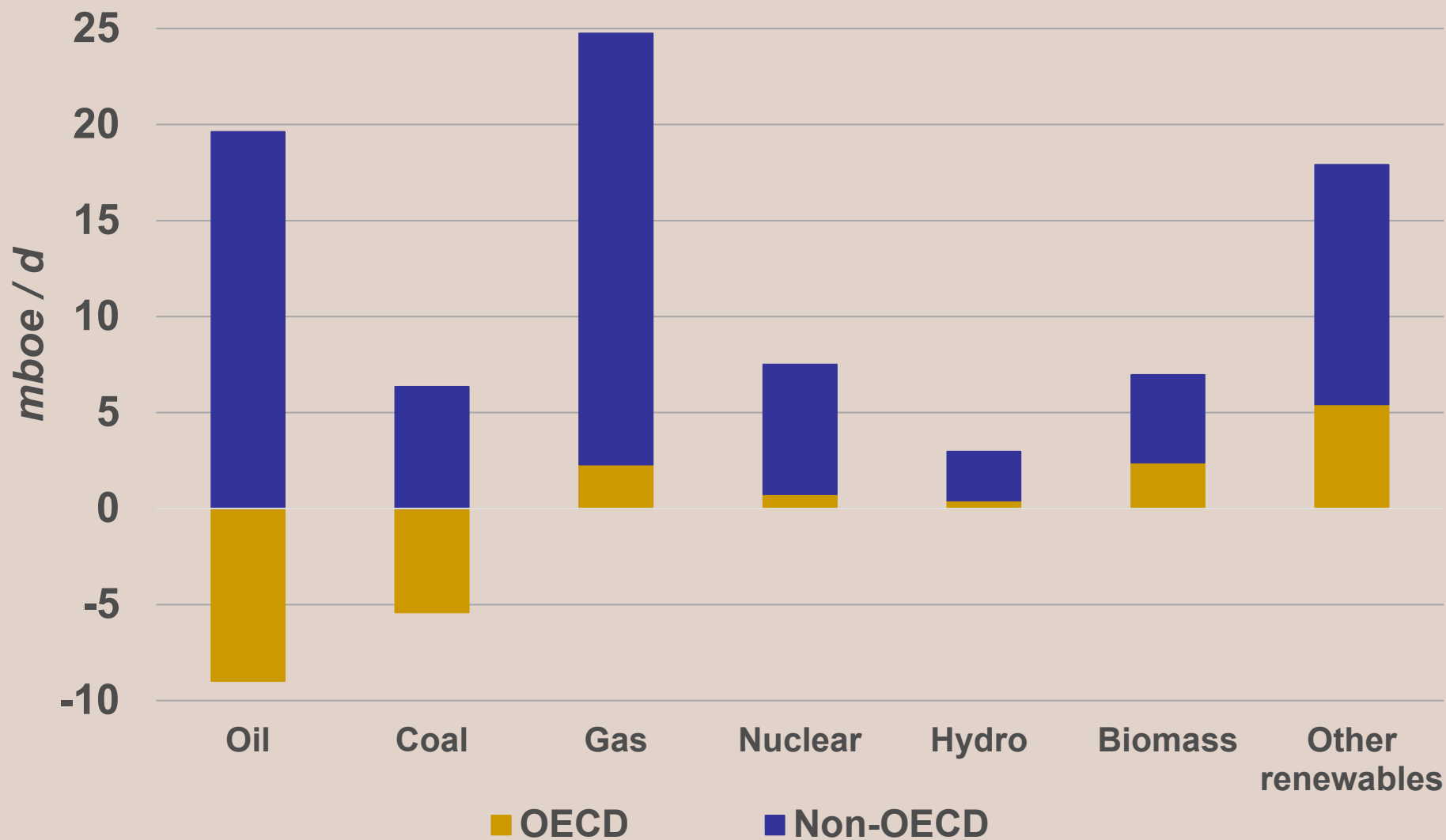
# Primary energy mix (1850 - 2035)



