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Carbon capture and storage's role within Australia's energy transition: necessary, safe, and reliable

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ABSTRACT

Globally, the annual amount of carbon dioxide stored via carbon capture and storage (CCS) must increase to 75–100 times the current CCS levels over the next 20 years. Within Australia, the proposed CCS projects offer the opportunity to reduce the nation's carbon footprint by 15–20% whilst encouraging new developments and expanded energy outputs. Any potential barriers to the efficient roll-out of these CCS projects, such as delays in regulatory approvals, must be mitigated as a matter of priority. CO2CRC considers that an active engagement process between CCS project proponents, regulators, and government will improve the collective understanding and genuinely facilitate this critical project roll-out phase. New technologies, such as enhanced injection (e.g. MicroBubble, surfactants) and innovative monitoring and modelling capacities, offer the opportunity to make CCS cheaper and dramatically improve storage efficiency, making the technology applicable to a broader geographic and geological footprint, including to those areas onshore with poorer reservoir characteristics. These new injection and monitoring approaches are also genuine enablers for the roll-out of Direct Air Capture plus Storage, as well as for CCS to support hard-to-abate industries – by bringing low-cost and efficient storage to the CO_2 sources/capture foci themselves. The industry's willingness to invest in CCS, a smooth regulatory approvals pipeline and the increased efficiencies derived from a range of new technologies will ensure that CCS's long-held promise is realised and delivers the much-needed reductions in national and global emissions.

Keywords: carbon capture and storage, CCS, enhanced injection, greenhouse gas regulation, London Protocol, monitoring, necessity of CCS, new technologies, project roll-out.

Introduction

Changing context for CCS in Australia

The advent of internationally accepted net-zero 2050 targets within Australia and globally has invigorated industry, resulting in an unprecedented focus and urgency on the use or potential use of carbon capture and storage (CCS) to allow many sectors and companies to meet their emission reduction targets. Australia's recently mandated 43% emission reduction target by 2030 has accelerated an already robust industry response.

The future of CCS in Australia will entail a more substantial 'project roll-out' phase, during which many lessons learnt and still being discovered will be applied at a project scale. There will soon be a significant number of large (multi-Mt) CCS projects under active development within Australia, both offshore and onshore. Most of these projects will be 'new builds', wherein the project proponents will be undertaking a whole-of-life-cycle project process, starting with the assessment of new greenhouse gas (GHG) assessment permits or simply applying for the release of GHG storage acreage. These projects will then extend to the CO_2 injection phase over a multi-year or decadal timeframe. These projects will be complemented by a progressively increasing number of small to medium-sized projects, many of which will probably involve repurposing

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existing but depleted oil and gas facilities and attendant reservoirs as GHG storage hubs.

Challenges for CCS in Australia

Whether these future projects are large or small, located offshore or onshore, or represent low-emissions solutions for fossil fuel production or hard-to-abate industries, the challenges these projects face are significant and represent potential threats to the ability of the sector to meet the mandated emissions reduction targets. Whilst the nature of the challenges does vary project by project, there are common themes:

- The scale of the CCS challenge and the recognition of CCS's necessity
- A too-large number of new CCS project applications
- Policy and regulatory challenges to CCS
- Technological opportunities for CCS

This paper discusses these challenges, particularly the policy–regulatory and technical–technological areas and provides practical suggestions. Assuming these challenges can be recognised and addressed promptly and appropriately, CCS can offer the genuine and significant solution to emissions reduction that has been hoped for over the last three decades. Matching these challenges to emerging technology solutions will be the key to success.

Discussion

The scale of the challenge and is CCS necessary in Australia?

The Intergovernmental Panel on Climate Change's (IPCC) Working Group III's Contribution to the Sixth Assessment Report (AR6) states that carbon capture and storage (CCS) is necessary for meeting global emissions reduction targets. The International Energy Agency and the US Department of Energy also share this view. The AR6 notes that CCS will be required in any scenario involving increased future global energy use. Even with the most optimistic uptake of renewable energy, annual storage using CCS will need 3 gigatons, nearly 75 times the current storage levels.

CCS is a critical component of emissions reduction strategies, as, without it, the legislated 43% and net-zero reduction targets cannot be met. The roll-out of CCS in Australia will require a significant increase in the appropriately skilled workforce. Therefore, training and reskilling represent critical future requirements.

CCS is not only necessary – it is an essential and urgent priority.

