

Optimising CO₂ storage resource utilisation: insights from Otway Stage 4

Otway Stage 4's field demonstration and R&D endeavour will enhance CO₂ storage technologies, improve the utilisation of storage resources, and accelerate the development of commercial CO₂ storage says the team from CO₂CRC in a recent paper published in the Australian Energy Producers Journal.

CO₂CRC's Otway Stage 4 program aims to improve site modelling workflows and demonstrate the potential for a >20% increase in CO₂ storage efficiency through innovative reservoir management techniques, and develop low-cost monitoring technologies. Further, this program will demonstrate the viability of lower-quality reservoirs for effective CO₂ storage.

The program, conducted at CO₂CRC's Otway International Test Centre (OITC), will involve two sequential injections of up to 10,000t of CO₂-rich fluid, with the first of these commencing in October 2024,

The GeoCquest Field Validation (GFV) project, a collaboration between CO₂CRC, University of Melbourne and Stanford University, is a key component of Otway Stage 4, demonstrating a new workflow for understanding fine-scale CO₂ flow processes in heterogeneous reservoirs, by acquiring and analysing time lapse CO₂ saturation and fluid data during the CO₂ plume's migration,

Another key area of field research, in collaboration with RITE, conducted as part of Otway Stage 4 involves the injection of CO₂ microbubbles (MBs), which, due to their smaller size, lower buoyancy effect, and enhanced dissolution properties, significantly increase storage efficiency compared to standard CO₂ injection.

Surfactant injection is also being explored by KIGAM (at bench-scale using the OITC's samples and datasets) to enhance CO₂ storage effectiveness. By modifying interfacial tension (IFT) and wettability, surfactants are expected to improve sweep efficiency and minimise CO₂ footprint. Such modifications could lead to improved injectivity, thus reducing the pressure requirement for CO₂ injection and increasing the overall storage capacity.

Two innovative techniques, CO₂ saturation monitoring from seismic and Distributed



SLB and Wild Desert contractors running cables down the outside of the tubing at CO₂CRC's Otway International Test Centre Stage 4 injection well CRC-3 (Image: CO₂CRC)

Strain Sensing (DSS), are also being trialled by CO₂CRC, in collaboration with Curtin University and RITE respectively, in conjunction with the CO₂ injections. Performance monitoring capabilities are an important component for storage optimisation, measuring effectiveness and providing on-demand information for operational decisions.

The monitoring component of the program aims to generate time-lapse, seismic-based CO₂ saturation maps, providing insights into storage efficiency. DSS will use Rayleigh scattering to assess geomechanical responses to CO₂ injection.

The outcomes of the Otway Stage 4 program are expected to include materially advanced reservoir management technologies, demonstrating a minimum 20% increase in CO₂

storage efficiency and cost-effective monitoring solutions, which will ultimately accelerate the commercial viability and uptake of CO₂ storage at scale.

Background

The optimised use of storage resources and accelerated commercial CO₂ storage development is vital for carbon capture and storage to play an important role in reducing emissions at scale.

CO₂CRC is seeking to address this challenge through an international collaboration – the Otway Stage 4 field program – that demonstrates a suite of cost-effective reservoir management techniques with the potential to improve CO₂ storage capabilities, particularly in

lower-quality reservoirs, maturing them for commercial readiness.

Aiming to enhance injectivity, improve sweep, increase model resolution, and develop performance monitoring capabilities, Otway 4 will substantially improve CO₂ storage resource usage, furthering economical viability for decreasing CO₂ emissions to the atmosphere.

Otway Stage 4 includes acquisition and analysis of CO₂ saturation and chemical data during plume migration and trapping, combined with investigation of fine-scale geological heterogeneity's role in CO₂ flow dynamics, to refine modelling workflows and, ultimately, develop strategies for optimising commercial CO₂ storage.

Otway Stage 4 program summary

The Otway Stage 4 program comprises a series of applied, CO₂ geological storage R&D projects to be undertaken between 2023 and 2027 at CO₂CRC's Otway International Test Centre. This program will undertake two sequential injections of up to 10,000t of CO₂-rich fluid to test in-field reservoir management technologies and use the resulting data and validated techniques to materially decrease the project cost and increase the viable commercial options for CO₂ storage.