- Low prices extend gas use for longer time period

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

# Energy demand growth; fuel type & region (2018 - 2040)



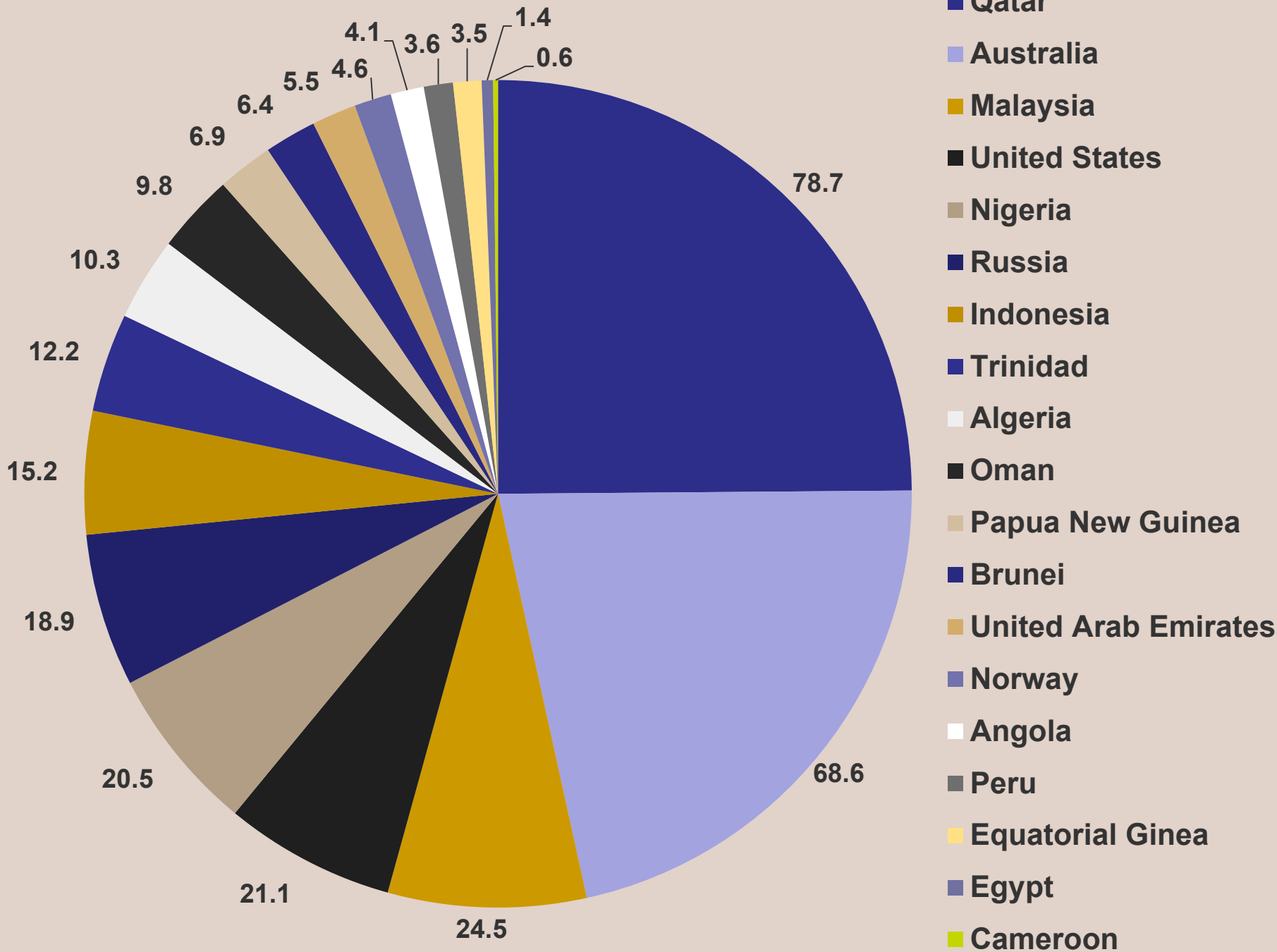
- Demand led by developing Asia
- Gas fastest growing energy source