A groundswell of new projects

The CCS commercial projects currently under evaluation in and around Australia are shown in Fig. 1. Also shown is the

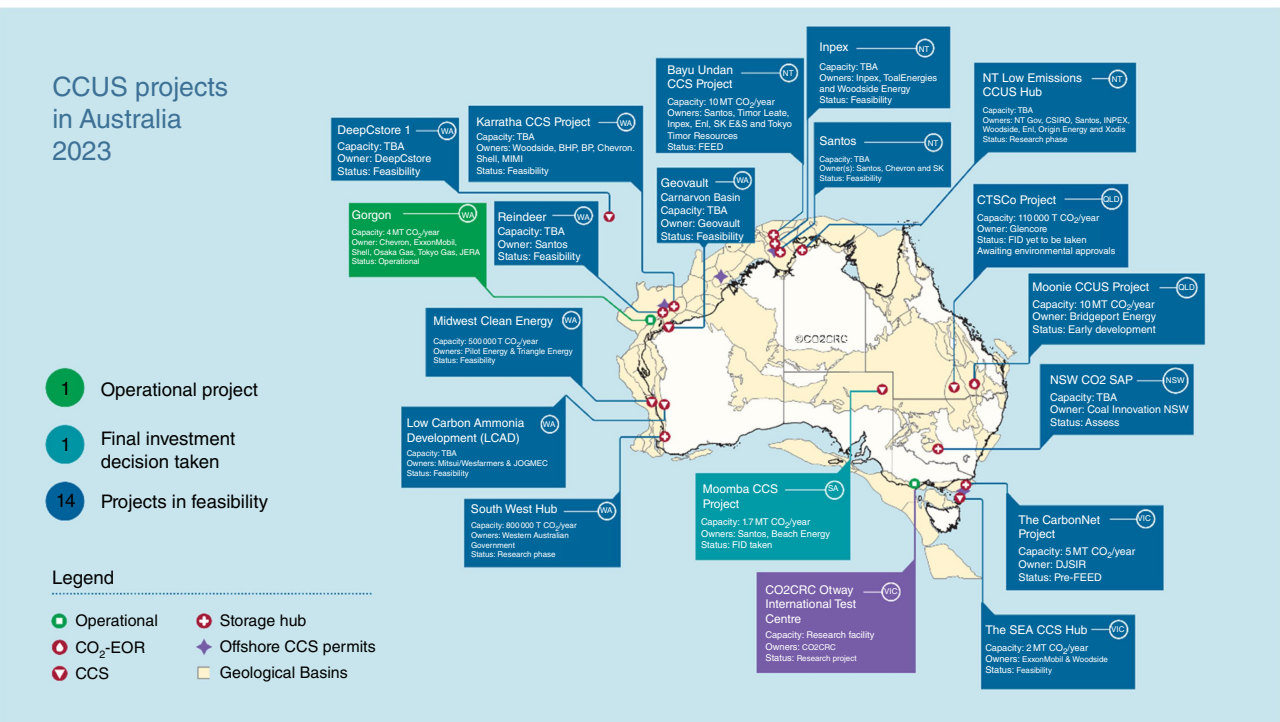

Fig. 1. Carbon capture, utilisation, and storage (CCUS) projects in various stages of development in Australia.

CO2CRC's Otway International Test Centre (OITC), a research facility in southwestern Victoria.

These projects are at various stages of maturity. Gorgon stores up to 4 Mt per annum (Mt/a), and the most advanced of the other projects is Santos's Moomba CCS project in South Australia, which will eventually store 1.7 Mt/a of CO_2. In addition to the CCS projects, five greenhouse gas (GHG) exploration permits were taken up in major consortia in offshore Western Australia and the Northern Territory in 2022. Strong interest has been shown in the subsequent GHG acreage release.

Some of this storage acreage will be utilised as a part of the projects already shown in Fig. 1, but other acreage will undoubtedly be used for storage within new projects. In addition, there is a likely slew of small to medium-sized projects in planning onshore, necessary to address hard-to-abate and other industries that will emerge soon. Since 2021, the interest in CCS has been substantial, and many projects will be traversing the regulatory pipeline simultaneously. These projects can sequester an above-global average of 15–20% of Australia's GHG emissions.

This groundswell of CCS projects, essential to meeting Australia's emissions reduction targets, will pressure the approvals processes and thereby cause unwanted delays.

Policy and regulatory challenges

There are potentially substantial mismatches between the existing regulatory framework and the needs of the CCS industry, especially one seeking to comply with short-term emissions reduction targets.

