RISC

decisions with confidence

Hydrogen Storage Potential of Depleted Oil & Gas Fields in Western Australia

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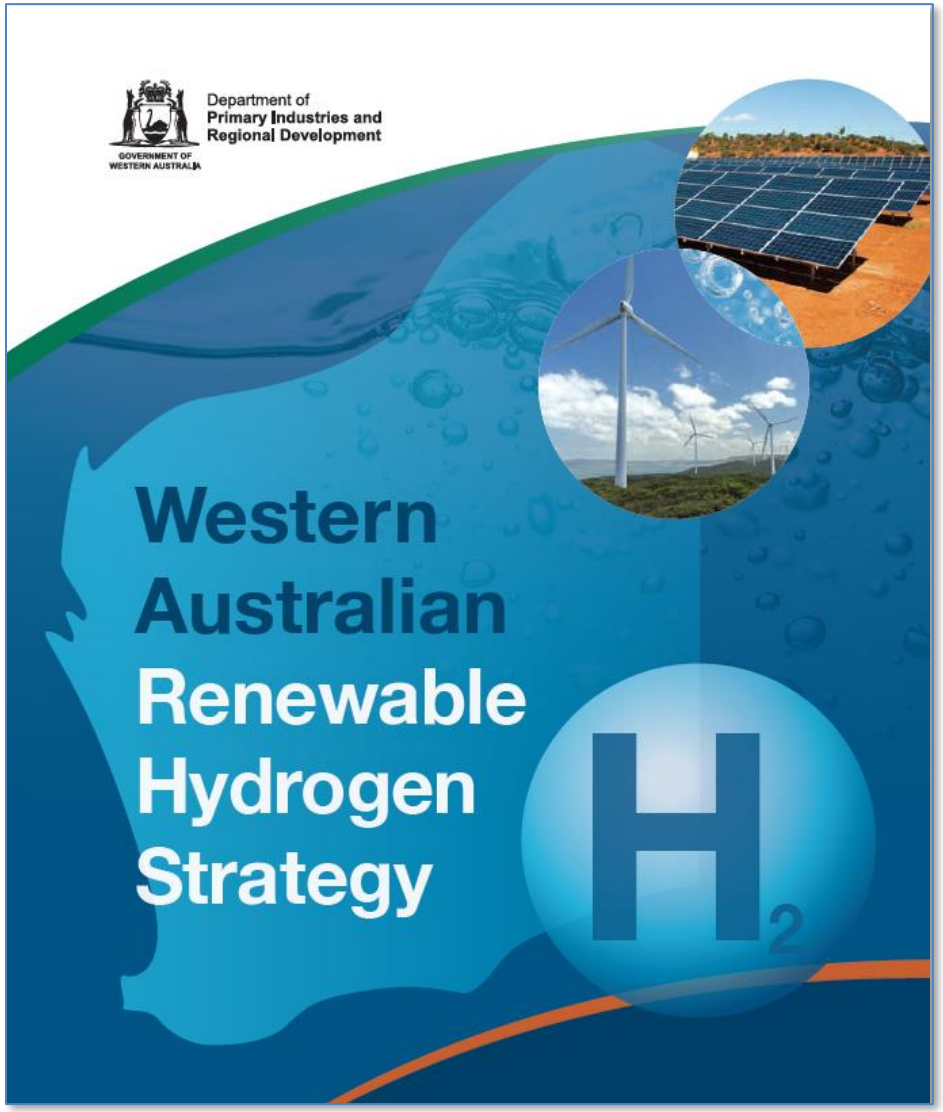
Presentation outline

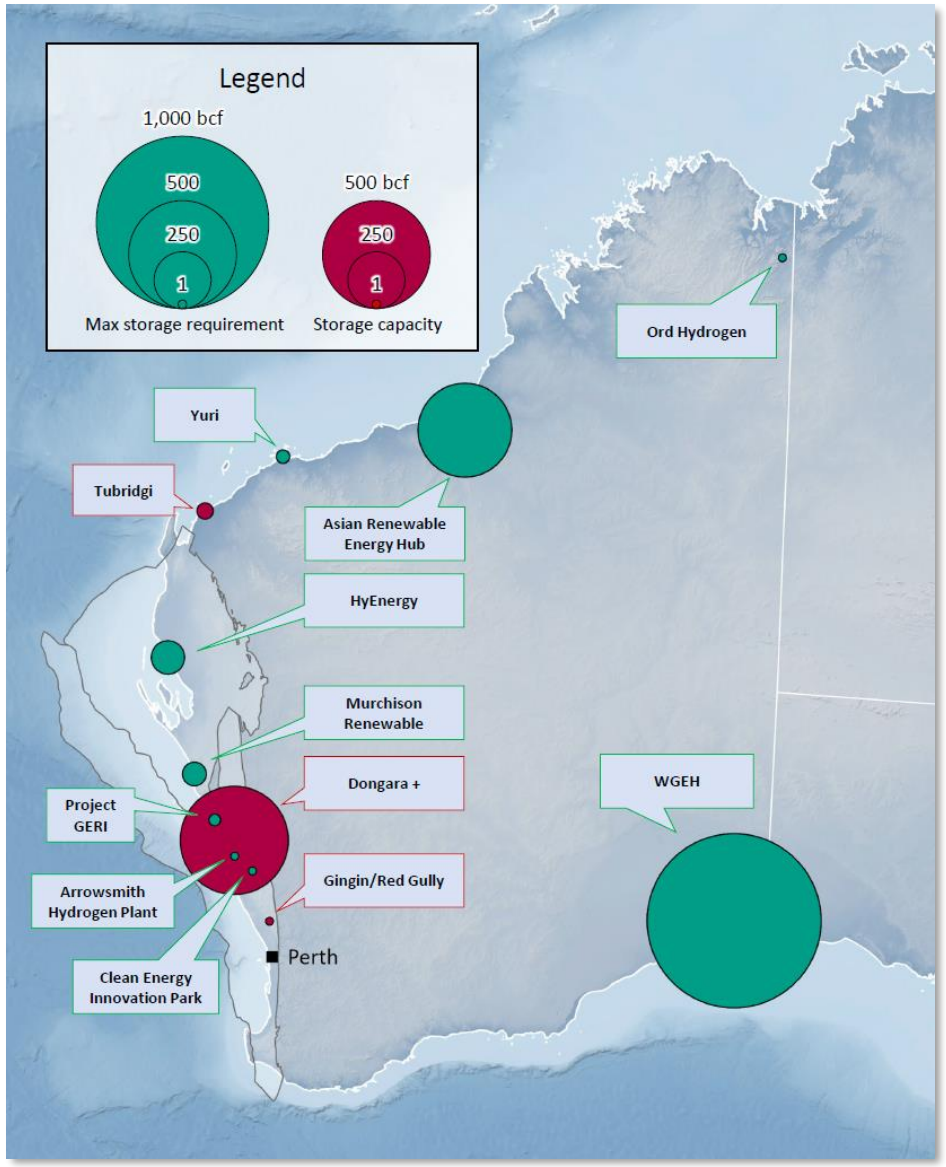
- Overview of WA renewable energy strategy & hydrogen projects
- Geological storage overview
- Issues and considerations for geological storage of hydrogen in depleted fields
- WA depleted fields assessment
- Summary and conclusions