# 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)

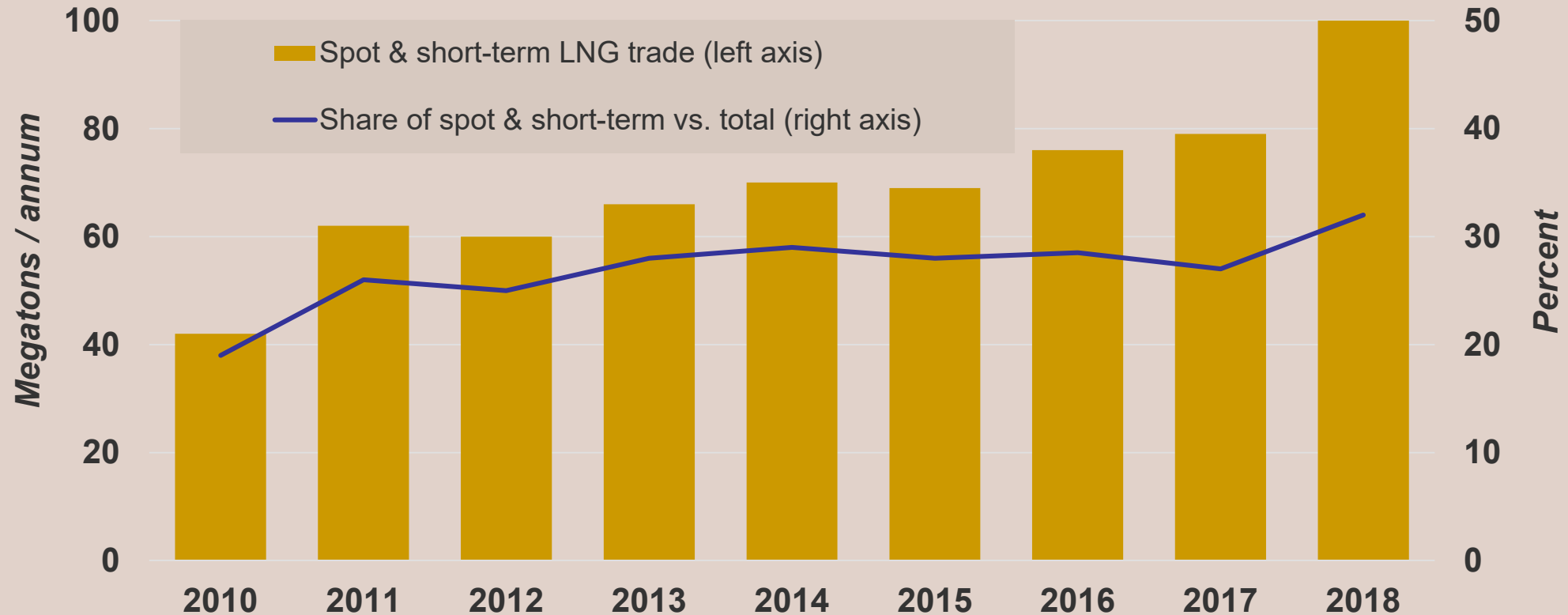
# H2 links with LNG

- 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





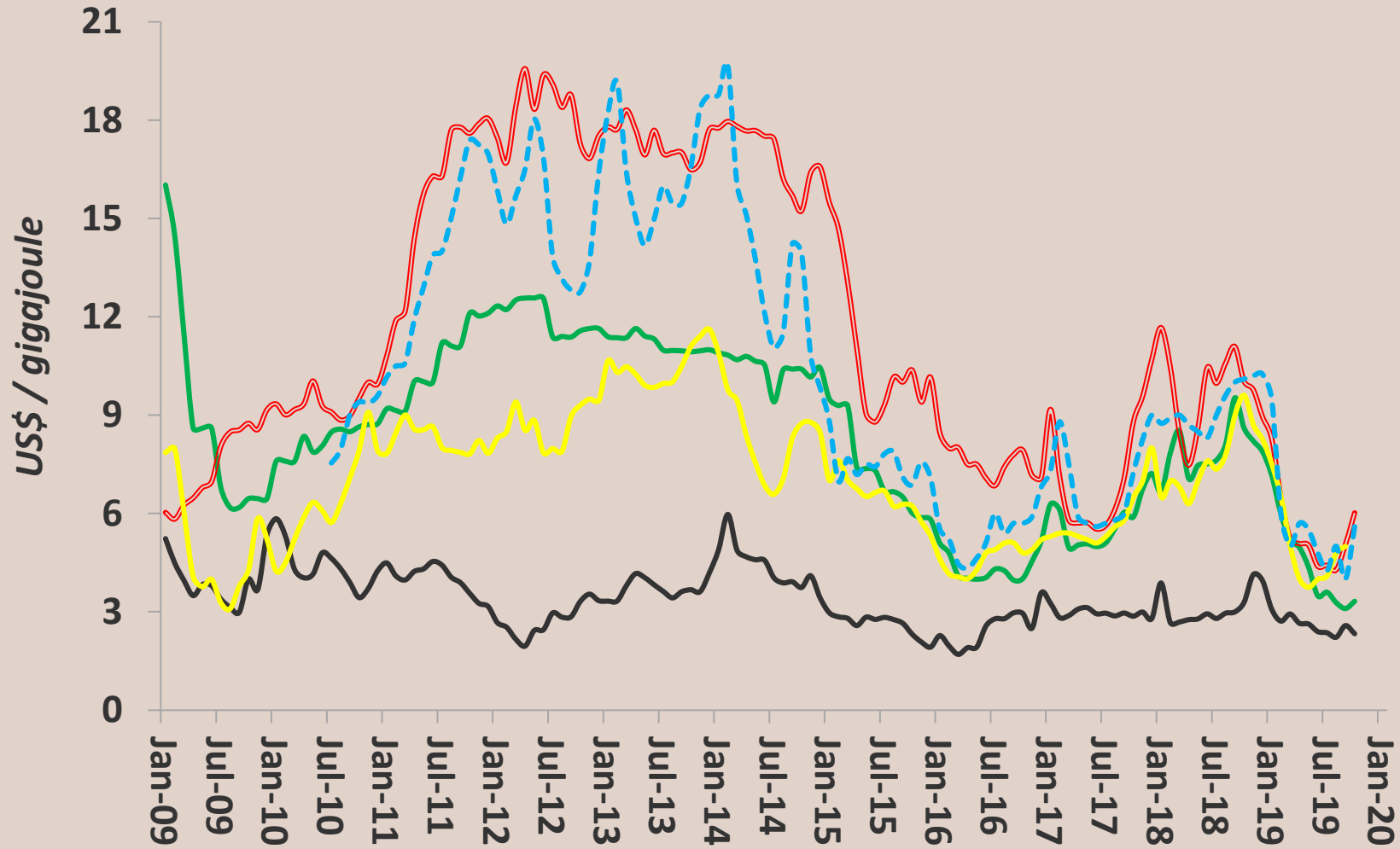
# Spot and short-term vs. total LNG trade



■ Source: GIIGNL (2019)

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

# Natural gas price developments



— US (Henry Hub spot)      — German border      — Japan LNG  
 — UK (NBP spot)          - - - LNG Asia (FOB)