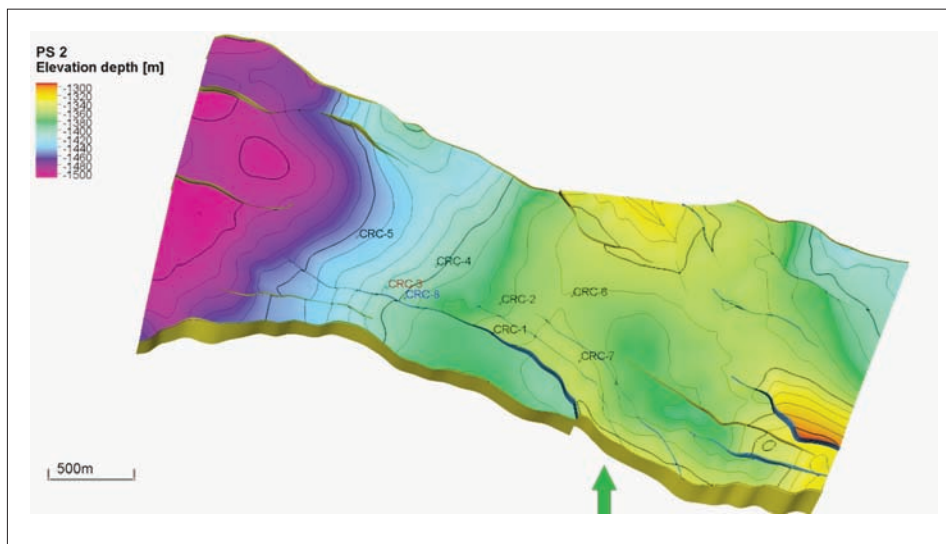
Otway Stage 4 activities include:

1. The GeoCquest Field Validation (GFV) project, an injection of up to 10,000 t of CO₂-rich fluid and subsequent logging operation that will test a new workflow for geological and dynamic modelling that is hypothesised to better represent and understand the impact of fine-scale reservoir heterogeneity on the flow of CO₂.

2. Assessing the effectiveness of CO₂ microbubble (MB) injection (in-field) and surfactant injection (bench- scale) for enhancing CO₂ storage efficiency against conventional injection methods.

3. Seismic monitoring to assess the efficiencies in reservoir utilisation and to derive CO₂ saturations from seismic data using an on-demand permanent seismic monitoring system.

4. Demonstrating Distributed Strain Sensing (DSS) to illustrate the capability for measuring the evolution of strain in the reservoir resulting from CO₂ injection operations.



Well depths at the Otway International Test Centre (OITC)

Otway Stage 4 key objectives

The overarching goal of the Otway Stage 4 program is to demonstrate and develop focused reservoir management technologies to improve CO₂ injection, storage, and monitoring efficiencies, thereby materially lowering costs for commercial CO₂ storage projects. This program aims to address the following objectives:

- Modelling: improve modelling workflow and software solutions, with a capacity to simulate optimisation technology effectiveness, and support performance-based site operations and closure decisions.
- Optimisation: prove the potential to achieve a minimum 20% increase in CO₂ storage efficiency for commercial storage and unlock poorer-quality storage systems' capacity for commercial CO₂ storage.
- Monitoring: develop storage performance monitoring and verification technologies and workflows that are fit-for-purpose and low cost.

Next steps

The Otway Stage 4 Program begins with the GFV injection & monitoring operations in ~October 2024, and the microbubble injection & monitoring operations in ~December 2025.

The microbubble injection trial does not incorporate surfactant, as an attempt to limit variables in this experiment. The role of sur-

factants on storage efficiency will therefore be tested through laboratory and modelling.

Data stemming from the injection operations will be used for the following additional R&D:

- Accurate model representation of optimisation techniques
- Improving model-observation conformance, including incorporation of 'saturation from seismic' and strain data
- Coupling CO₂ injection related thermal, hydraulic, mechanical and chemical (THMC) changes into simulation models, using new Otway 4 data, to understand the influence these processes have for safe CO₂ storage operations
- Deliver commercially relevant reservoir management solutions for the emerging CO₂ storage industry

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More information

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