



Department of
Jobs, Tourism, Science
and Innovation

Western Australia's Carbon Capture, Utilisation and Storage Action Plan

November 2024



Acknowledgement of Country

The Department of Jobs, Tourism, Science and Innovation acknowledges the Traditional Custodians throughout Western Australia and their continuing connection to the land, waters and community. We pay our respects to all members of Aboriginal and Torres Strait Islander communities and their cultures, and to Elders past and present.

Lombadina Community, Ardi - Dampier Peninsula.
CREDIT: Tourism Western Australia

Cover image: Dongara CCS injection assessment.
CREDIT: Mitsui E&P Australia

Premier's foreword

Western Australia has a clear and realistic ambition to become a globally recognised renewable energy powerhouse.

Our State is fundamental to the clean energy transition and global fight against climate change. The abundance of land, sunshine, and wind in Western Australia lends itself to renewable power generation. Our wealth of resources—particularly critical minerals and rare earths—are key ingredients in renewable products. At the same time, we are a major supplier of natural gas, helping our trading partners to move away from coal-fired power.

For many decades, our State's economy has been underpinned by a mining, resources and processing industry with world-recognised expertise and a skilled workforce. The challenge for Western Australia will be decarbonising these hard-to-abate sectors. The Western Australian Government's efforts to upgrade our electricity grids to harness more

renewable energy in the South West and North West will get us much of the way there. However, there will also be a crucial role for carbon capture, utilisation and storage (CCUS).

CCUS technologies now have numerous proven applications across the world, including in Western Australia. In the short to medium term, it will play a key role in the gas sector. In the longer term, it will have an increasingly important role in hard-to-abate and low-carbon industries. There are also multiple technologies aimed at removing carbon directly from the atmosphere.

Western Australia is well placed to become a world leader in CCUS, leveraging our existing infrastructure, highly skilled workforce, and suitable geological formations.

The CCUS Hubs Study, commissioned by the Western Australian LNG Jobs Taskforce, found that the State has enormous potential to develop CCUS hubs, which could create an estimated 37,000 construction jobs and 500 permanent jobs in Western Australia.

This Action Plan sets out the Western Australian Government's vision for CCUS in Western Australia, establishing the actions we will take to support decarbonisation and economic diversification.

The actions within provide the policy certainty and guidance designed to attract investment and accelerate deployment of proven technologies and infrastructure, while also supporting the development of new and emerging CCUS technology.

Hon Roger Cook MLA

Premier; Minister for State and Industry Development, Jobs and Trade; Public Sector Management; Federal-State Relations



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Plan on a page

Our vision is to establish a world leading carbon capture, utilisation and storage (CCUS) industry in Western Australia that supports the transition to a low-carbon future and the State's economic diversification.

Objectives

Enable the accelerated deployment of proven technology and infrastructure

Support the development of new and emerging CCUS technology

Attract investment

Foster coordination, and collaboration across government, industry and research to facilitate action

Action areas

1

Implement a leading legislative and regulatory framework for CCUS

2

Work with industry to enable and facilitate CCUS projects

3

Share information and knowledge

4

Support research, development and demonstration with clear pathways to commerciality

5

Support Aboriginal and community engagement

6

Attract investment and deepen strategic international partnerships

Heavy industry snapshot

Heavy industry is a major part of the Western Australian economy and will need to significantly lower its carbon emissions to continue to support economic growth into the future.

Heavy industry comprises:

- » Minerals mining and processing (iron ore, gold, lithium, bauxite/alumina, nickel, mineral sands, copper, rare earths, and other minerals)
- » Oil and gas extraction and processing (liquefied natural gas, crude oil and condensate, liquefied petroleum gas, and natural gas for the domestic market)
- » Heavy manufacturing (cement, ammonia, fertiliser).



Heavy industry contribution in Western Australia

Gross value added

\$213 billion

(48% of GDP)

Investment

\$37 billion

(45% of total investment)

Exports (2023-24)

\$235 billion

(93% of total exports)

Sales and service income

\$328 billion

(44% of total sales and service income)

Employment

150,000

(10% of total employment)

Wages and salaries

\$148,000 per year

(more than double the state average of \$70,000)

2022-23 (unless otherwise stated). Source: Based on data from the Australian Bureau of Statistics.



Carbon emissions of Western Australia's heavy industry

Emissions (scope 1)

47 million tonnes

of carbon dioxide equivalent (CO₂-e)

57% of total net emissions

in Western Australia

Contribution to national emissions (scope 1)

30% of heavy industry emissions

in Australia

11% of total net emissions

in Australia

Safeguard Mechanism (2022-23)

76 facilities covered

35% of all facilities covered in Australia

2021-22 (unless otherwise stated).

Source: Based on data from the National Greenhouse and Energy Reporting Scheme (Clean Energy Regulator, 2024).



Global market outlook along the pathway to net zero emissions by 2050

Battery and critical minerals

- » Global minerals demand from clean energy technologies almost triples by 2030 relative to 2023 and grows to over 3.5 times current levels by 2050.
- » Clean energy technologies become the largest portion of demand for most minerals by 2040.

LNG

- » Global LNG demand falls 38% by 2035 relative to 2023 and falls 73% from current levels by 2050.
- » Despite the decline in LNG demand, natural gas is likely to fill some of the gap left by declining coal and oil in the global clean energy transition.

Ammonia

- » Global demand for ammonia triples by 2050 relative to 2023.
- » Ammonia is mainly used as a fertiliser and has potential as a fuel in shipping and power generation and as a hydrogen carrier.

Note - Global demand for heavy industry products is based on the International Energy Agency (IEA) Net Zero Emissions by 2050 (NZE) Scenario: this scenario sets out a pathway for the global energy sector to achieve net zero carbon dioxide (CO₂) emissions by 2050.

Source: IEA (2024), Global Critical Minerals Outlook 2024, IEA, Paris <https://www.iea.org/reports/global-critical-minerals-outlook-2024>, Licence: CC BY 4.0 IEA (2024), World Energy Outlook 2024, IEA, Paris <https://www.iea.org/reports/world-energy-outlook-2024>, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A); IEA (2024), Energy Technology Perspectives 2024, IEA, Paris <https://www.iea.org/reports/energy-technology-perspectives-2024>, Licence: CC BY 4.0

Global trends in CCUS

Momentum is building in the deployment of carbon capture, utilisation and storage (CCUS) globally, as governments and industry recognise the potential of CCUS to reduce emissions at a large-scale and help meet their emissions reduction targets as part of a suite of decarbonisation technologies.

In 2023, eight large-scale carbon capture facilities started operating in the United States and China. There were around 45 commercial CCUS facilities operating worldwide, capturing over 50 million tonnes of carbon dioxide (CO₂) a year, mainly from natural gas processing plants.

Government policy has been the main driver of global CCUS project deployment in recent years, with most operating CCUS projects having benefited from policy support. In 2023, Governments supported CCUS through public funding, strategic signalling, and cross-border collaboration.

- » Ongoing subsidy programs in the United States (2021 Infrastructure Investment and Jobs Act) and Europe (Innovation Fund and Connecting Europe Facility) made over US\$20 billion available to CCUS projects.
- » Twenty countries (including Australia) and the European Commission have joined the Carbon Management Challenge to help accelerate the worldwide deployment of CCUS technologies.
- » Several countries in Europe have formed the necessary agreements under the 1996



Arca scientist working at a mine site in Western Australia.
CREDIT: Arca

Information in this section was sourced from: International Energy Agency (IEA), 2023, Tracking Clean Energy Progress 2023, <https://www.iea.org/reports/tracking-clean-energy-progress-2023>

Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Protocol), an international agreement that protects the marine environment from pollution, to allow for cross-border transport of CO₂ for offshore storage. The world's first cross-border carbon transport and storage facility became operational in Norway in 2024.

