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The Cygnus Hub
An Onshore CCS Facility for WA Industry

May 2024

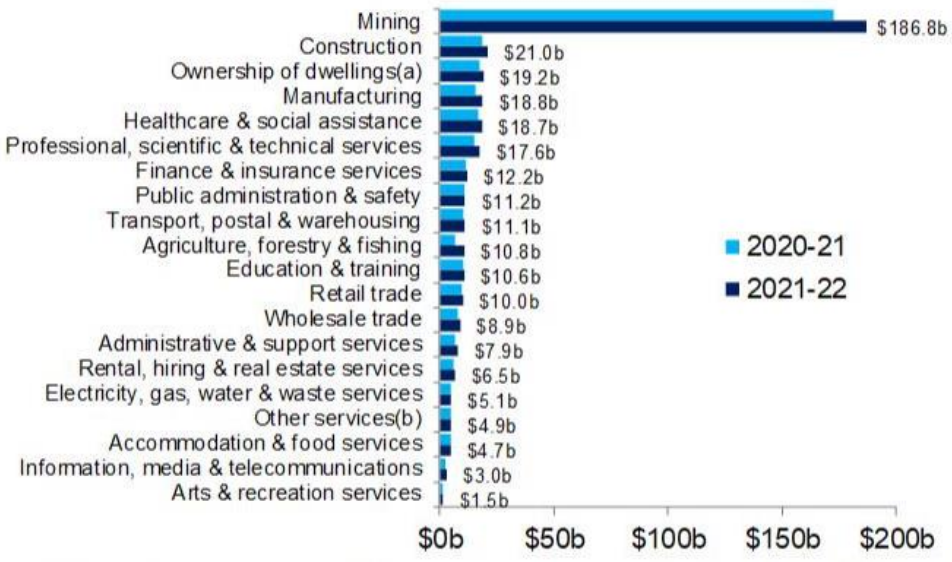
Why is CCS Important For WA

- WA has an export-oriented economy with a strong reliance on emissions intensive industries
  - Resources, agriculture and industrial processes.
  - >A$215 Billion per annum to the WA and Australian economies.
  - Between 1990 and 2019, emissions from these industries more than doubled from 47.25 Mt to 98.55 Mt.

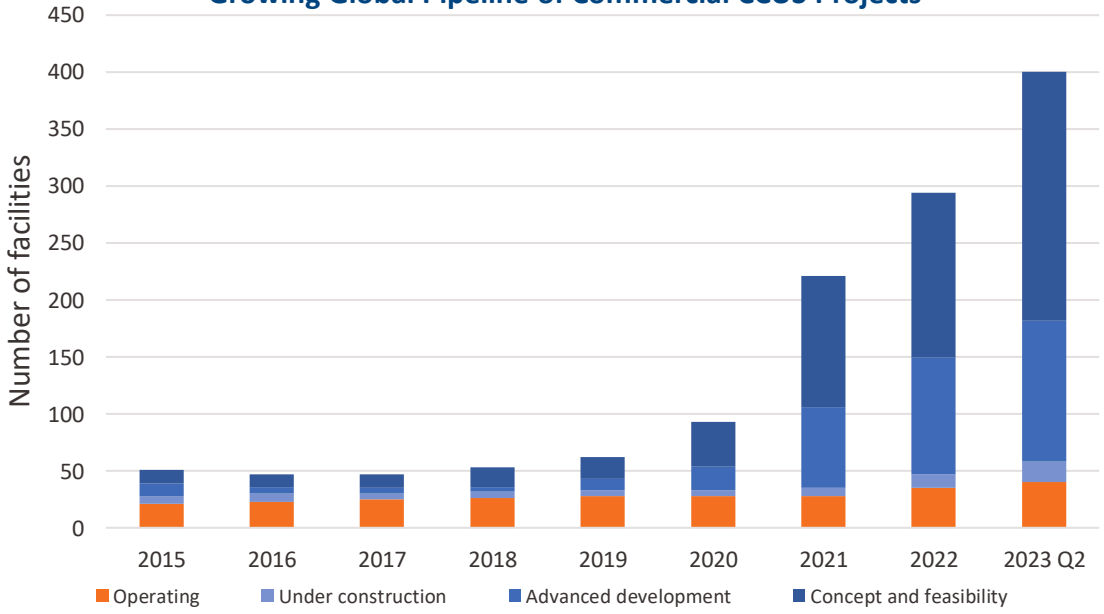
- The WA Government, Australian Government and IEA recognise that CCS is critical for decarbonising LNG industry and support the development of new low-carbon industries such as ammonia.