- 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

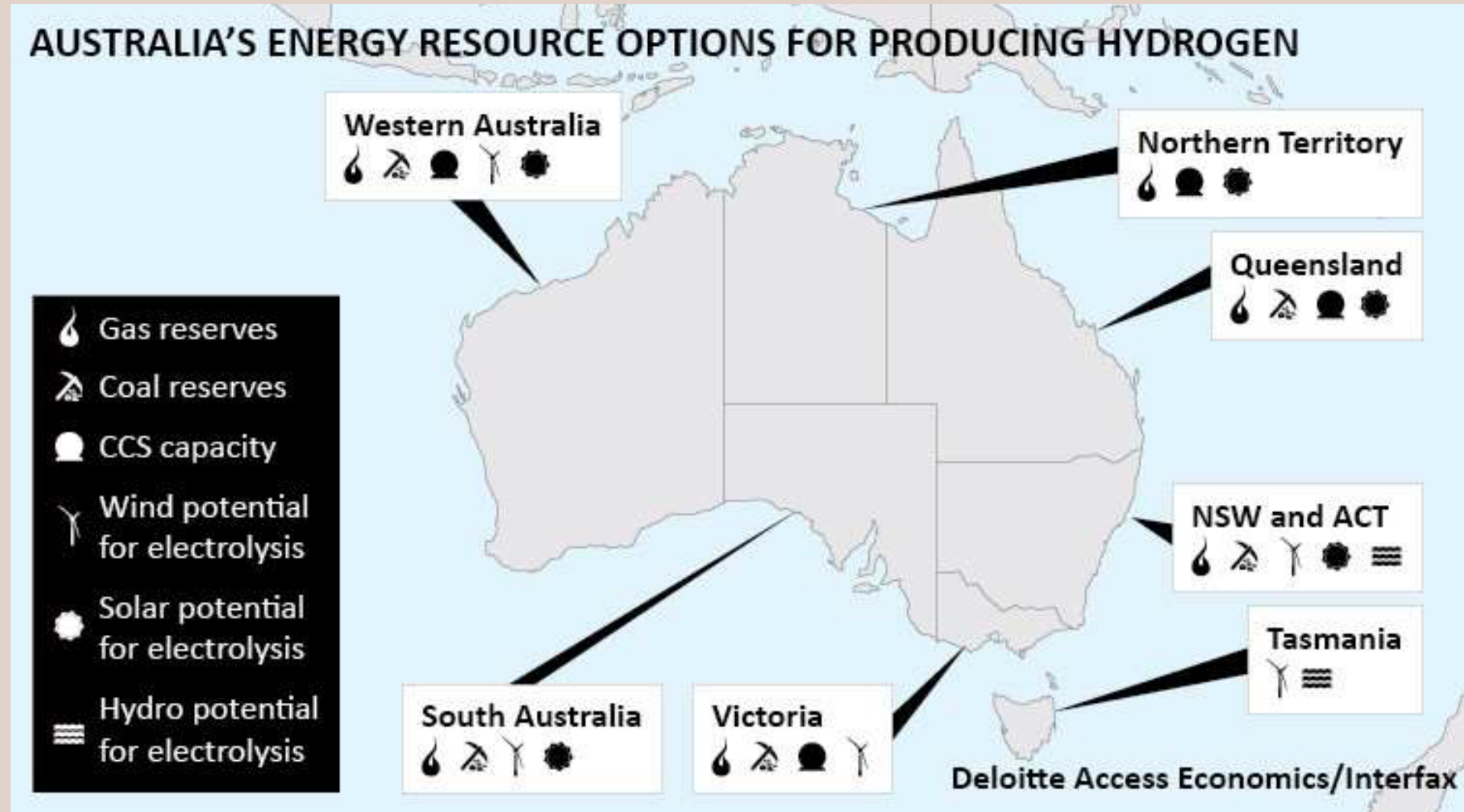
- Improved productivity and operational efficiencies
- Better planning, cooperation, standardisation, simple construction, floating LNG
- On consumption side, floating LNG enables poor countries to increase gas use
- Lessons applicable to H2



Source: Shell

# Australian hydrogen potential

- H2 potential throughout Australia
  - Blue, grey, green, brown
- Proximity to Asia ideal for exports (low shipping costs)
- Plans to leverage LNG for H2 development