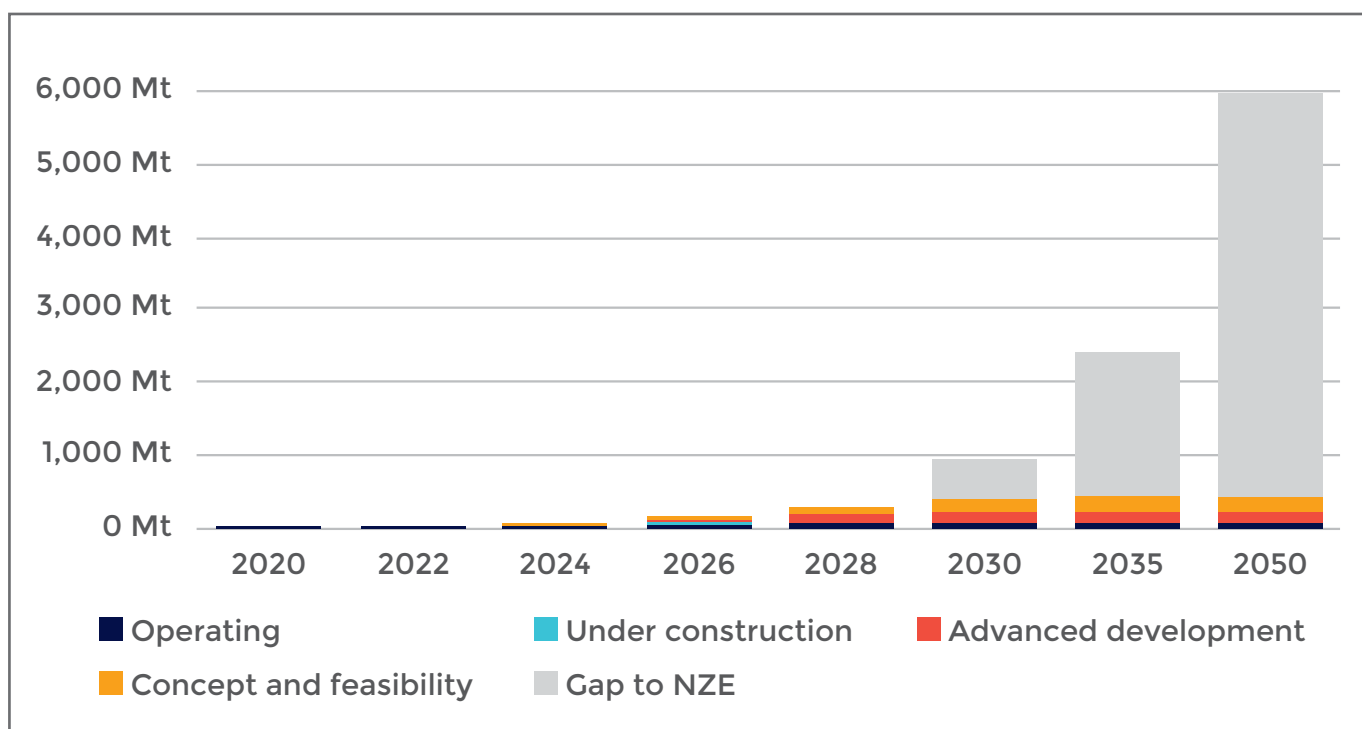
In the Asia Pacific region, Japan has released its Carbon Capture and Storage (CCS) Long-Term Roadmap that set targets for its CO₂ storage capacity in 2030 and 2050 and passed its Act on Carbon Dioxide Storage Businesses (CCS Business Act) in May 2024, which established a legal framework for businesses to launch CCS business ventures. South Korea also passed

its Act on the Capture, Transportation, Storage and Utilisation of Carbon Dioxide (CCUS Act) in January 2024, which set the legal foundation for the implementation of CCUS policies at the national level to promote CCUS projects.

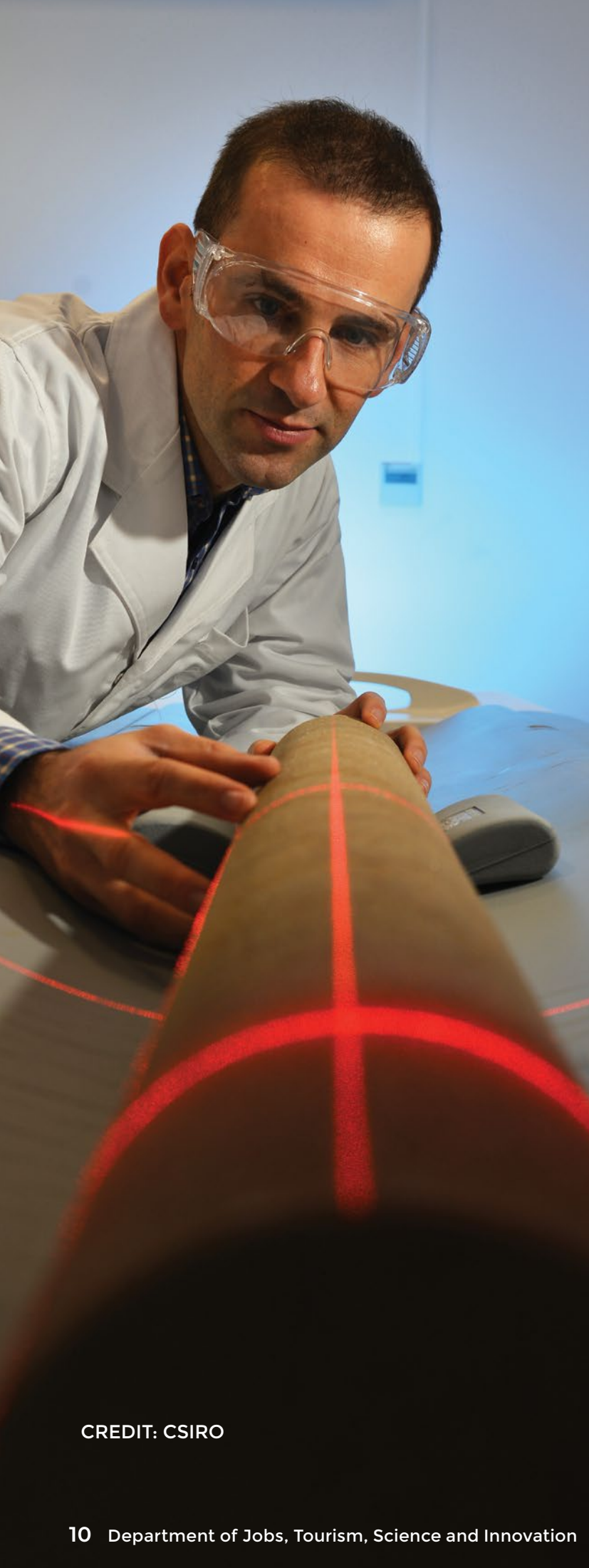
The geographic distribution of CCUS projects is expanding, with over 700 projects being developed across more than 50 countries in 2023. Projects currently under development will increase carbon capture capacity to over 10 times the current global operating capacity.

There are 12 CCUS projects in operation and around 88 projects in development in the Asia Pacific region. Japan selected seven large-scale projects for development in 2023 to capture and store around 13 million tonnes of CO₂ a year by 2030, with two projects looking to ship CO₂ from Japan to

Chart 1: Global carbon capture capacity under the IEA's Net Zero Emissions (NZE) Scenario



Source: IEA (2023), CCUS, IEA, Paris <https://www.iea.org/reports/ccus>, Licence: CC BY 4.0. IEA (2023), and Capacity of current and planned large-scale CO₂ capture projects vs. the Net Zero Scenario, 2020-2030, IEA, Paris <https://www.iea.org/data-and-statistics/charts/capacity-of-current-and-planned-large-scale-co2-capture-projects-vs-the-net-zero-scenario-2020-2030>, Licence: CC BY 4.0. This is a work derived by the Department of Jobs, Tourism, Science and Innovation from IEA material. The Department of Jobs, Tourism, Science and Innovation is solely liable and responsible for this derived work. The derived work is not endorsed by the IEA in any manner.



