CO2CRC Otway Research Facility

Max Watson, CO2CRC
CO2CRC Otway Research Facility

One of the most comprehensive CO₂ storage demonstration laboratories in the world

Verification of the fundamental science of CO₂ storage in Australia and further validated the technology globally

Features an investment of over A$110 million to demonstrate real-world injection, storage and monitoring techniques

In-situ access to approximately 400,000 t of CO₂ from the Buttress gas field (79% CO₂ and 19% CH₄), providing the site with a unique storage bank of CO₂ for an array of experiments.

Multiple reservoir-seal pairs within the 1 – 2 km depth range and is ideal for appraising storage and monitoring performance.

Including a state-of-the-art seismic monitoring array (buried receivers and permanent sources) fully validated from past experiments for observing and benchmarking subsurface technologies and processes.

All regulatory approvals for testing and piloting technology and local community support

Availability of high quality, comprehensive, datasets, from previous operations (data obtained from three closely spaced wells).
CO2CRC Otway Research Facility’s Projects

**Otway Stage 1: 2004 – 2009**
- Demonstrated safe transport, injection and storage of CO₂ into a depleted gas reservoir

**Otway Stage 2: 2009 – 2019**
- Demonstrate safe injection of CO₂ into a saline formation
- Stage 2B – Near well residual & solution trapping characterisation
- Stage 2C – Minimum detection, 4D M&V & Plume stabilisation

**Otway Stage 3: 2015 – 2022**
- Demonstrate safe, reliable and cost-effective subsurface monitoring of CO₂

**Otway Shallow CO₂ Migration: 2016 - 2021**
- Improve capability to predict the role of faults in controlling CO₂ fluid flow in the near surface;
- Improve near surface monitoring capabilities

**Otway Capture Skid: 2016 – 2019**
Separating natural gas under high pressure and with high CO₂ content
Otway Basin Region
The CO2CRC Otway Project Stage 2

2A: Drill CRC-2

2B: Measure parameters affecting residual and dissolution trapping in a saline formation

2B Extension: interactions with impurities & well test refinement

2C: Spatially track injected CO₂ in a saline formation
  - Minimum detection limit
  - Migration behaviour
  - Stabilisation

DE-RISKING THE STORAGE OF CO₂ IN SALT FORMATIONS

Saline formations have the greatest potential for CO₂ storage globally. Their utilisation will be necessary to ensure we remain within the COP21 2C target.

2015–2019

THROUGH THE MONITORING AND VERIFICATION OF 15,000 TUNNES OF INJECTED CO₂ WE WILL VALIDATE SALINE ROCK FORMATIONS FOR CARBON CAPTURE AND STORAGE BY:

A

B

C

VALIDATING THE ACCURATE MODELLING OF CO₂ STABILISATION AND TRAPPING IN A SALT FORMATION

UNDERSTANDING THE SAFE STORAGE CAPACITIES OF THIS RESOURCE

DEMONSTRATING THE MINIMUM DETECTION LEVEL OF CO₂

Appraisal

Operation

Recognized Project
Otway Stage 2B timeline
Value of the Conformance and Stabilisation Workflow

With a small, short-term empirical trial (Otway 2C), a generic and validated workflow for conforming long term plume predictions (including stabilisation) to early monitoring observations will be developed.
Otway Stage 2C Challenges

Challenge: Plume’s seismic detection

• Very thin plume
• Seismically noisy environment relative to modelled signal
• Poor repeatability
• Best chance to demonstrate achievement of objectives
  • Minimum detection limit
  • Migration behaviour
  • Stabilisation

Solution:

• Buried seismic array
• Re-completion of CRC-2
Recompletion of CRC-2 for Improved Plume Sweep

