Hydrogen Prospects in WA

Synergies with Gas and LNG

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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
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

- **Production**
  - Fossil fuel derived (*Thermochemical*)
  - Electrolysis

- **Storage**
  - Compression
  - Liquefaction
  - Chemical

- **Transport**
  - Pipeline
  - Truck
  - Ship
  - Rail

- **Utilization**
  - Heat
  - Electricity
  - Industrial feedstocks
  - Transport

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

Source: adapted from CSIRO (2018)
Hydrogen applications

- H2 useful as energy source or feedstock

Source: CSIRO (2018)
Green/clean hydrogen

- Source: Venture Insights (2017)

- Cost: US$3-6 / kg

- Wind or solar farms generate surplus energy

- Electrolysis

- Natural Gas terminals

- Natural Gas pipelines

- Liquefied Hydrogen Gas

- Fuel cell cars, trains, public transport

- Householding, appliances, heating

- Petrochemicals, steel, refineries

- Direct use electricity
- Short- vs long-term costs, assume rising CO2 prices

**Green hydrogen production costs**

- Source: IEA (2019)
Blue hydrogen (sometimes grey)

- **Source:** Energy Information Australia (2019)

- **Steam methane reforming**
- **Partial oxidation**

- **Cost:** US$1-3 / kg
Price of natural gas accounts for about 50% of costs

Source: IEA (2019)
- 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

Source: OPEC World Oil Outlook (2019)
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

- Qatar: 78.7
- Australia: 68.6
- Malaysia: 24.5
- United States: 21.1
- Nigeria: 20.5
- Russia: 18.9
- Indonesia: 15.2
- Trinidad: 12.2
- Algeria: 11.7
- United Arab Emirates: 10.3
- Angola: 9.8
- Oman: 6.9
- Papua New Guinea: 6.4
- Peru: 5.5
- Equatorial Guinea: 4.6
- Cameroon: 4.1
- Brunei: 3.6
- Norway: 3.5
- Egypt: 1.4
- Peru: 0.6

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
Gas-on-gas pricing growing with global LNG trade

But progress is gradual

Source: GIIGNL (2019)
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
- Natural gas share peaks near 2050
- Non-fossil energy, like H2, leads market 2H 21st century

Source: Aguilera and Aguilera, Mineral Economics (2019)
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

Source: IEA (2019)