WA hydrogen strategy



- The Government of Western Australia has developed a renewable hydrogen strategy with the vision that Western Australia will become a significant producer, exporter and user of renewable hydrogen.
- Western Australia has outstanding potential for renewable energy, with an abundance of sun, wind and space.
- Goals of an approved export project by 2022, and by 2040 that its share of global hydrogen exports is similar to LNG exports of today
- **The Western Australian Renewable Hydrogen Roadmap includes the evaluation of utilising depleted oil and gas fields for hydrogen storage.**

WA renewable hydrogen projects



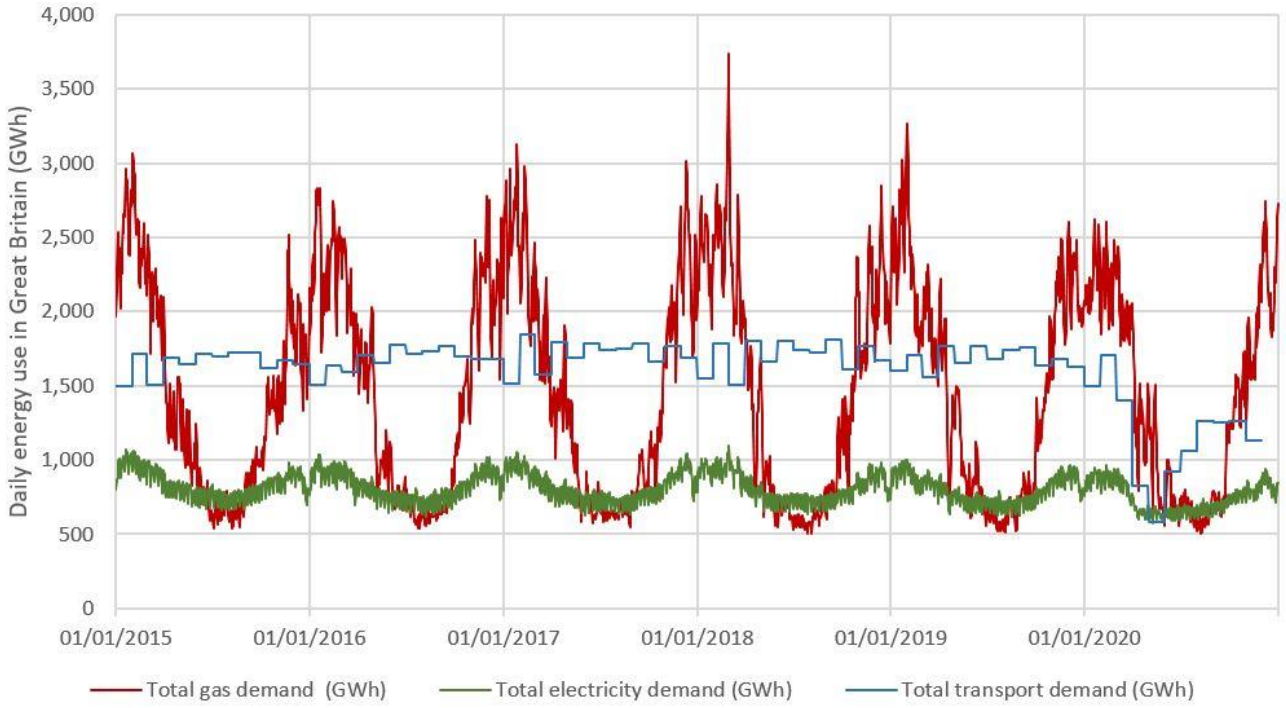
- 30 renewable energy projects with hydrogen generation*
  - Western Green Energy Hub (WGEH), 50GW of solar and wind, 15,000 km^2
  - Asian Renewable Hub Project, 26 GW of solar and wind, 6,500 km^2
- To estimate hydrogen storage requirement, it has been assumed:
  - All capacity available for hydrogen generation
  - 30-50% annual generative capacity (periodic and seasonal effects)
  - Storage capacity is 30% of annual production
- For comparison, estimated hydrogen demand in the UK by 2030 is ~20 Twh (source HyStorPor). Storage requirement is estimated at 6.6TWh or 78 Bcf (assuming 30% storage requirement).

Notes:
1 TWh = 0.33 Bcm = 11.8 Bcf @ 120 MJ/kg energy density and ambient conditions

* At time of writing

Hydrogen storage – why?

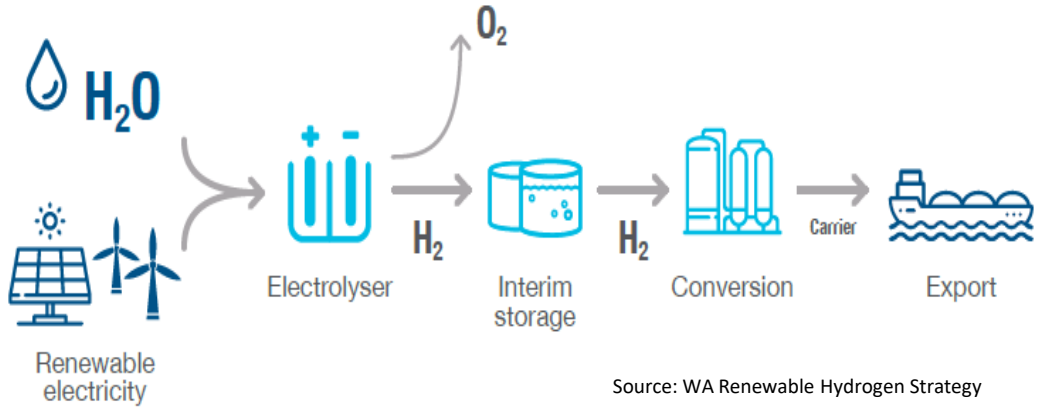
A UK Energy Demand



Source: https://ukerc.ac.uk/news/the-energy-system-transition-what-are-the-research-priorities/