- Rapid escalation in the development of new CCS projects globally, with a recognition that CCS is critical to achieving net zero.

Industry contribution to WA Gross State product (*Source:* JTSI, 2023)



Growing Global Pipeline of Commercial CCUS Projects



WA Government CCS Leadership

Legislation

- Petroleum Act Amendment Bill creating system for onshore CCS passed Legislative Assembly in April, now before Legislative Council.

Comments attributed to Premier Roger Cook:

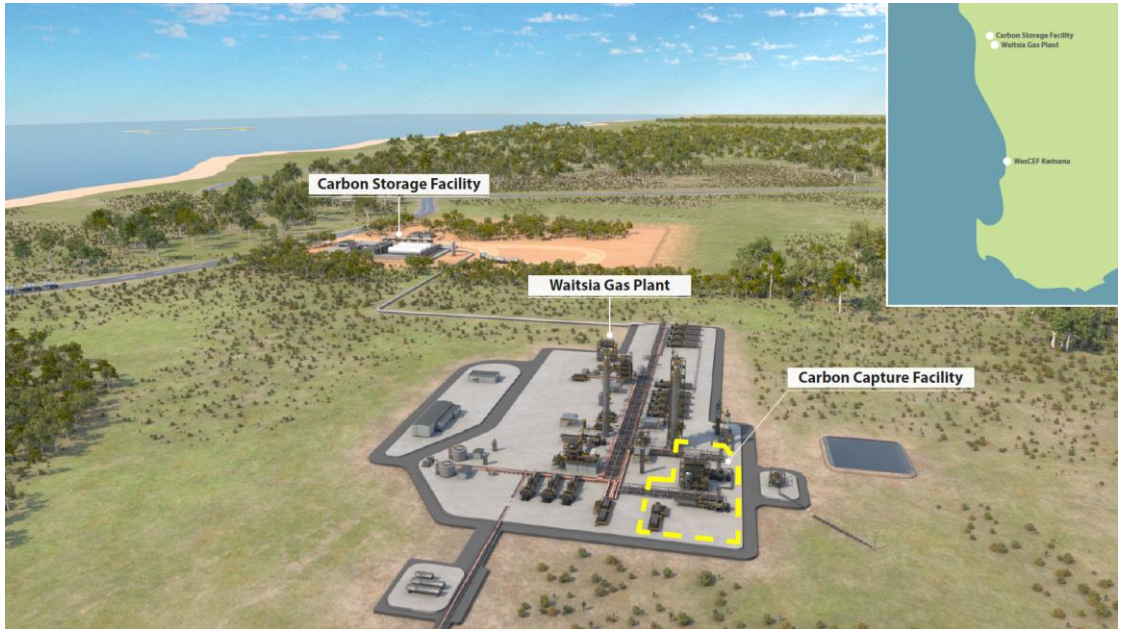
- "WA is a world leader in mining and natural gas, and that means we are perfectly placed to become **a world leader in Carbon Capture, Utilisation and Storage.**
- "We can leverage our skilled workforce, existing infrastructure and unique geology to **attract global CCUS investment** – helping to create local jobs and strengthen our State's economy.
- "We know there is growing demand from our trading partners for projects that support their energy security, but that also incorporate CCUS.
- "My Government is committed to slashing our State's emissions and supporting decarbonisation across the globe – and **CCUS will play an important role in managing the transition to a low-carbon future."**

Comments attributed to previous Mines and Petroleum Minister Bill Johnston:

- "Carbon Capture, Utilisation and Storage will provide **WA's industrial and mining industries** with access to opportunities to decarbonise.
- "Understanding the benefits of developing one or more **CCUS hubs**, and developing legislation to facilitate greenhouse gas transportation and storage, is important for our State's future."