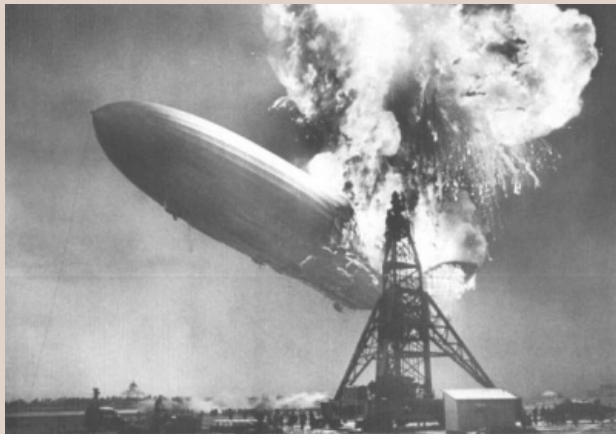


# Hydrogen development obstacles

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



# Hydrogen development obstacles



- Hindenburg air ship, New Jersey, 1937

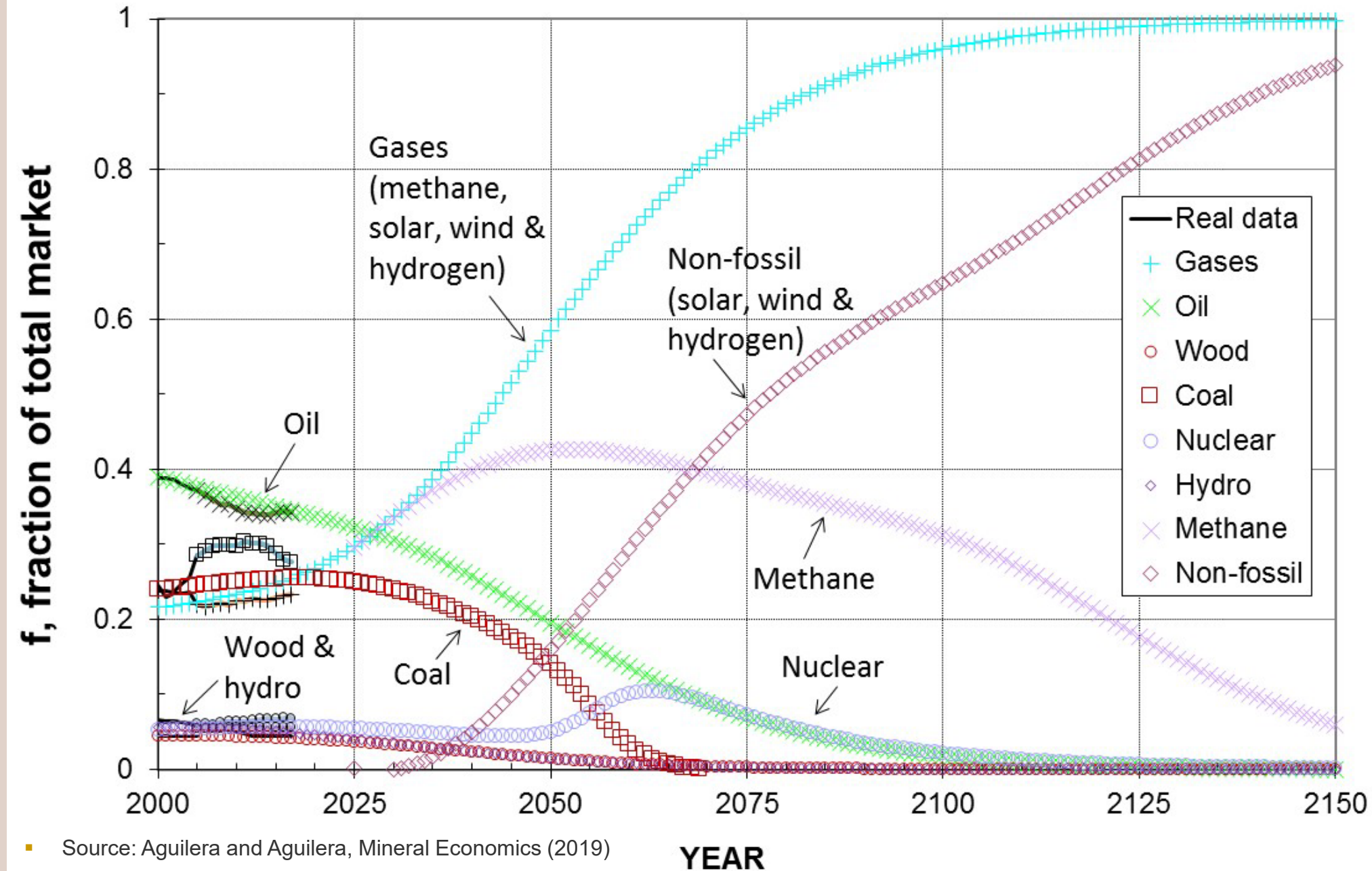


# Requirements for increased H2 market share

- 