B H_2 also has lower energy per unit volume

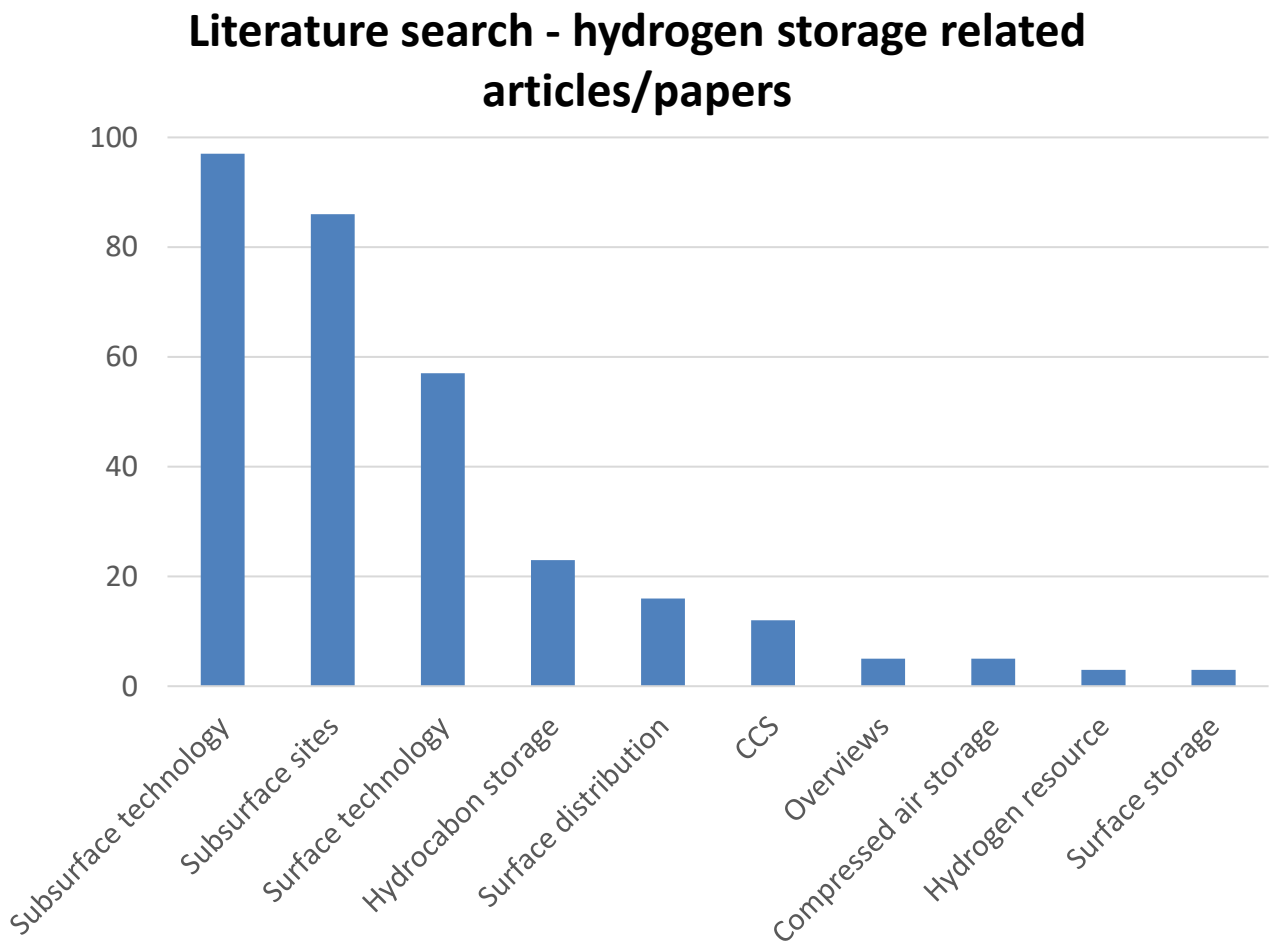
But in WA…….