Firstly, the regulatory framework could be more fit-for-purpose for the purpose of GHG storage, like the one for petroleum. The Offshore Petroleum and Greenhouse Gas Storage Act 2006 was written nearly 20 years ago, and the GHG Regulations over a decade ago. Numerous inconsistencies can materially reduce project proponents' flexibility and, in some cases, could prevent viable projects from being approved; the treatment of sources of CO_2 (onshore versus offshore) is one of these. Key technical terms, such as the meaning of 'engineering enhancements' or '10% probability', amongst others, are either poorly defined or not defined at all, which can create unwanted confusion in terms of the exact requirements within compliant submissions.

Secondly, the regulators themselves and the wider government cohort are inexperienced in the approval of CCS projects and project activities (relative to their extensive petroleum experiences); many of the CCS projects will be the first of their kind to be approved, and the regulators will be assessing applications within charged political and social environments. The availability of a robust set of guidelines for all stages of the GHG approvals process would help considerably.

Finally, there are vital issues that are external to the existing regulatory process, such as resolving legal uncertainties around the transboundary shipment of CO_2 (London Protocol), which could affect the ability of a wide range of CCS project proponents from making confident and timely commercial decisions.

Establishing a robust and open communication process between the regulators, government, and the CCS industry is essential to avoid delays in approvals and ensure that the rapid decarbonisation legislative requirements can be met.

Technological opportunities

CCS-related research over the last 20 years has shown how to undertake CCS safely and reliably. During that period, injection into depleted reservoirs and saline aquifers was demonstrated, a range of monitoring and verification technologies was validated, and storage was shown to be safe and reliable.

More recent research by CO2CRC and its partners will support the project roll-out phase:

- Reducing the cost of monitoring and developing very low-impact and near-real-time monitoring capability.
- Improving storage and injection efficiency to allow the more effective and efficient use of available storage pore space, lower injection costs, and turn a much more comprehensive range of reservoir qualities (especially lower-permeability reservoirs) into viable storage opportunities.
- Adding value to existing oil and gas projects within a low-emissions context.

Estimates on injectivity enhancements are that new technologies are 25% more efficient due to better penetration into the pore space, which leads to decreased need for injection wells. Costs are thus lowered, and storage efficiency is improved significantly via increased and rapid CO_2 dissolution into the pore waters.

Critically, this increased efficiency potentially brings geological areas not currently considered suitable for CCS into 'play', such as areas onshore that may have poorer reservoir quality. This will facilitate the widespread deployment of Direct Air Capture plus Storage, plus storage associated with hard-to-abate industries, as the injection and storage of the captured CO_2 will be cheaper, more efficient, and critically, viable (because poorer quality reservoirs can be used) across a wider geological and geographic area; new technologies can bring low-cost and efficient storage to the CO_2 sources/capture foci themselves.

Summary

Within Australia, numerous CCS projects are currently being planned, 12 of which are offshore and seven onshore. These projects offer the opportunity to reduce the nation's carbon footprint by 15–20% whilst encouraging new developments and expanded energy outputs. Any potential barriers to the efficient roll-out of these CCS projects, such as delays in

regulatory approvals, must be mitigated as a matter of priority. CO2CRC considers that an active engagement process between CCS project proponents, regulators, and government will improve the collective understanding and genuinely facilitate this critical project roll-out phase.

In addition, new technologies offer the opportunity to not only make CCS cheaper but to dramatically improve storage efficiency, making the technology applicable to a much wider geological and geographic footprint, including to those areas onshore with poorer reservoir characteristics.

In summary, it is the combination of the industry's willingness to invest in CCS, a smooth regulatory approvals pipeline, and the increased efficiencies derived from a range of new technologies that will ensure that CCS's long-held promise is realised and delivers the much-needed reductions in national and global emissions.

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Dr Geoffrey O'Brien is the Chief Scientist for CO2CRC. Geoff has over 35 years' experience in the marine research, petroleum, and CCS sectors and has worked in and for the petroleum industry as a petroleum systems and CCS technical specialist. He has also worked for Geoscience Australia, where he was the Research Group Leader for the Marine Environment & Offshore Petroleum Group, as a research consultant at the University of Adelaide, as the Energy Geoscience Manager at Geoscience Victoria and as the Chief Geoscientist for NOPTA. Dr O'Brien has a comprehensive understanding knowledge of Australia's sedimentary basin systems and their petroleum potential, and over the last 15 years has become increasingly involved in the CCS sector. A passion is the development of tailored and targeted CCS work programs that relate specifically to the ultimate regulatory requirements, thereby facilitating the Pathway to Storage and providing greater efficiencies for CCS project proponents.