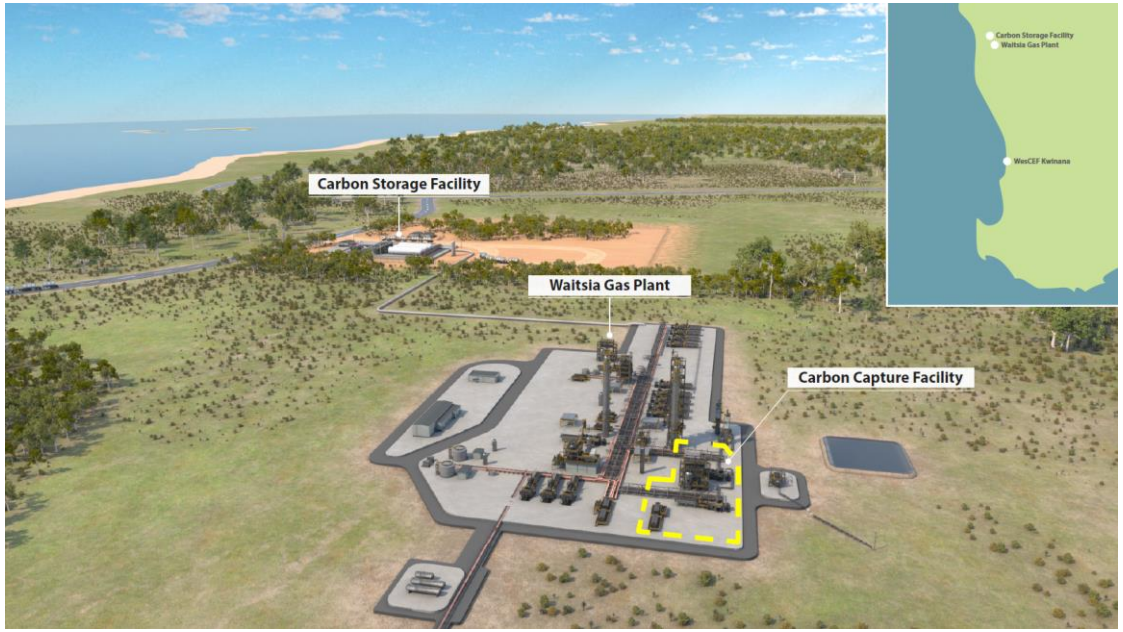
Cygnus CCS Hub

- Mid-West regional CCS Hub
- Support **industrial decarbonisation**
- Utilise **existing infrastructure** and **depleted reservoirs** around core infrastructure and acreage to develop a **low-cost CCS hub**
- Underpinned by emissions from the Waitsia Gas Plant and WesCEF ammonia facilities
- Operator of choice for WA industries pursuing a low carbon future.



Supporting WA Decarbonisation

- Decarbonise existing industries while developing new, low carbon industries:
  - Critical minerals
  - Low carbon ammonia
- Cost effective deployment of onshore CCS to decouple emissions from economic growth
- Ensures WA industries remain globally competitive
- Significant contributor to Net Zero pathway.



Phased Hub Development

- **Injection test**
  - Injection of 50 tonnes of CO2 into depleted Dongara reservoir
  - Proof of concept to build capacity in CCS and support stakeholder and community engagement.
- **Phase 1**
  - Capacity ~ 0.5 mtpa
  - Decarbonising Waitsia and Wesfarmers AP2 operations, safely injecting CO2 in depleted gas reservoirs.
- **Phase 2**
  - Capacity > 1 mtpa, cost of CCS reduces with scale, improving margins
  - Storage in depleted gas reservoirs complemented by saline aquifer storage
  - Multi-customer model, decarbonizing Kwinana and regional emissions.

The First Step - CO2 Injection Test

Overview and Objectives

Technical

Injectivity into the depleted Dongara reservoir, flow assurance models, facility engineering and material selection.

Govt Approvals

Utilise existing regulatory processes/submissions, and actively supporting introduction of new legislation.

Stakeholders

Develop robust plans for stakeholder engagement and community support. First stage of engagements with key stakeholders.

Partnerships

Build early engagement with key emitters, supported by key partnerships with scientific and research organisations.