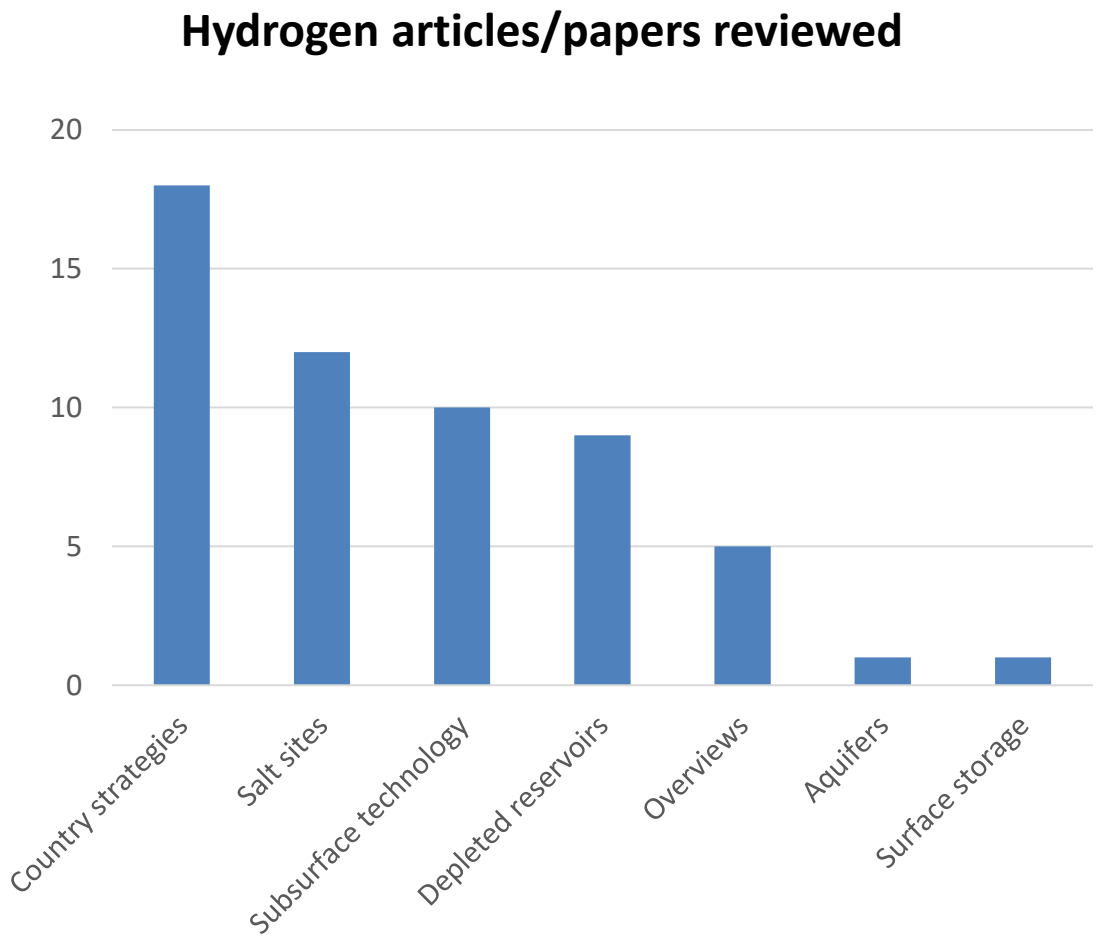


Source: WA Renewable Hydrogen Strategy

Source: Kawasaki Heavy Industries

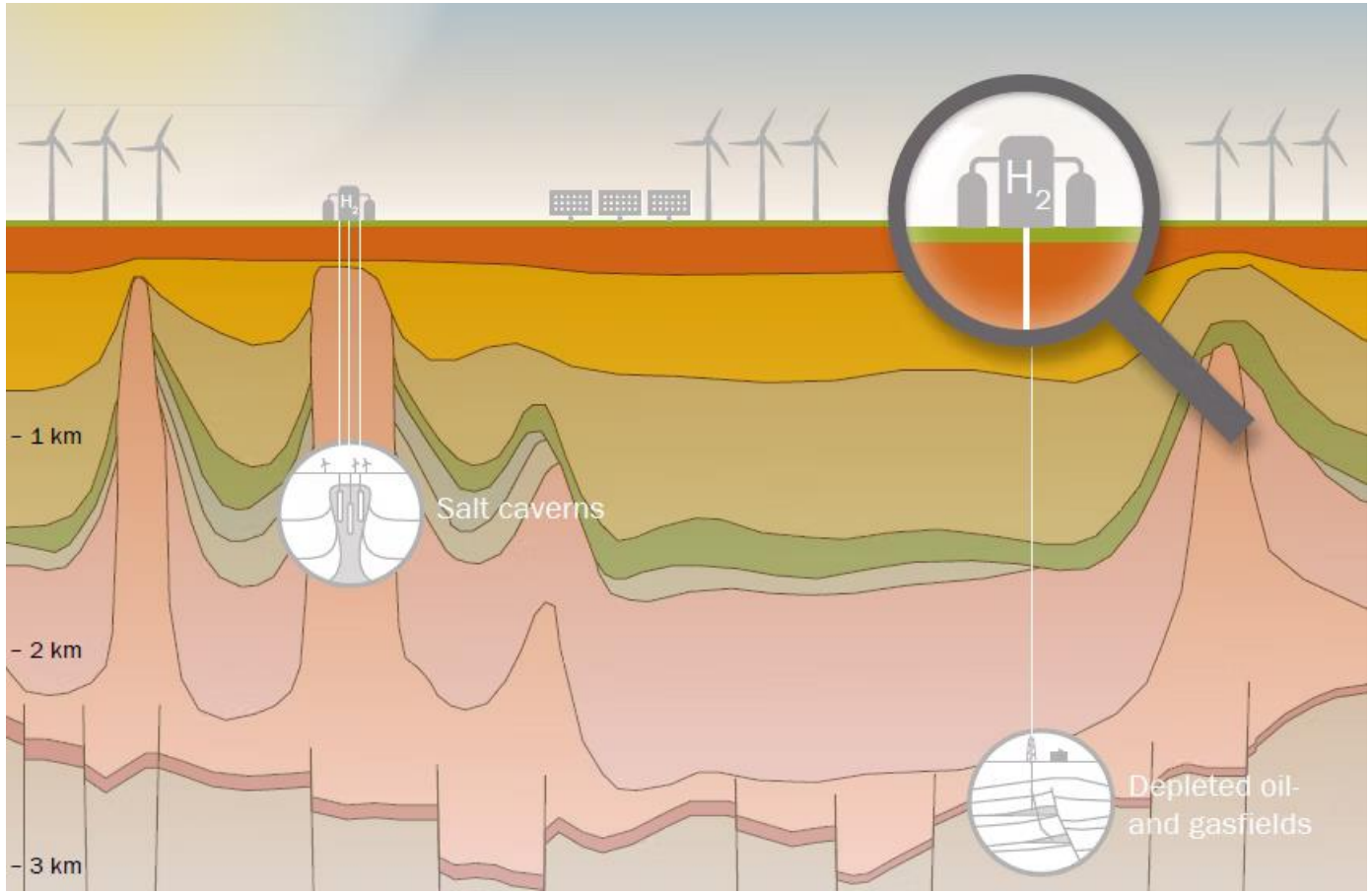
It's a hot topic – 340+ articles and counting!





High level of interest in hydrogen as a solution to abating GHG emissions.
Research, and hence published literature is accelerating.

Transitory geological storage



Source: IEA

Salt

- Manufactured salt caverns
- Considered best technical solution (size, containment, contamination, injection-withdrawal cycle)
- Currently only subsurface (pure) hydrogen storage operations

"Porous Media"