CREDIT: CSIRO

storage sites in Southeast Asia. All planned CCUS projects across the Asia Pacific could see around 50 million tonnes a year of CO₂ captured and 85 million tonnes a year of CO₂ stored by 2030. In the Middle East, there are three CCUS projects in operation and around 15 projects in development, including two carbon transport and storage hubs in Bahrain and the United Arab Emirates.









While momentum is growing, the International Energy Agency (IEA) has noted that CCUS deployment remains well below what is required under its Net Zero Emissions by 2050 (NZE) Scenario, and estimates that around 1 billion tonnes of CO₂ a year needs to be captured by 2030 for the world to be on track to reach net zero emissions by 2050. By 2050, over 6 billion tonnes a year of CO₂ capture and storage capacity is needed globally.

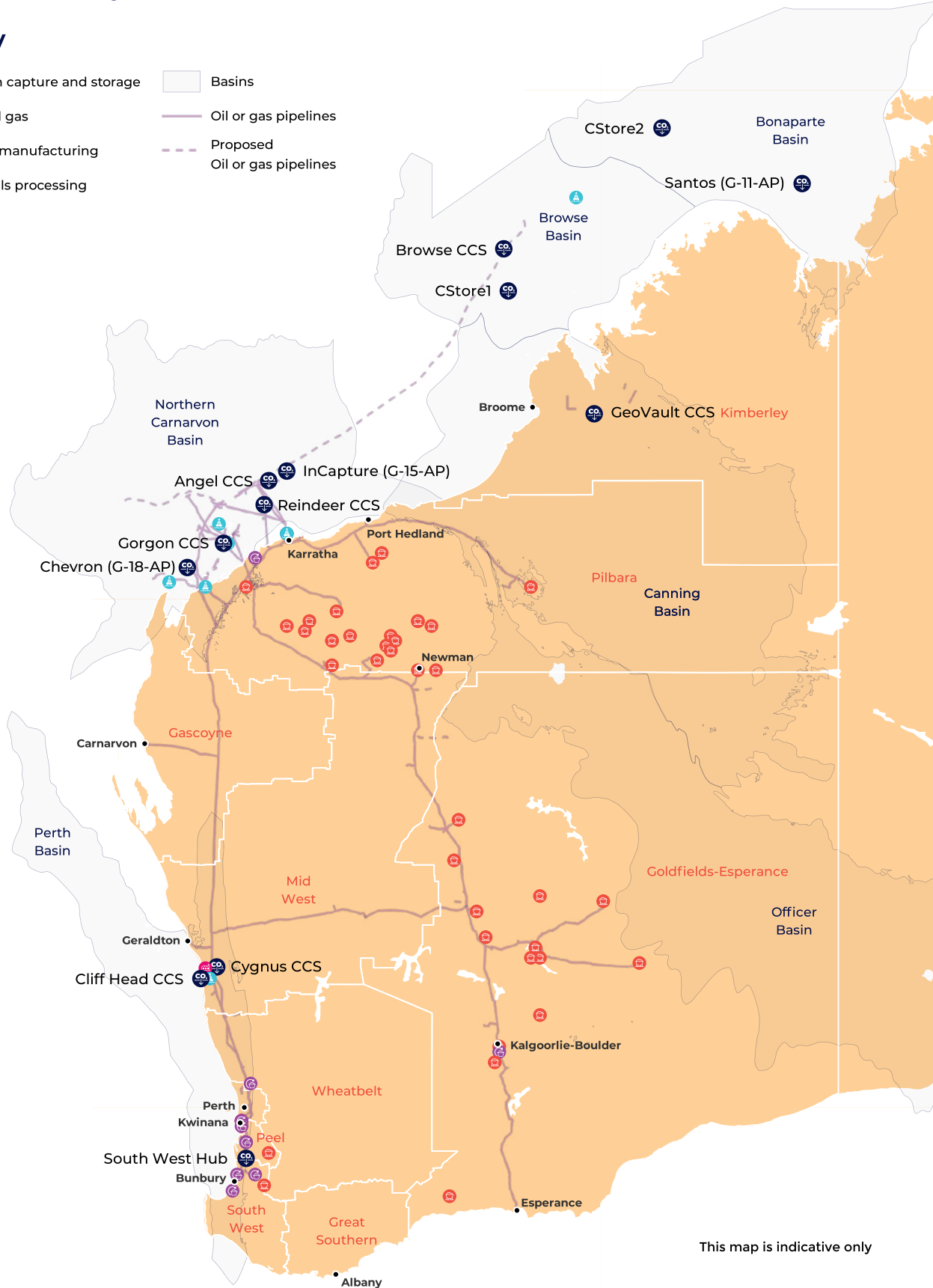
Western Australia is responding to these global trends and is poised to attract new investment into its CCUS industry. The State is already home to one of the largest operating CCS facilities in the world as part of the Gorgon LNG project. The Gorgon CCS facility has stored 10 million tonnes of CO₂ since August 2019 and is expected to store more than 100 million tonnes of CO₂ over the life of the project.

Western Australia also has numerous CCUS projects proposed for development over the next decade. Japanese companies have interests in several of these projects while South Korean companies are actively exploring CCS opportunities in Western Australia. If all the proposed major CCUS projects were developed, Western Australia would have a capacity to store over 20 million tonnes of CO₂ a year, based on the initial capacities of these projects. This is around a quarter of the State's current total net emissions (Scope 1).

Western Australia's major CCS projects and heavy industry facilities

Map key

-  Carbon capture and storage
-  Oil and gas
-  Heavy manufacturing
-  Minerals processing
-  Mining
-  Basins
-  Oil or gas pipelines
-  Proposed Oil or gas pipelines



This map is indicative only

Note - This map includes major CCS projects with geological storage components in offshore (Commonwealth and State waters) and onshore areas of Western Australia, as well as greenhouse gas storage assessment permits awarded in offshore areas of Western Australia (in Commonwealth waters) as of September 2024. Some CCS projects in the Bonaparte Basin are excluded from the map because they are primarily linked to storing carbon from emissions sources in the Northern Territory. The map also includes the State's major heavy industry facilities covered by the Safeguard Mechanism in 2022-23. Not all sedimentary basins are included on the map. Carbon utilisation projects are not shown.

What is CCUS?

Carbon capture, utilisation and storage (CCUS) is a value chain of technologies that removes CO₂ emissions from sources such as industrial or power generation facilities. CO₂ can also be removed directly from the atmosphere, rather than from the point of emission. These technologies are called 'carbon dioxide removal' technologies and are related to CCUS.

What is CCUS?

CCUS is a value chain of technologies that:

- **capture** CO₂ from burning fuels or CO₂ generated from industrial activities
- **transport** captured CO₂ via pipelines, trucks, trains or ships to places where the CO₂ can be:
 - **used** to make products; or
 - **stored** permanently underground.

Capture

CO₂ can be captured from gas streams produced or emitted from industrial processes such as in the production of natural gas, fertilisers, cement, minerals, and from power generation.