- X-nipple at 1417.31 m
- X-nipple at 1430.78 m
- X-nipple at 1243.47 m
- X-nipple at 1098.53 m
- JFE Bear Casing 5.5” 13 CR80 17 ppf, ID 4.892”
- Tubing 2 3/8” 13 Cr85 Fox 4.6 ppf, ID 1.995”
- Gas Lift Mandrel (annulus)
- Gas Injection Mandrel
- On-Off tool (1435.12 m and 1490.36 m)
- P/T gauge (1440.63 m and 1442.51 m)
- Existing perforations 1440 m – 1447 m
- Packer at 1486.02 m
- Packer at 1430.78 m
- UTube filter (1437.64 m)
- UTube filter (1437.23 and 1442.47 m)
- On-Off tool (1437.23 and 1442.47 m)
- New perforations 1501 m
- P/T gauge (1509.19 m and 1511.07 m)
- Sliding Side Door (SSD) (1435.12 m and 1490.36 m)
- U-tube TinT line 3/8”
- Gas Injection line 3/8”
- DTPS Cable with Fibre Optics 0.25”
- P/T Gauge line 0.25”
- U-tube TinT line 3/8”
- P/T Gauge line 0.25”
- JFE Bear Casing 5.5” 13 CR80 17 ppf, ID 4.892”
- Gas Injection Mandrel
- Gas Lift Mandrel (annulus)
Buried Array for Noise Reduction and Improved Repeatability
Buried Array for Noise Reduction and Improved Repeatability
Seismic Time-Lapse Signal

M1 (5kt)  M2 (10kt)  M3 (15kt)  M4 (+ 9 mo)  M5 (+ 23 mo)

Objective 1: Detect injected CO₂

Objective 2: Observe CO₂ plume development using TL seismic

Objective 3: Verify stabilisation
Otway Stage 2C

History Matching

Injection interval

Above Zone Monitoring Interval (AZMI)
Otway Stage 3
Subsurface Monitoring & Validation

1. We will develop a high-resolution, real-time monitoring capability to identify and track CO2 plume movement in the Subsurface.

2. We will employ Non-Invasive monitoring techniques that will be acceptable for community and regulators.

3. The project will evolve these technologies from benchtop application to in-field validation, aligned with operator need.

4. The project will provide a suite of technologies and workflows that can be selected to create bespoke solutions which optimize effectiveness and costs in commercial monitoring projects.
Concept:
- Monitor from the subsurface
- Monitor relatively small regions of highest risk
- Monitor frequently or continuously
- In operational settings, escalate to planned risk management response if anomalies are detected

Core Monitoring Methods:
- Pressure
  - Pressure Inversion
  - Earth Tide response
  - Pressure Tomography
- Down hole seismic
  - Multi-well 4D VSP with permanent sources & F/O receivers
  - Time-Lapse cross-well seismic
  - Microseismic monitoring
Otway Stage 3 Timeline

Opportunity Definition Phase
Jan 2015 - Sep 2015

Early Evaluate Phase

Evaluate Phase
Apr 2016 - Nov 2017

Define Phase
Dec 2017 - Nov 2018

Execute Phase
Dec 2019 - Nov 2019

Operate Phase
Dec 2019 - Jun 2022


May 2018 CRC-3 Drilled

Today

Jan 2019 Site Preparation
Feb 2020 Injection Operations
Aug 2019 Drilling Operations
Otway Stage 3 Execute

Well Design Summary

Drilling Four Monitoring Wells
- 12 ¾” hole x 9 ½” Casing to ~930m MD
- 8 ½” hole x 5 ½” 13Cr80 Casing to ~1700m MD
- Drilled with water based mud system
- Fibre Optics installed behind 5 ½” Casing
- Single zone perforated completion design
- 2 ¾” tubing, with multiple control & FO lines

Completion of previously drilled appraisal well
- Appraisal well drilled in 2017
- Single zone completions in 5 ½” casing (currently not perforated)
- 1 x ~10m perforations
- 2 ¾” tubing, with multiple (8) control & FO lines

Provisional Well Completion Schematics
- Injector and M&V Designs -
Injection Scenarios

Injection from CRC-3 into PS1 - One year post Injection Plume thickness
Otway Research Facility - Future

Deliver:
- Otway Stage 3 Project
- Otway Fault Project
- Demonstrate real world CCS for the local community, and the community at large
- Provide an opportunity to overcome real-world engineering challenges under operational conditions
- Enable the decrease technical risk & uncertainty, and tests technical performance, prior to embarking on a large sale project
- Provide impetus to regulators to confront some of the regulatory issues when there is a real project

Scoping:
- Lateral well logging of saturation and residual trapping
- Safe operations management trials
  - Pressure relief
  - Barrier formation
- Data & Facility access for external testing (seismic, near surface M&V, optimization trials)
- Well integrity and abandonment studies
Government, Industry and Research Partners
Thank you
CSLF