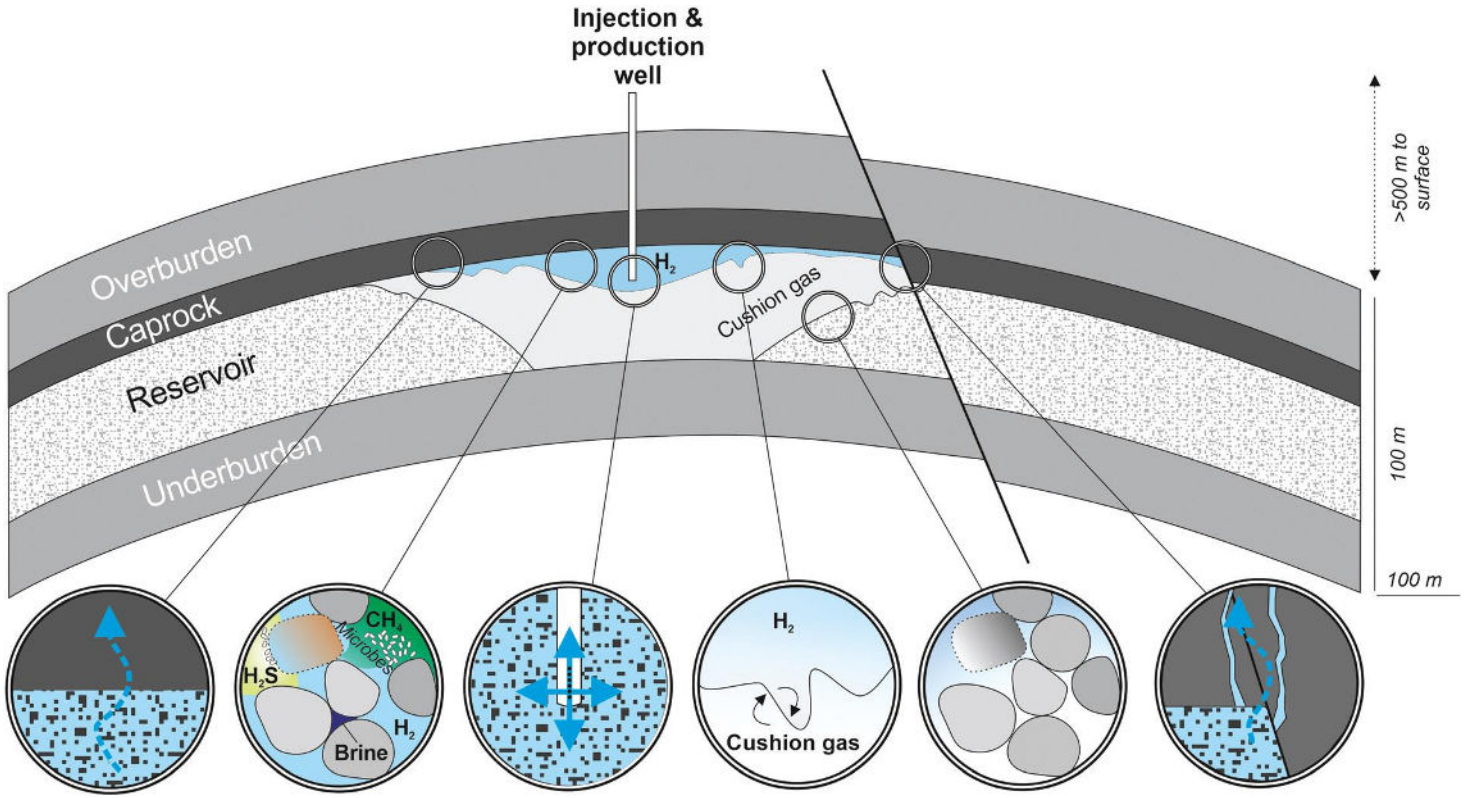
Depleted oil & gas fields

- Proven trap (containment)
- Losses and subsurface considerations

Aquifers

- Containment?
- Losses and subsurface considerations
- Some global experience with hydrogen mixtures