The CO₂ emissions can be captured at the source in an industrial facility or power plant:

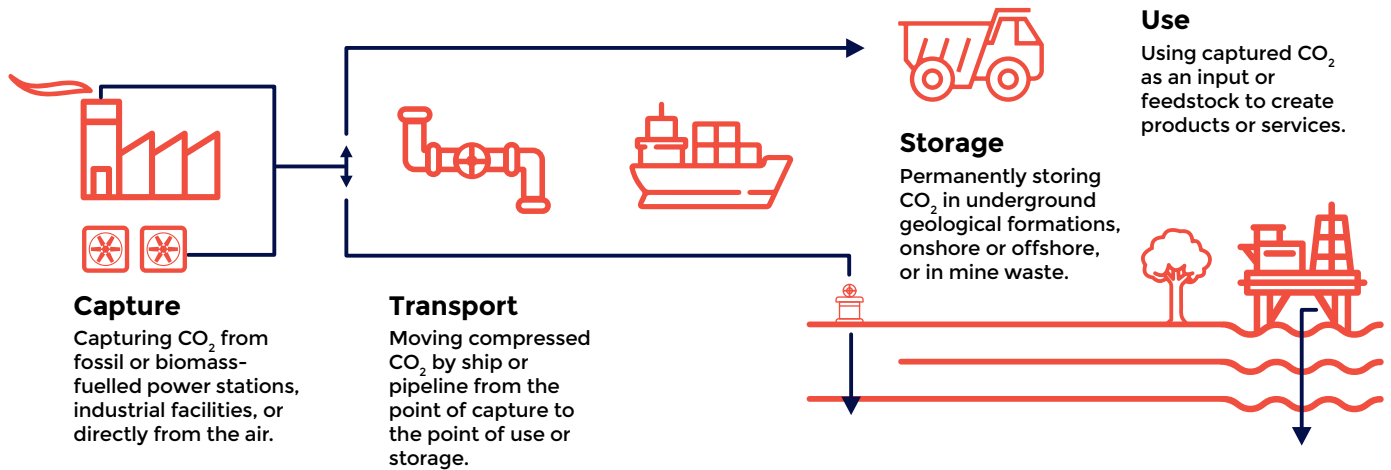
- » before fuels are burnt by removing the CO₂ from the fuel gas before combustion (pre-combustion carbon capture).
- » after fuels are burnt and the CO₂ has been separated from the gas emitted (post-combustion carbon capture) or the product gas (oxyfuel).
- » after CO₂ is generated using liquid absorbents, calcium looping or cryogenic processes (post-combustion carbon capture).

The method of carbon capture chosen largely depends on the type of industrial activity and site-specific requirements. Industrial processes tend to use the pre-combustion capture method for capturing CO₂ from the fuel gas while power plants tend to use the post-combustion capture method. Liquefied natural gas production already captures CO₂ as a by-product, in a process called acid gas removal.

Transport

Once the CO₂ has been captured, it can be conditioned, compressed and transported to a location where it can be used to make products or stored permanently underground. CO₂ can be transported safely through pipelines or as a liquid by ship, train or truck depending on where the CO₂ will be used or stored.

The CCUS value chain



Source: IEA, 2024, Carbon Capture Utilisation and Storage, <https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage#how-does-ccus-work>

Utilisation

Captured CO₂ can be used directly (chemically unaltered) or indirectly (chemically altered) to make various products.

Currently, CO₂ is mainly used directly in the fertiliser industry to make urea. Urea is used in fertilisers as a source of nitrogen. Urea is produced through combining ammonia and CO₂. Ammonia production involves using natural gas to produce hydrogen which is then combined with nitrogen to form ammonia. This process generates a relatively pure source of CO₂, which is captured and combined with the ammonia to make urea.

There is also an opportunity to use CO₂ in new ways to create synthetic fuels, chemicals and building materials. For example, CO₂ can be converted and used:

- » to produce synthetic hydrocarbon fuels such as methane, methanol, gasoline and aviation fuels
- » as an alternative to fossil fuels in the manufacture of chemicals used to produce plastics, fibres and synthetic rubber
- » in the production of building materials such as concrete and building aggregates.

CO₂ use can reduce emissions significantly when the application is scalable, uses low carbon energy and displaces a product with higher emissions.

Biochar is another way to use or remove CO₂ from the atmosphere. Biochar is a carbon-rich material made from organic and organic-based materials, such as plastics, tyre rubbers, agricultural residues, wood materials and forest residues.

Biochar stores CO₂ within its chemical and physical structure and can be used in steelmaking (as a coal and coking coal substitute); aluminium, copper, and silicon smelting; heating fuel; and industrial catalysts such as hydrogen and biodiesel. Some applications of biochar can be considered CO₂ removal because the CO₂ is stored permanently. These applications include use in construction materials (concrete, insulation, paint), road base, energy storage (batteries, supercapacitors, fuel cells) and additives in rubber and plastic products.

Storage

Captured CO₂ can be injected and permanently stored in rock formations deep underground or in mine waste. Geological storage can be onshore or offshore in depleted oil and gas reservoirs or saline aquifers. The natural containment of CO₂ in underground oil and gas deposits over tens of millions of years provides confidence that captured CO₂ can be stored securely. CO₂ can also be stored on the Earth's surface in dissolved or mineralised form in mine tailings or crushed rock, although these storage options are technologically less advanced.

Carbon Dioxide Removal

CO₂ can be removed from the atmosphere rather than at the point of emission. These technologies are called 'carbon dioxide removal' technologies (CDR) and are related to CCUS. CDR is at a relatively early stage of development with further work required to scale up the technologies and reduce costs. The main way to capture CO₂ from the atmosphere is by using chemical reactions, which come in many different forms.

Some promising CDR methods include:

Direct air capture

Direct air capture (DAC) is a technology that captures CO₂ directly from the atmosphere using large fans and filters. There are two broad approaches for DAC:

- » Liquid absorbent DAC systems pass air through alkaline solutions that react with the CO₂ and return the treated air to the atmosphere.
- » Adsorbent DAC systems use filters that chemically bind with CO₂ molecules, and the concentrated CO₂ can then be transformed into other products or stored.

Mineral carbonation

Mineral carbonation is a natural chemical process where CO₂ from the atmosphere can be permanently stored in certain rock types and mine waste. This natural process occurs at a very slow rate. Mineral carbonation technologies can accelerate this natural process to enable more CO₂ to be stored. There are two main methods of mineral carbonation:

- » Ex situ mineral carbonation takes place above ground and involves reacting CO₂ with wastes such as mine tailings where it is permanently stored.
- » In situ mineral carbonation involves injecting a CO₂ rich fluid underground where it reacts with minerals to permanently store carbon.

The role of CCUS in Western Australia

The opportunity

The Western Australian Government is committed to achieving net zero greenhouse gas emissions by 2050 and leveraging Western Australia's advantages to unlock the economic development and diversification opportunities presented by the global energy transition.

Interest in carbon capture, utilisation and storage (CCUS) is growing globally. It plays a key role in global net zero pathways and presents both a key decarbonisation and economic diversification opportunity for Western Australia.

To reach domestic and global net zero by 2050, there will be an important role for CCUS in the decarbonisation mix as part of a suite of low emissions technologies. In Western Australia, CCUS will have a key role in particular in decarbonising our hard-to-abate heavy industries. This is likely to start with application in the gas sector, but in the long run the main uses will be for other hard-to-abate and low-carbon industries and in removing CO₂ from the atmosphere. It will also be an important

technology for our key trading partners to decarbonise their own economies.

There is an economic opportunity for Western Australia to leverage its advantages to become a world leader in CCUS. This includes our highly skilled workforce, existing infrastructure, suitable geological formations, and globally recognised energy ecosystem.

In developing a world leading CCUS industry in Western Australia, there are two key strategic opportunities:

1. Supporting the transition to net zero.
2. Supporting economic diversification through the development of new low carbon industries.

Western Australia's key advantages

- » **Skilled workforce** - Western Australia has a well-established workforce with the skills, experience and technological expertise needed to support a thriving CCUS industry.
- » **Existing infrastructure** - Western Australia has existing, strategically located infrastructure.
- » **Suitable geology** - there is immense potential for CCUS projects through our large volume of suitable geological storage formations, both onshore and offshore.
- » **Energy ecosystem** - Western Australia boasts a globally competitive energy ecosystem, with existing dedicated energy hubs, established export markets and a track record of delivering successful major projects.