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 H<sub>2</sub>, leads market 2H 21<sup>st</sup> 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?**

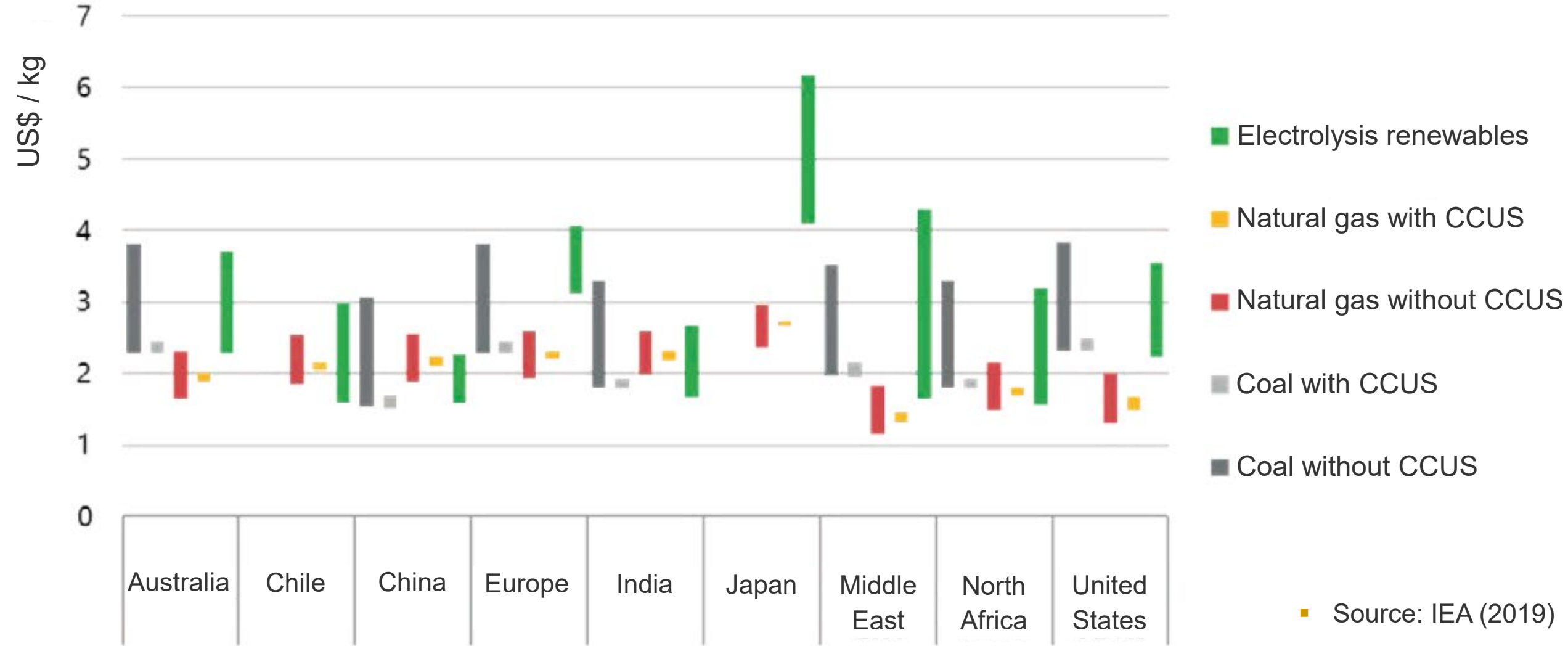
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# Hydrogen costs around the world



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