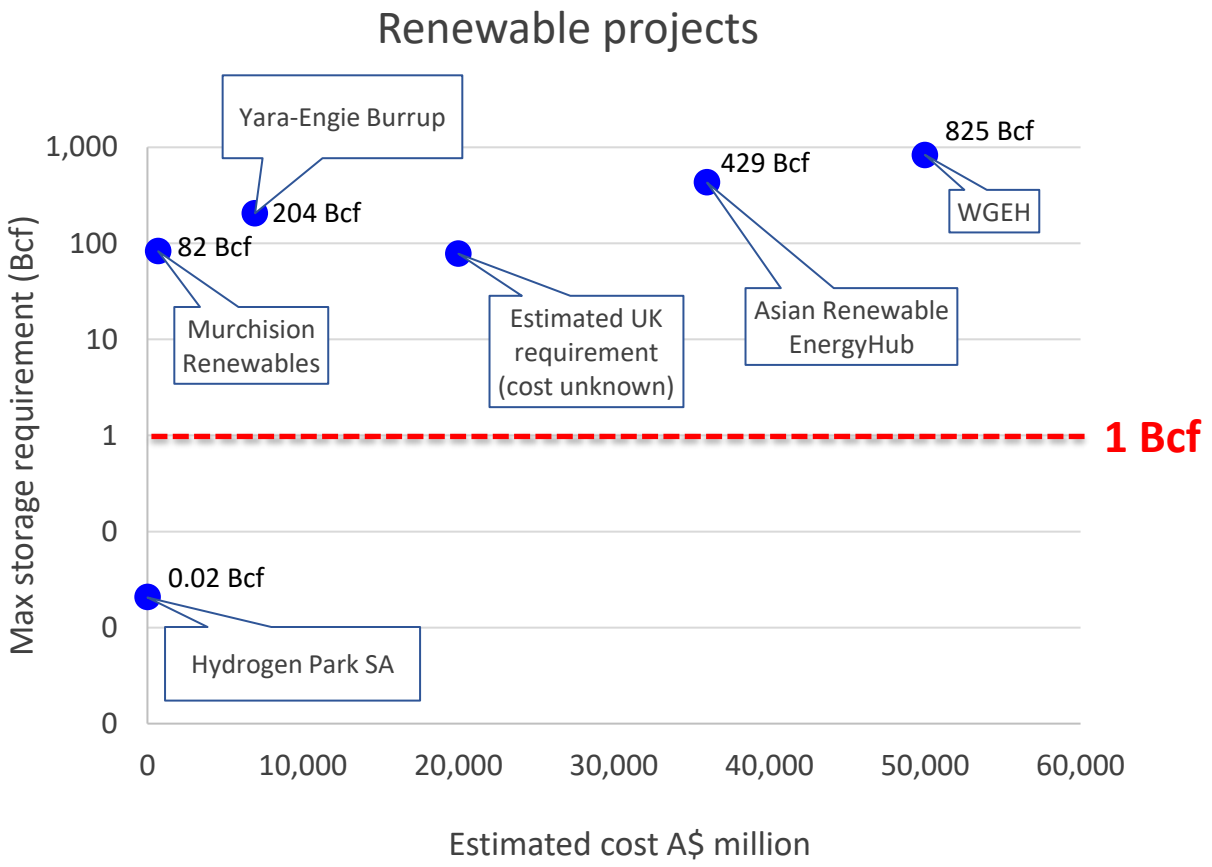
Hydrogen storage in porous media

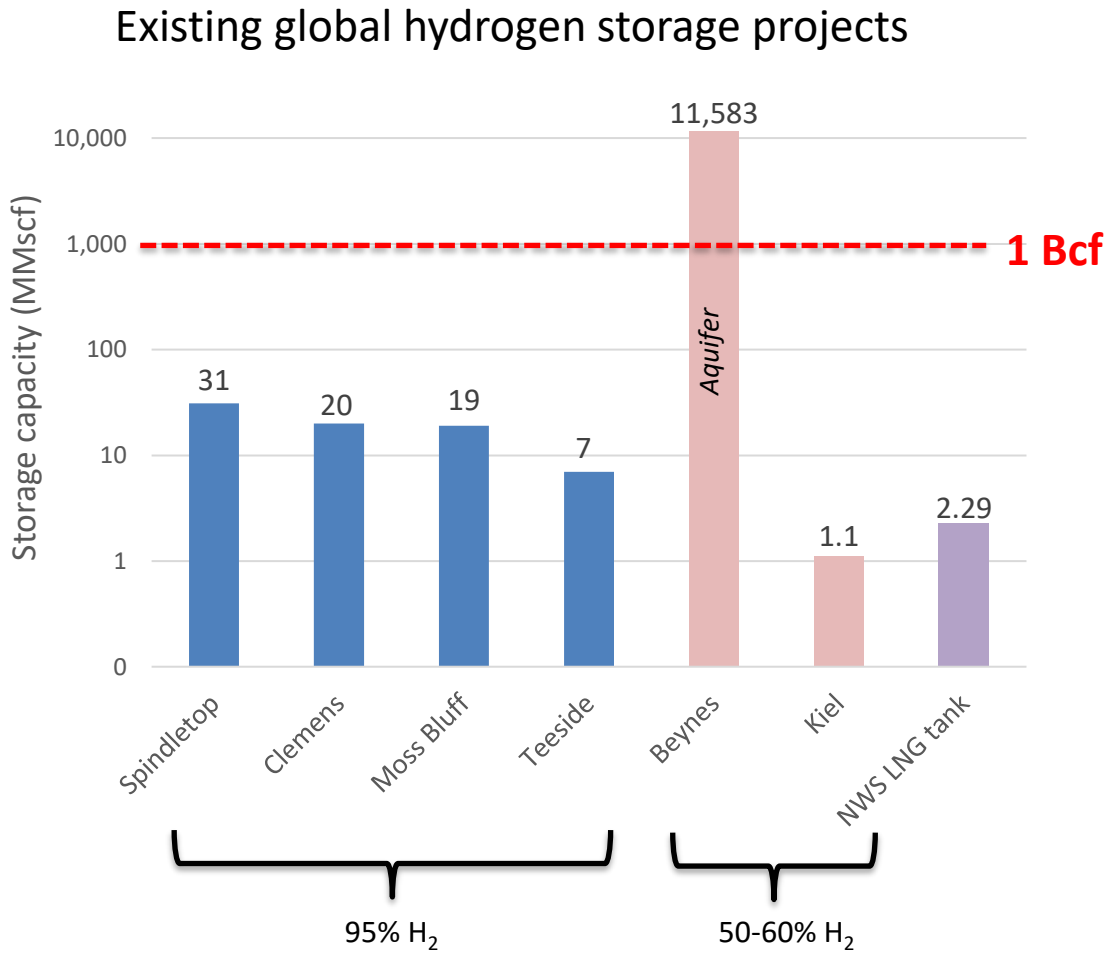


- H_2 is 4-times more diffusive than CH_4
- H_2 is reactive, potential reactions with caprock, reservoir, reservoir fluids (losses, permeability reduction)
- Microbial losses
- Souring and production of SOx from microbial and geochemical reactions
- H_2 reacts with CO_2 to form CH_4
- H_2 soluble in H_20 and oil (oil > H_20)
- Mixing with native hydrocarbon gases
- Mixing with cushion gas
- Injection fingering

Modified from: Heinemann et al (2021) 'Enabling large-scale hydrogen storage in porous media – the scientific challenges', Energy & Environmental Science (14)

What volumes are we talking about?



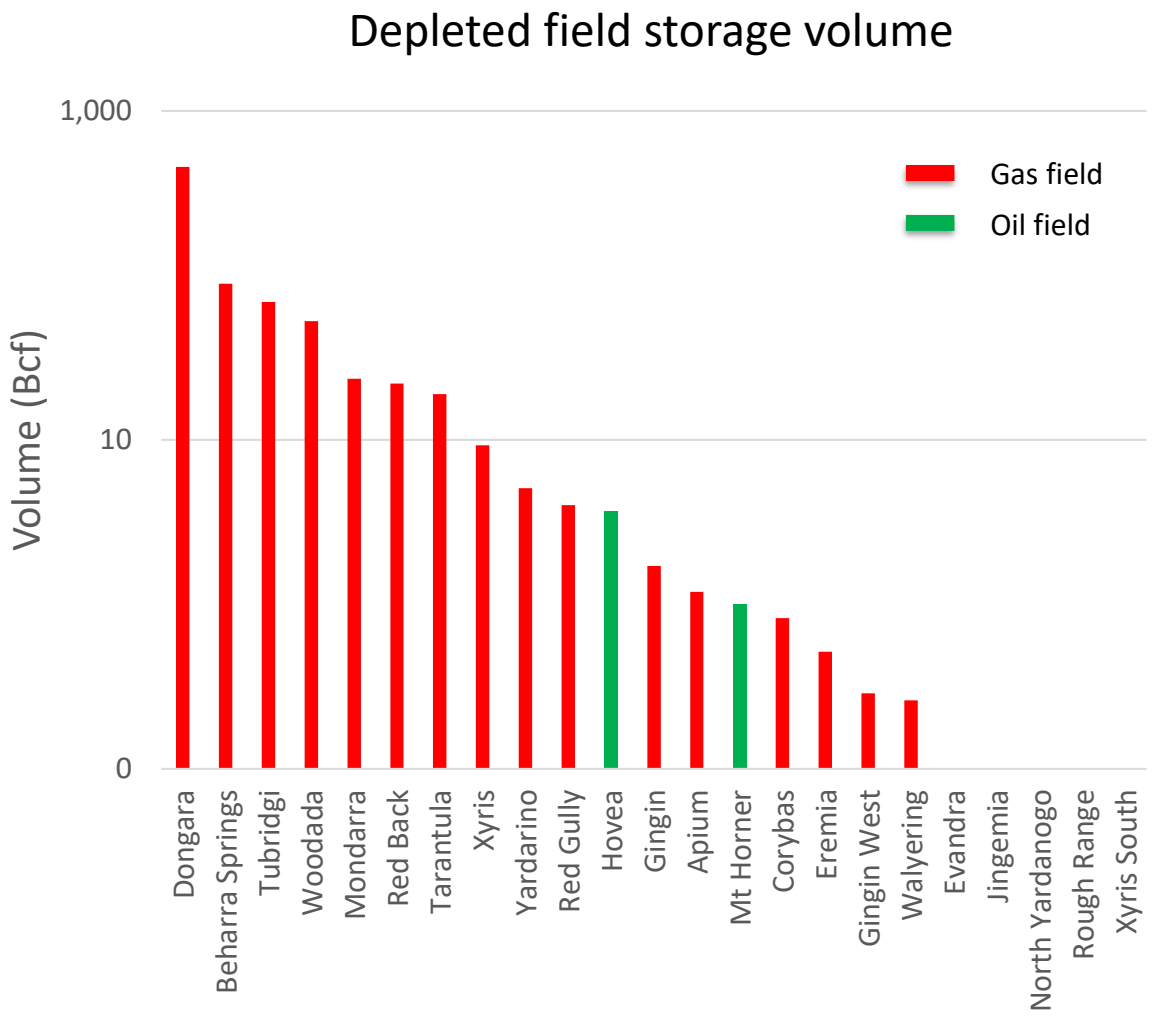


Maximum storage requirement assumptions:

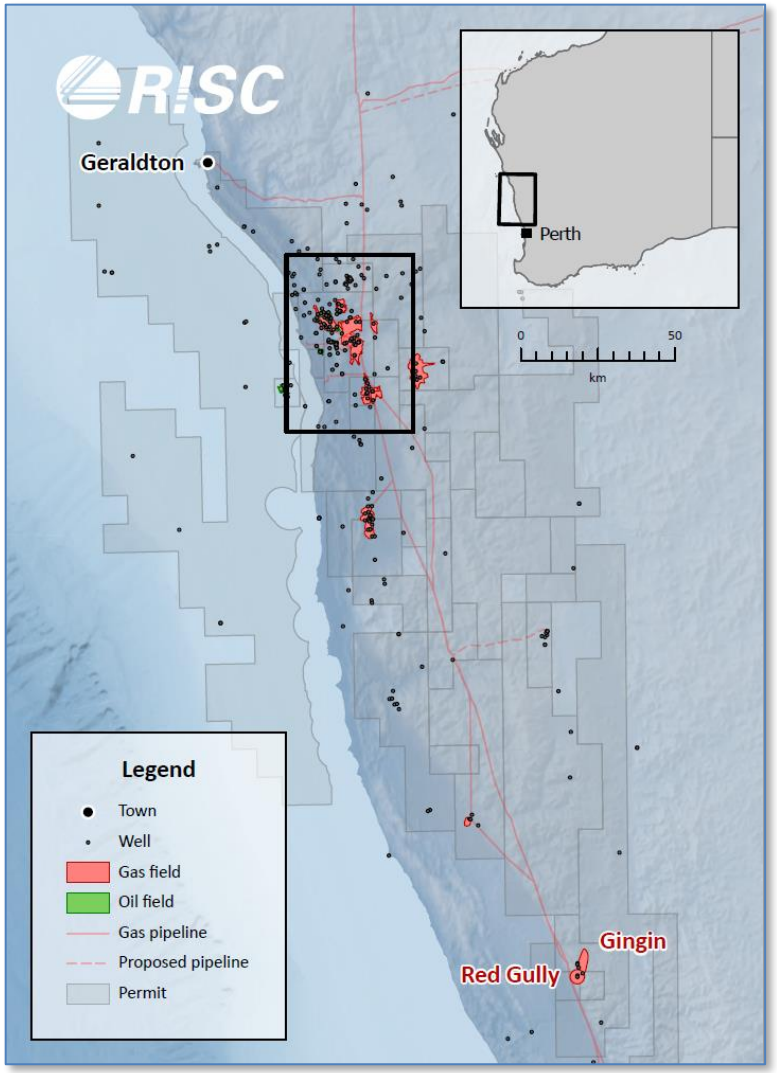
- All stated target capacity is used to generate locally used hydrogen (unlikely)
- Assume renewable sources operate 30-50% capacity
- Required to store 30% of annual hydrogen production (EU gas average ~ 20%)

WA depleted fields assessment

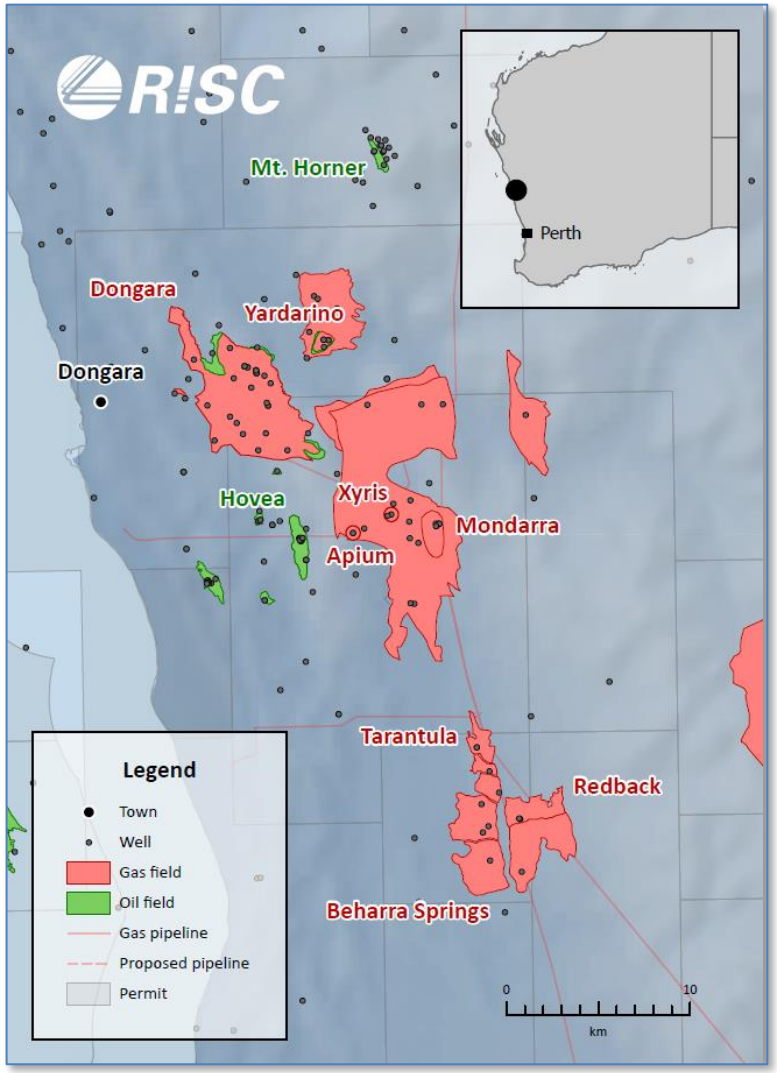
- Study restricted to onshore Northern Perth Basin and Southern Carnarvon Basin.
- 23 fields were assessed as ‘depleted’, with some historical production.
- Production history was used to estimate storage capacity
  - Production up to June 2015 available through WAPIMS
  - Open file reports
  - WA Atlas of Petroleum Fields Onshore Perth Basin (Owad-Jones & Ellis, 2000)
- Gas fields, total gas production used to estimate storage capacity.
- Oil fields, oil production converted using FVF’s used to estimate storage capacity.
- Need to account for sealing capacity of cap-rock and cushion gas volume.
- Current (or future) commercial use not taken into consideration (Tubridgi, Mondarra)