Supporting the transition to net zero

The Western Australian Government is taking a multifaceted approach to decarbonisation, working with all sectors of the economy to reach net zero by 2050.

Building on the Western Australian Climate Policy and the introduction of climate change legislation, the **Sectoral Emissions Reduction Strategy for Western Australia** outlines priority actions to help reduce emissions across the economy, including the State's industry sector.

The heavy industry sector makes a significant contribution to the State's economy. The prominence of heavy industry in Western Australia, coupled with growth over the past decade in response to global demands, means this sector accounts for over half of the State's total net emissions (scope 1). Western Australia also has around one third of heavy industry facilities regulated under the Australian Government's Safeguard Mechanism.

Achieving the State's emission reduction targets will require short and long-term actions to reduce emissions. This is particularly the case for Western Australia's heavy industries that face unique challenges, including relatively high emissions, high costs to reduce emissions, and a lack of viable low emissions technologies.

In Western Australia, significant reductions in industry emissions will be underpinned by shifting to renewable electricity firmed with gas, combined with the electrification of industrial processes where viable. Recognising this, the Western Australian Government has invested \$5.4 billion since 2017 to upgrade the State's electricity grids and unlock renewable energy generation opportunities.

In addition to renewable electricity, a suite of technologies, including CCUS, will be

needed to decarbonise heavy industry, particularly where decarbonisation through other methods, such as electrifying operations, is challenging.

While demand for gas is expected to reduce over time, gas will still be needed in the State's energy mix to replace coal and provide dispatchable power to complement renewable energy generation and storage. It will also continue to play a role in industrial processes such as the downstream processing of critical minerals, where there are no lower emissions technologies available. Gas from Western Australia will also continue to play a role in underpinning the energy needs of our trading partners, with CCUS presenting an opportunity to reduce emissions from our energy exports.

Although the gas sector is likely to be the main driver of CCUS in Western Australia in the short to medium term, in the long term, modelling⁴ indicates that the dominant use of the technology will be in other sectors. CCUS will particularly have a role in other emissions-intensive, hard-to-abate industrial sectors, such as fertilisers, other chemicals, cement and lime, and iron and steel, as well as in low-carbon industries, such as hydrogen, ammonia, and synthetic fuel.

As well as reducing emissions from industrial activities, emissions already released into the atmosphere need to be addressed. Carbon dioxide removal (CDR) technologies enable the removal of emissions that have already been released. CCUS infrastructure will enable CDR development through methods that might

⁴ <https://www.netzeroaustralia.net.au/final-modelling-results/>



Solar farm in Merredin.
CREDIT: Tourism Western Australia.

share the same capture process, transportation or storage infrastructure. In the long run, this may be the single most crucial role for CCUS.

The role of CCUS in the decarbonisation mix is recognised in global decarbonisation pathways, including from international organisations such as the Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA).

All IPCC modelled pathways consistent with the Paris Agreement goals to limit global warming to 2°C or lower by 2100 include a role for CCUS and CDR measures.

Similarly, the IEA, in its 2023 update of **Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach**, recognises CCUS as one of the critical technologies needed to achieve net zero emissions which needs to be rapidly scaled up by 2030.

Reducing emissions while continuing to create economic opportunities and provide energy security will require advancements in CCUS and low-carbon energy technologies. Research and development will be critical to reducing the cost of these technologies. Development of CCUS and low-carbon energy technologies will be supported through Western Australia's new 10-Year Science and Technology Plan, which includes 'clean energy and decarbonisation' as a focus area for research and development.

The Western Australian Government recognises the scale and complexity of the clean energy transition. CCUS and CDR technologies are part of these opportunities and are critical in helping Western Australia, and the world, transition to net zero.

Supporting economic diversification and the development of new low-carbon industries

The global energy transition is an unprecedented opportunity for Western Australia to grow the State's economy and create and sustain new high-value jobs for the future.

Building on **Diversify WA**, the State's economic development framework, **Future State: Accelerating Diversify WA** identifies CCUS as one of nine targeted opportunities aligned to Western Australia's unique strengths and global trends.

Future State highlights that CCUS technology will be a critical tool to support the decarbonisation of hard-to-abate industries and ensure they remain globally competitive into the future.

Along with CCUS, Future State also identifies decommissioning of oil and gas infrastructure as a targeted opportunity for the State. Decommissioning includes the safe removal of equipment and infrastructure, plugging and closing wells and restoring the environment. As part of decommissioning activities, there is opportunity to repurpose some oil and gas infrastructure for CCUS as a more beneficial alternative to direct decommissioning and removal of equipment and unlock greater economic value and decarbonisation opportunities.

There is also an opportunity to develop CDR technologies, such as mineral carbonation, which similarly aligns to the State's advantages. For example, mineral carbonation technology, while still at relatively early stage of development, presents the State's mining industry with an opportunity to convert very large stockpiles of mining and processing waste into CO₂ storage assets. In Western Australia, this can potentially be achieved at the scale of billions of tonnes of CO₂.

CCUS and CDR technologies will help sustain jobs in industrial sectors by supporting the transition to low emissions production and supporting long-term employment opportunities, as new jobs are created through the growth of low-carbon industries that use natural gas as a feedstock, such as hydrogen, ammonia, urea and synthetic fuel and material production.

The scaling up of CCUS and CDR, along with the development of these low-carbon industries, will enable the growth of a carbon service industry. A carbon service industry would support job creation through the provision of services and infrastructure relating to capturing, transporting, using and storing emissions. For example, jobs would be created through the design, construction, operation and maintenance of facilities and associated transport and storage infrastructure. The potential transboundary movement of CO₂ would further underpin the growth of a carbon service industry in Western Australia.

The CCUS Hubs Study, commissioned by the Western Australian LNG Jobs Taskforce and undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Global CCS Institute, found that the State has enormous potential to develop CCUS hubs, which could create an estimated 37,000 construction jobs and 500 permanent jobs in Western Australia.

The growth of these new industries supports diversification of the State's economy through not only creating jobs, but also enabling regional development, improved

industry competitiveness, investment, innovation, and strengthening Western Australia's environmental, social and governance (ESG) credentials. The Western

Australian Government is committed to working with industry to realise these opportunities.

Targeted diversification opportunities

Government commitment, strategies and existing investment

Alignment with global trends and market demands

Economic (and social) benefits

Level of industry investment and capability (feasibility)



Targeted sector-specific diversification opportunities

Renewable hydrogen Produce and scale	Critical minerals Advanced processing	CCUS technology Develop and commercialise	LNG decommissioning Develop and commercialise	High-value food and beverage Manufacture and export
Naval vessels Construct and maintain	Medical products and digital health Manufacture and commercialise	Space and cross-sector technologies Manufacture, utilise and maintain	Regional tourism destinations Develop and maintain	

Cross-sector enablers to accelerate growth

Key infrastructure and project-ready land	Skilled and productive workforce	Science, innovation and technology	Policy and regulatory frameworks (including industry development plans)
Investment and trade ecosystem (including incentives)	Advanced manufacturing capabilities	Environmental, social and governance frameworks	

Clear actions, implementing opportunity-specific roadmaps, targeted evaluation

Future State: Accelerating Diversify WA - targeted opportunities and cross cutting enablers

Action areas

The Western Australian Government will take a range of actions to support investment in CCUS and realise our vision to establish a world leading CCUS industry in the State.

We will implement a leading legislative and regulatory framework, work with industry to enable and facilitate CCUS projects, share information and knowledge, support research, development and demonstration with clear pathways to commerciality, support Aboriginal and community engagement, and attract investment and deepen our strategic international partnerships.