Capability

Leverage global experience and deep local knowledge and incumbent position across the Perth Basin.

Inject truck-supplied CO2 in the Dongara reservoir

Project Conclusion

- System design, equipment selection and procedures were suitable for the safe conversion of liquid CO2 to CO2 vapor
  - Achieved BOD objectives
  - Capable to inject larger volumes at negative carbon balance with more supply
- Confirmed ability to inject CO2 into depleted reservoir
  - System can be applied to other depleted reservoirs
- Met strict regulatory conditions and requirements for well operations
- Well control and well integrity of repurposed production well was maintained
- Quality data obtained throughout operations
  - No failure of any data points observed
- Project enabled development of CO2 system design workflows and safe CO2 handling procedures for industry

Success factors	Result
Complete a successful test of CO2 at various injection rates utilizing up to 54 tonnes of liquid CO2	• Successful injected 45 tonnes of CO2 utilizing 3 step rates. • Achieved 2hr stable injection period meeting the BOD "stable" criteria (0.7 bpm)
Zero reportable/reportable HSE incidents	• Achieved
Zero non-compliance Environmental incidents.	• Achieved
Full documentation of test procedures and data collection	• Achieved
Zero non-compliance with applicable regulatory requirements	• Achieved

Analysis Observations and Insights

- Good quality downhole data
- Flow very stable once established
- CO2 injectivity appears similar to gas productivity at current P_{res}
- Apparent improvement in injectivity during the test:
  - May be a function of rate (increasing access to lower perfs over time as brine is displaced)
  - May be a function of time and/or cumulative injection (increase in gas saturation around wellbore over time improves gas rel. perm.)

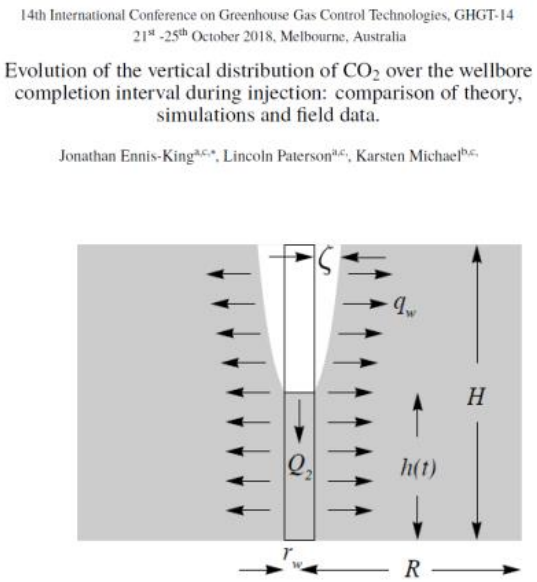
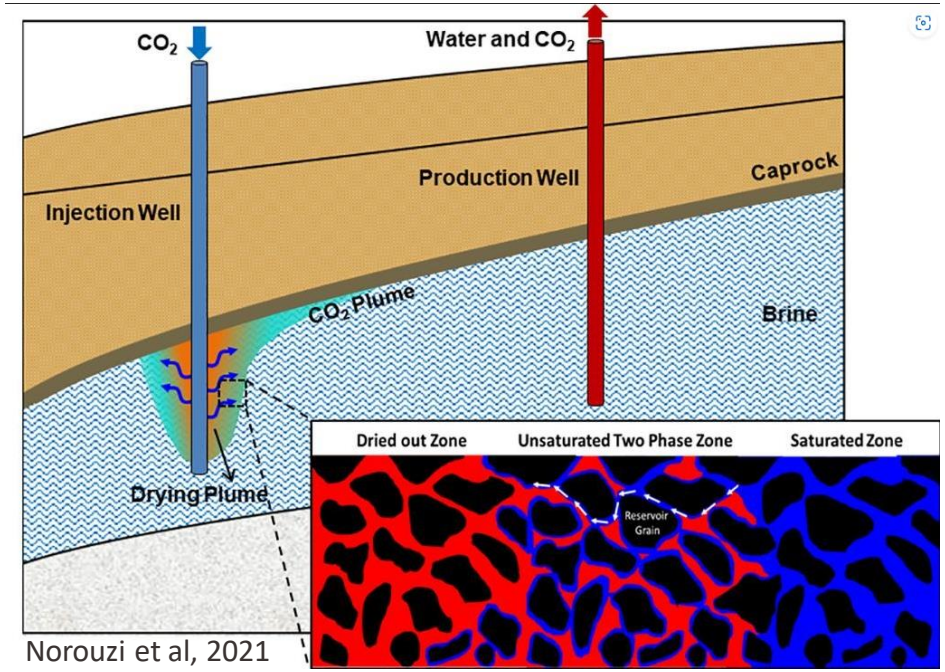