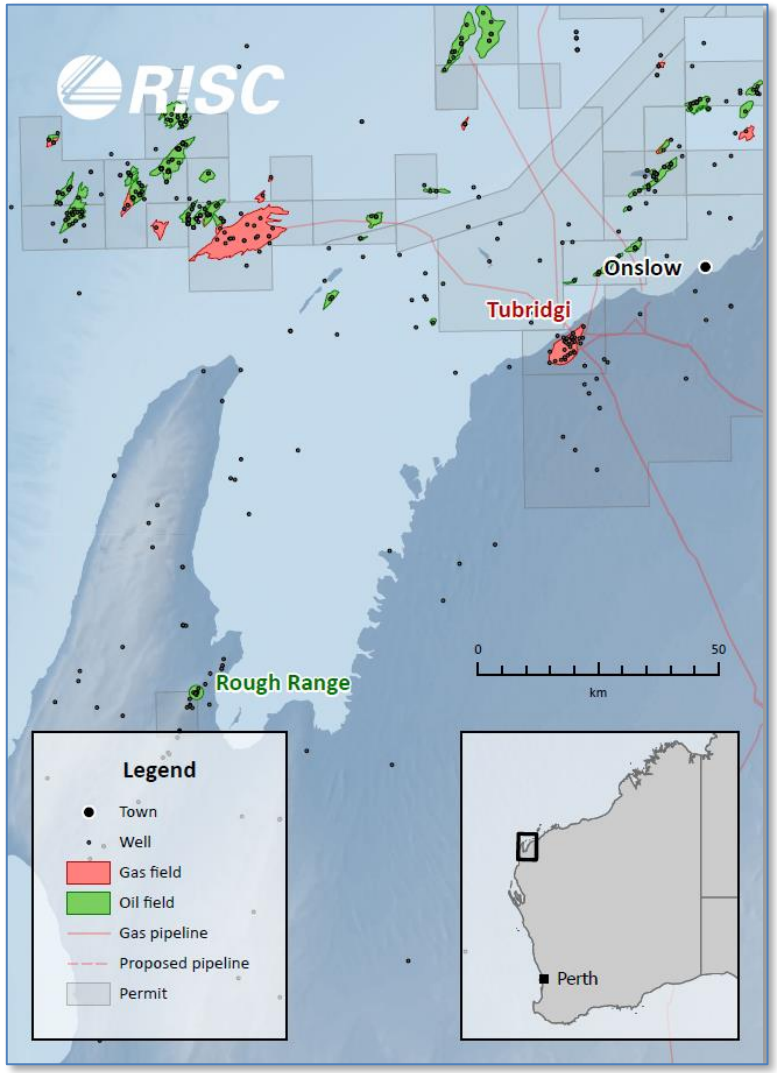
WA depleted fields assessment



Onshore Perth Basin



Onshore Northern Perth Basin



Onshore Southern Carnarvon Basin

WA depleted fields assessment

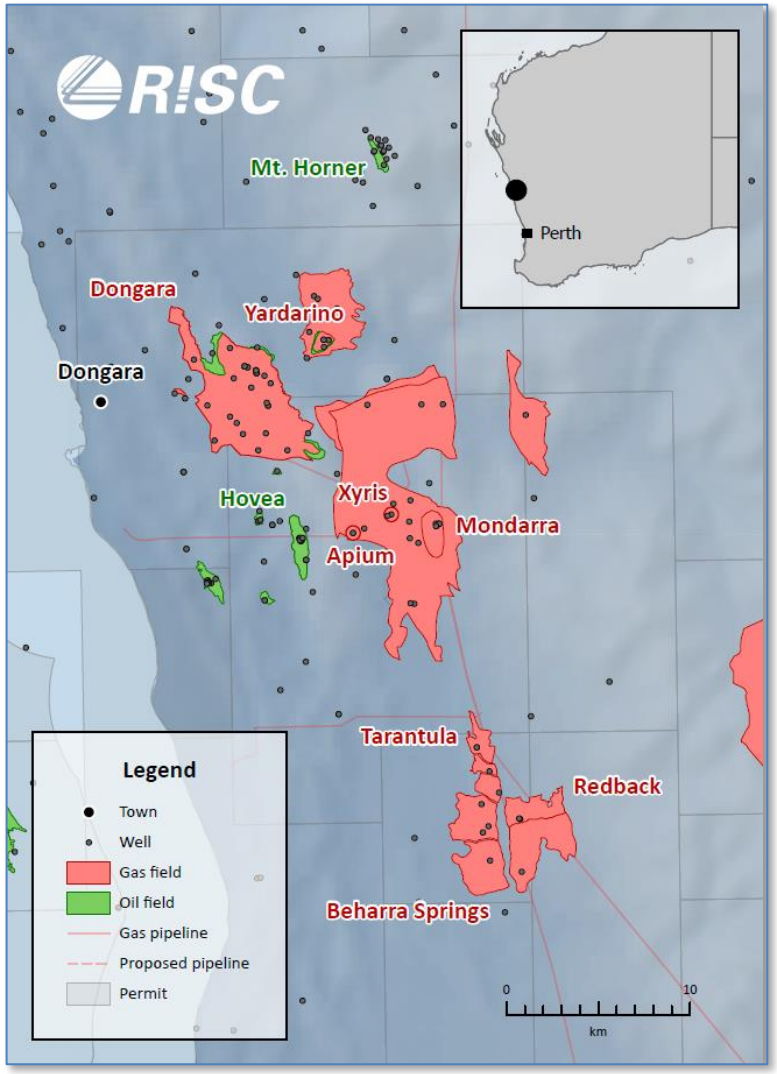
Field	Basin	Storage (Bcf)	H2 Storage Potential	Ranking
Xyris gas field	Perth	9.3	Strong	1
Yardarino gas field	Perth	5.1	Strong	2
Beharra Springs gas field	Perth	89.0	Strong	3
Red Back gas field	Perth	22.0	Strong	4
Tarantula gas field	Perth	19.0	Strong	5
Tubridgi gas field	Carnarvon	69.0	Strong	6
Mondarra gas field	Perth	23.9	Strong	7
Dongara gas field	Perth	458.0	Moderate	8
Red Gully gas field	Perth	4.0	Moderate	9
Apium gas field	Perth	1.2	Moderate	10
Gingin gas field	Perth	1.7	Moderate	11
Hovea oil field	Perth	3.4	Moderate	12
Mt Horner oil field	Perth	1.0	Moderate	13
Corybas gas field	Perth	0.8	No	
Eremia gas field	Perth		No	
Evandra oil field	Perth	minor	No	
Gingin West gas field	Perth	minor	No	
Walyering gas field	Perth	0.3	No	
Woodada gas field	Perth	52.9	No	
Xyris South gas field	Perth		No	
Jingemia oil field	Perth		No	
North Yardanogo oil field	Perth	minor	No	
Rough Range oil field	Carnarvon	minor	No	

Examples of ranking

Xyris field (#1)

- Produced 9.3 Bcf between 2004 and 2010
- Single production well
- Dongara Sandstone reservoir
- Average porosity 11%
- Permeability up to 2,078 mD
- Sw 18%

Fluid	Volume
Condensate production (MMstb)	0.02
Water production (MMstb)	0.03
Gas production (Bcf)	9.3
Approximate hydrogen storage capacity (Bcf)	9.3



Dongara field (#8)

- Produced 458 Bcf between 1972 and 2015
- 47 wells (31 prior to 1991)
- Dongara Sandstone reservoir
- Average porosity 21%
- Permeability up to 2,744 mD
- Sw 15%

Fluid	Volume
Oil production (MMstb)	1.5
Water production (MMstb)	2.2
Gas production (Bcf)	457.7
Approximate hydrogen storage capacity (Bcf)	457.7

Summary & conclusions

- There is significant global interest in transitory geological storage of renewable hydrogen
- It can be used to compensate for demand & supply cycles and prior to export
- Research and published literature is ever increasing
- Evaluation of transitory geological storage is included in WA's renewable hydrogen strategy
- Salt caverns are considered the best technical solution, but depleted oil and gas fields are good candidates (gas > oil)
- There are issues that need to be considered with respect to transitory geological storage of hydrogen in depleted fields
- In this study, 23 depleted fields were screened. 10 were considered not suitable, 13 were considered suitable and ranked.

Acknowledgements

This study was funded by the Government of Western Australia's Department of Mines, Industry Regulation and Safety.

Available at DMIRS eBookshop:

https://dmpbookshop.eruditetechnologies.com.au/product/hydrogen-storage-potential-of-depleted-oil-and-gas-fields-in-western-australia-literature-review-and-scoping-study.do