The Western Australian Government will take a range of action towards the vision of establishing a world leading CCUS industry in the State.
CREDIT: Shutterstock

Action area 1: Implement a leading legislative and regulatory framework for CCUS

Actions

- 1.1 Finalise and implement the regulations, procedures and guidance underpinning the new greenhouse gas legislation to establish a fit-for-purpose regulatory regime.
- 1.2 Develop guidance to support proponents to navigate State and Australian Government legislative regimes for CCUS.
- 1.3 Streamline approval processes for projects that support the energy transition, including CCUS.
- 1.4 Uphold high standards of operational, maintenance, and health, safety and environmental practices to support international competitiveness in CCUS.

A high-quality legislative and regulatory framework will be a key factor in encouraging the development of CCUS projects in Western Australia.

The Western Australian Government has established a legislative framework for CCUS through the *Petroleum Legislation Amendment Act 2024* and is developing regulations, procedures and guidance to support the reformed greenhouse gas legislation. Implementing a best-practice regulatory regime will ensure onshore storage activities are safe and effective, through rigorous site selection and monitoring and verification.

The Western Australian Government recognises that some projects cross more than one jurisdiction (i.e. occur across State and Australian Government jurisdictions).

Guidance to support proponents to navigate the potential interplay between legislative regimes for CCUS will help projects proceed in a timely manner. The Western Australian Government will ensure that our guidance supports proponents to navigate between these legislative regimes.

The Western Australian Government is taking complementary action to streamline the approvals process for projects supporting the energy transition more broadly. For instance, the Western Australian Government's amendments to the *Environmental Protection Act 1986* will allow approval processes to run simultaneously while also reducing duplication with Commonwealth processes. Additionally, the Western Australian Government has established the Coordinator General position within the Department of Jobs, Tourism, Science and Innovation to enhance environmental approvals by accelerating regulatory reforms and improving cross-agency collaboration. While not exclusively targeted on CCUS, these initiatives are expected to benefit the CCUS industry.

Establishing a high-quality legislative and regulatory framework and project approvals system will enhance Western Australia's competitiveness in attracting international investment and trade in CCUS by supporting positive environmental, social and governance outcomes. Western Australia will continue to uphold high standards of operational, maintenance, and health, safety and environmental practices.

Action area 2: Work with industry to enable and facilitate CCUS projects

Actions

- 2.1 Establish an industry-government engagement mechanism to support the growth of a CCUS industry.
 - 2.1a Explore options to encourage data sharing among proponents across the CCUS value chain.
 - 2.1b Support industry to further develop the business case for CCUS hubs.
- 2.2 Explore options to use existing funding mechanisms to provide support to both CCUS projects and enabling infrastructure.
- 2.3 Investigate opportunities for CCUS in the decommissioning value chain.
- 2.4 Continue to work with the Australian Government to explore options to support the CCUS industry in Western Australia.

Establishing a world class CCUS industry is a complex endeavour with many moving parts across the value chain. Industry and Government cooperation will therefore play an essential role in enabling CCUS projects.

The Western Australian Government has a proven track record of collaborating with industry to support coordination, foster industry growth and grasp opportunities for the State. Established in 2018, the Western Australian LNG Jobs Taskforce is an example of collaboration, bringing together Government, industry and unions to address the challenges and opportunities facing the LNG sector.

Building on successful collaborations such as this and recognising that CCUS is an important opportunity for a range of heavy industry sectors, the Western Australian Government will establish an ongoing government-industry engagement mechanism dedicated to supporting the growth of a CCUS industry in Western Australia. This mechanism will facilitate engagement between major emitters, users, storers, and transporters to improve supply chain coordination, data and knowledge sharing and collaboration across the entire CCUS value chain to help accelerate CCUS projects.

The establishment of CCUS hubs across Western Australia presents one such opportunity where collaboration between government and industry could reap significant opportunities for the State. Commissioned by the LNG Jobs Taskforce, the Western Australian CCUS Hubs Study outlines the potential to develop CCUS hubs centred around two major emissions clusters in the Pilbara and Kwinana areas. However, more detailed work is required to progress the hubs concept in Western Australia. The Western Australian Government will support industry to further develop the business case for hubs.

There is also opportunity for CCUS to complement decommissioning activity by utilising depleted fields that would otherwise be abandoned through full plug and abandonment activities for carbon storage, offering economic and decarbonisation opportunities. The Western Australian Government will investigate opportunities for CCUS in the decommissioning value chain.

The Western Australian Government recognises that the cost of CCUS technology is likely to decline over time but

currently presents a barrier to investment. The Western Australian Government will continue to provide project-level support through existing mechanisms such as the Investment Attraction Fund. The New Energies Industries Funding Stream is designed to accelerate innovation, scale up commercial potential and expand local manufacturing capacity in a range of new energies industries, including CCUS.

To support the national transition to net zero, the Australian Government is also delivering a range of initiatives that aim to reduce CO₂ and transform Australia into a renewable energy superpower.

Key national frameworks, including the Future Gas Strategy, recognise the increasing role of CCUS in decarbonising national gas operations and hard-to-abate industries in Australia, while investments such as the Resourcing Australia's Prosperity program are delivering critical data to help de-risk investment into CO₂ storage. The Western Australia Government will continue to work closely with the Australian Government to inform national

policy and support the delivery of CCUS projects in Western Australia.

Additionally, the Western Australian Government continues to invest in a range of enabling activities to support CCUS development, such as:

- » Committing \$500 million through the Strategic Industries Fund to unlock Western Australia's Strategic Industrial Areas and support the development of major industrial projects, particularly from the green energy sector. The Western Australian Government will also explore options to utilise this funding to invest in common user infrastructure to assist CCUS projects located in Strategic Industrial Areas and key economic hubs.
- » Jointly investing \$70.5 million with the Australian Government to establish Australia's first Clean Energy Skills National Centre of Excellence, which will expand access to clean energy skills training opportunities to enable our workforce to meet the complex challenges associated with the clean energy transition, including for CCUS projects.



Skilled workers at the Chevron-operated Gorgon carbon capture and storage (CCS) system.
CREDIT: Chevron Australia

Action area 3: Share information and knowledge

Actions

- 3.1 Establish an online 'one-stop-shop' for information on CCUS in Western Australia.
- 3.2 Provide accessible and credible information to enhance community awareness and understanding of CCUS.
- 3.3 Expand available pre-competitive geological data for prospective CCUS and mineral carbonation locations in Western Australia.

Information and knowledge sharing is critical to advancing CCUS technology. The dissemination of information helps to overcome knowledge gaps, accelerate technology development, reduce risks and costs, and promote collaboration by enabling the sector to learn more quickly.

Information and knowledge sharing also benefits the community through increased transparency and education, enhancing public understanding and trust in CCUS.

The Western Australian Government is committed to providing better access to reliable and credible information relating to CCUS in a way that is easy to find and navigate.

While the Western Australian Government currently shares a range of information relating to CCUS, it is dispersed across various online channels, legislation, reports, data and information, policy documents, and grants programs.

The Government will consolidate and streamline this information into a 'one-stop-shop' to better support community understanding of CCUS and industry knowledge sharing.

CCUS investment decisions require high-quality pre-competitive geological data. Since 2013, the Western Australian Government has made this data available through the Western Australia CO₂ Geological Storage Atlas (the Atlas). A refresh of the Atlas has been underway since 2022, providing an increase in scope (covering five onshore basins and offshore areas in state jurisdiction), additional statewide datasets, and an update of the prospectivity on CO₂ storage.

The Western Australian Government is committed to expanding the available pre-competitive data, for example through the addition of appraisal-ready subsurface data for potential onshore CO₂ storage locations.

This work will complement the Australian Government's Resourcing Australia's Prosperity program, led by Geoscience Australia, which is investing \$3.4 billion over 35 years and aims to support Australia's net zero transition and enable responsible management of all resources, including information to help de-risk investment into CO₂ storage.