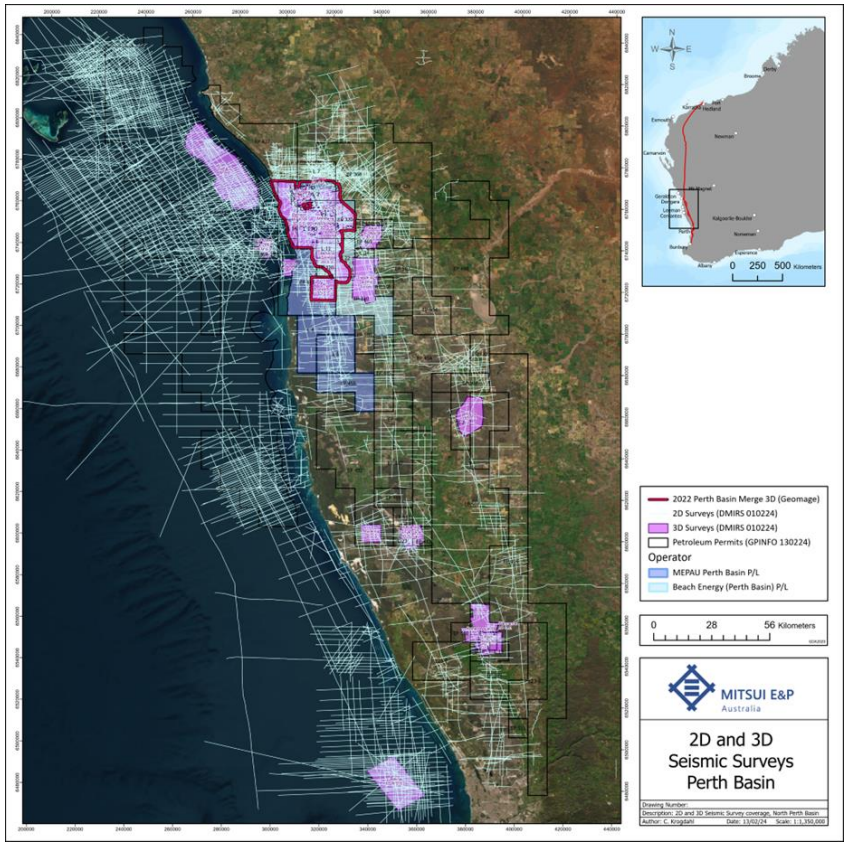
Figure 1: Schematic diagram of transient flow during injection via a well showing the symbols used in the equations.



Norouzi et al, 2021

Next Steps

- MEPAU is currently assessing several options for gaining additional R&D value from the IA well, subject to Government approvals.
- MEPAU its partner WesCEF have completed CCS assessments of several depleted gas fields in the NPB and are actively developing plans for Cygnus Phase 1 utilising a depleted reservoir.
- The MEPAU/WesCEF multi-disciplinary CCS team has evaluated key elements of a CCS Hub concept in the Mid West which forms the basis of the planning for Cygnus Phase 2:
  - subsurface evaluation and modelling,
  - well integrity assessments,
  - facility design,
  - market assessment
  - stakeholder engagement.
- Timing of the next steps will be dependent on securing the appropriate approvals, including securing GHG Injection Licenses and potentially exploration permits.
- It is expected that once Cygnus Phase 1 is more mature and ultimately operational, and industrial emitters can see CCS in action, the growth potential of the hub concept can be realised.
- **MEPAU believes that onshore CCS is an important part of the carbon-abatement solution for WA emitters.**



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