Existing Western Australian Government CCUS information

Legislation and regulation

- *Petroleum Legislation Amendment Act 2024*

Reports, data and information

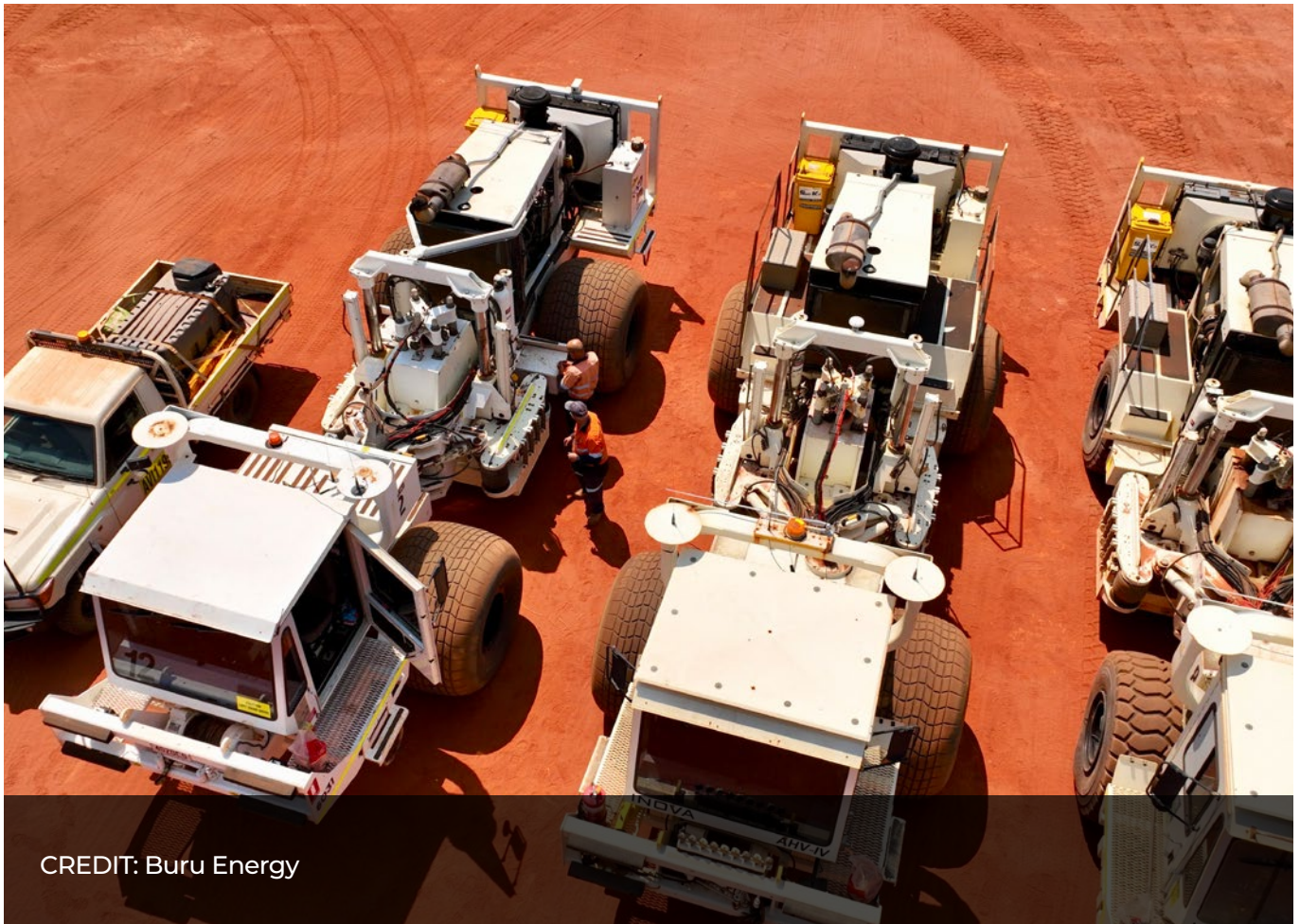
- CCUS Hubs Study - Summary of Key Findings
- South West Hub project information and data
- Western Australia CO₂ Geological Storage Atlas
- Geological data including seismic surveys, drilling logs and core analysis.
- Mineral carbonation (in-situ and ex-situ) information
- Biochar information

Policy documents

- Sectoral Emissions Reduction Strategy for Western Australia
- Future State: Accelerating Diversify WA

Grants

- Lower Carbon Grants Program - Gorgon Fund
- Investment Attraction Fund - New Energies Industries Funding Stream
- Carbon Innovation Grants Program



CREDIT: Buru Energy

Action area 4: Support research, development and demonstration with clear pathways to commerciality

Actions

- 4.1 Support new research aligned to the Mineral Carbonation Roadmap.
- 4.2 Continue to work with Cooperative Research Centres to support innovation in CCUS through RD&D.
- 4.3 Enable better access to venture capital to drive innovation across a range of industries, including in CCUS technologies.

Research, development and demonstration (RD&D) projects are needed to reduce the cost of proven CCUS technologies and support the development of new and emerging technologies.

Significant cost reductions are needed to make proven CCUS technologies commercially viable, especially for industries that will rely on CCUS because of limited alternatives to reduce emissions.

RD&D also has an important role to play in progressing the technical readiness of new and emerging CCUS technologies, particularly in carbon utilisation and CDR.

The Western Australian Government is supporting RD&D in CCUS through programs such as the Carbon Innovation Grants Program (CIGP) and the Lower Carbon Grants Program - Gorgon Fund.

The CIGP funds feasibility studies and trials that help to avoid, reduce or offset carbon emissions from heavy industry processes, with a focus on supporting innovative technologies for carbon abatement and sequestration.

The Lower Carbon Grants Program - Gorgon Fund will fund large, transformational research and innovation activity across industries, technology platforms and regions that support practical and effective decarbonisation solutions.

In 2023, the Minerals Research Institute of Western Australia commissioned the development of a research roadmap to decarbonise Western Australia through integrated mineral carbonation. The roadmap sets out a coordinated program of work using mine tailings or waste to enable accelerated ex-situ mineral carbonation in Western Australia across four themes: science and technology, economic viability, social and environmental impacts and policy and regulatory needs. The Western Australian Government will provide support to new research aligned to the roadmap.

The Western Australian Government will also continue to invest in RD&D through support for Cooperative Research Centres, such as the Future Energy Exports Cooperative Research Centre (FEnEx CRC) and the Kwinana Energy Transformation Hub, which plans to provide an industrial-scale facility to research and test decarbonisation technologies, including CCUS. The Western Australian Government will continue to work with CRCs to support RD&D and drive innovation in CCUS.

The Western Australian Government will encourage the growth of an active local venture capital market to support innovation across all industries, including CCUS. The WA Venture Capital Initiative takes a significant step in helping to facilitate this investment, offering co-investment opportunities to global venture capital firms to support early-stage businesses to grow. The Western Australian



Hazer Group Ltd – Commercial Demonstration Plant.
CREDIT: Photographer: Tony McDonough from Raw Image

Government will utilise programs such as the WA Venture Capital Initiative to encourage innovation in CCUS through better access to venture capital.

The Western Australian Government continues to support innovation and technology development more broadly through Western Australia's Innovation Strategy and support for innovation hubs. Announced in February 2024, the emerging GreenTech Hub aims to support local low-carbon industries through accelerating research, development and commercialisation, fostering collaboration, attracting investment and supporting knowledge and capability growth in the State.

The Government has also developed a new Western Australian 10-Year Science and Technology Plan (Plan) which recognises the important role science and technology will play in the State's future. The Plan aims to position Western Australia as a world leader in research and innovation, including in clean energy and green technologies such as CCUS. Consultations on the Plan identified several research priorities for CCUS in Western Australia such as reducing the cost of CCUS methodologies, novel emission utilisation, including e-fuels and materials, and mineral carbonation applications.

Western Australian Government Grants for CCUS

Several CCUS projects have received funding through the Western Australian Government's Carbon Innovation Grants Program.

- CSBP Limited: \$500,000 for a pilot project to reduce industrial process emissions through the installation of tertiary abatement technology.
- CSIRO: \$300,000 for a feasibility study of direct air capture technology from a Wesfarmers industrial manufacturing process.
- Airbridge Pty Ltd: \$422,565 for a feasibility study to assess patented technology for carbon capture and storage.
- Sea-Quester Offshore Pty Ltd: \$500,000 to assess the feasibility of an offshore CO₂ sequestration hub to support decarbonisation of the Kwinana heavy industry precinct.

Action area 5: Support Aboriginal and community engagement

Action

- 5.1 Support early engagement and enduring partnerships between Government, industry, Aboriginal peoples and regional communities on CCUS.

The Western Australian Government understands the importance of early and genuine engagement with regional communities and Aboriginal groups.

Acknowledging the rights and interests of Aboriginal peoples is critical to building trust and meaningful stakeholder relationships. The CCUS industry has the opportunity to build strong relationships with Aboriginal peoples and regional communities by leveraging existing networks and adopting best practice for

engagement. Best practice engagement with stakeholders includes early and ongoing engagement with free, prior and informed consent. Industry and community relationships are key to building social licence for CCUS projects.

The CCUS industry is at an early stage of development. However, it is expected to present a range of opportunities for Aboriginal communities to partner with industry on projects, particularly in areas such as mineral carbonation, biochar and other projects.

The Western Australian Government is committed to supporting early engagement and enduring partnerships between Government, industry, Aboriginal peoples and regional communities to ensure rights and interests are respected and the economic benefits are shared as the industry develops.



Geraldton Air Charter, Geraldton.
CREDIT: Tourism Western Australia

Action area 6: Attract investment and deepen strategic international partnerships

Actions

- 6.1 Continue to promote Western Australia and deepen our international partnerships in targeted markets, including through Invest and Trade WA's international office network.
- 6.2 Work with our international partners to explore CCUS partnership opportunities.

Establishing a leading CCUS industry in Western Australia will require significant private investment. The State is well positioned to attract international investment, with major trading partners actively looking to invest in CCUS within our region.

Our international partners continue to explore opportunities to leverage CCUS technologies to decarbonise their economies. The Australian Government has committed \$32.6 million to establish a

new initiative on regional cooperation on the transboundary movement of CO₂, which is intended to provide options for energy security and carbon management solutions for our regional trading partners.

Western Australia is well positioned to benefit from increased engagement with our regional partners and serve as a leading player in CCUS, based on our advantages which include our established infrastructure, our highly skilled workforce, and our suitable geological formations for CO₂ storage.

The Western Australian Government is committed to deepening the State's relationship with our international partners to explore CCUS partnership opportunities. Such work would be facilitated by leveraging our existing partnership arrangements while also tapping into the expertise of our highly capable network of trade and investment offices around the globe.

Active strategic partnerships between Western Australia and key trading partners that include CCUS

Some notable examples of active strategic partnerships between Western Australia and our key trading partners that include CCUS are:

- » Australia China Natural Gas Technology Partnership Fund
- » Memorandum of Understanding between Western Australia and Japan Oil, Gas and Metals National Corporation (JOGMEC)
- » Memorandum of Understanding on a Comprehensive Strategic Partnership between the Government of Western Australia and Japan Bank for International Cooperation
- » Memorandum of Understanding between Western Australia and the Ministry of Trade, Industry and Energy, Republic of Korea
- » Letter of Intent between Western Australia and the Abu Dhabi Investment Office

Invest and Trade Western Australia Offices





Delivering our vision

The Department of Jobs, Tourism, Science and Innovation is responsible for leading the delivery of Western Australia's Carbon Capture, Utilisation and Storage (CCUS) Action Plan and will work closely with agencies across the Western Australian Government to ensure strong governance, oversight and coordination as actions are delivered. Implementation of the plan will be reviewed periodically.

The Department of Jobs, Tourism, Science and Innovation will also ensure ongoing engagement with key stakeholders across the CCUS value chain to foster collaboration and help identify future opportunities and needs as they arise.

The Western Australian Government recognises that ongoing action will be required to support and accelerate the CCUS industry in Western Australia and will work with all stakeholders to ensure the benefits are shared across our community.

Responsibility and timeframes for the implementation of actions included in the CCUS Action Plan are outlined in the following table.

Actions will support existing efforts and lay the foundation for future initiatives to deliver our vision of establishing a world leading CCUS industry in Western Australia.

Hazer Group Ltd – Commercial Demonstration Plant, located in Munster, Western Australia.
CREDIT: Photographer: Tony McDonough from Raw Image

Actions

Action	Lead agency	Target completion date
Action area 1: Implement a leading legislative and regulatory framework for CCUS		
1.1 Finalise and implement the regulations, procedures and guidance underpinning the new greenhouse gas legislation to establish a fit-for-purpose regulatory regime.	DEMIRS	2025
1.2 Develop guidance to support proponents to navigate State and Australian Government legislative regimes for CCUS.	DEMIRS	2025
1.3 Streamline approval processes for projects that support the energy transition, including CCUS.	JTSI/DWER/DEMIRS	Ongoing
1.4 Uphold high standards of operational, maintenance, and health, safety, and environmental practices to support international competitiveness in CCUS.	DEMIRS	Ongoing
Action area 2: Work with industry to enable and facilitate CCUS projects		
2.1 Establish an industry-government engagement mechanism to support the growth of a CCUS industry. 2.1a Explore options to encourage data sharing among proponents across the CCUS value chain. 2.1b Support industry to further develop the business case for CCUS hubs.	JTSI	2025
2.2 Explore options to use existing funding mechanisms to provide support to both CCUS projects and enabling infrastructure.	JTSI	2025
2.3 Investigate opportunities for CCUS in the decommissioning value chain.	JTSI	2026
2.4 Continue to work with the Australian Government to explore options to support the CCUS industry in Western Australia.	JTSI	Ongoing

Action	Lead agency	Target completion date
Action area 3: Share information and knowledge		
3.1 Establish an online 'one-stop-shop' for information on CCUS in Western Australia.	JTSI	2025
3.2 Provide accessible and credible information to enhance community awareness and understanding of CCUS.	JTSI/DEMIRS	2025
3.3 Expand available pre-competitive geological data for prospective CCUS and mineral carbonation locations in Western Australia.	DEMIRS	Ongoing

Action area 4: Support research, development and demonstration with clear pathways to commerciality		
4.1 Support new research aligned to the Mineral Carbonation Roadmap.	MRIWA	2026
4.2 Continue to work with Cooperative Research Centres to support innovation in CCUS through RD&D.	JTSI	Ongoing
4.3 Enable better access to venture capital to drive innovation across a range of industries, including in CCUS technologies.	JTSI	Ongoing

Action area 5: Support Aboriginal and community engagement		
5.1 Support early engagement and enduring partnerships between Government, industry, Aboriginal peoples and regional communities on CCUS.	JTSI/MRIWA/DEMIRS	Ongoing

Action area 6: Attract investment and deepen strategic international partnerships		
6.1 Continue to promote Western Australia and deepen international partnerships in targeted markets, including through Invest and Trade WA's international office network.	JTSI	Ongoing
6.2 Work with our international partners to explore CCUS partnership opportunities.	JTSI	Ongoing

Western Australian Government agencies:

Department of Energy, Mines, Industry Regulation and Safety - **DEMIRS**
 Department of Jobs, Tourism, Science and Innovation - **JTSI**
 Department of Water and Environmental Regulation - **DWER**
 Minerals Research Institute of Western Australia - **MRIWA**



Brian Lee Hunters Creek Tagalong Tours, Cape Leveque.
CREDIT: Tourism Western Australia



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