

## BROWSE CARBON CAPTURE & STORAGE

### BROWSE BASIN, NORTH-WEST AUSTRALIA

#### Project overview

Woodside, as Operator for and on behalf of the Browse Joint Venture (BJV), is proposing to develop the Brecknock, Calliance, and Torosa conventional natural gas fields located in the offshore Browse Basin, approximately 425 km north of Broome Western Australia.

The proposed concept includes using two floating, production, storage, and offloading (FPSO) facilities to extract hydrocarbons from the gas fields and send them via a pipeline approximately 900 km long to North West Shelf (NWS) Project's existing infrastructure, for processing and conversion into liquefied natural gas (LNG) and other products.

To reduce the greenhouse gas (GHG) emissions footprint of the Browse Project, a carbon capture and storage (CCS) system has been incorporated into the offshore design. This system will be designed to capture the majority of Browse reservoir carbon dioxide (CO<sub>2</sub>) and inject the CO<sub>2</sub> deep underground within the Calliance Storage Formation, which has a proven capability to trap high pressure gas.<sup>1</sup>

The CCS system may deliver a significant reduction in potential Scope 1 GHG emissions from Browse by approximately 53 million tonnes (MT) (47%). The system design also means less CO<sub>2</sub> would be sent to the NWS onshore facilities, enabling a further reduction of 9 MT of emissions that might otherwise be released into the atmosphere.

Equipment on each Browse FPSO will separate CO<sub>2</sub> from natural gas, compress it into a concentrated stream, and then transport it approximately 10 km via a subsea pipeline to injection wells. These wells will control the flow of CO<sub>2</sub> into the Calliance Storage Formation at a depth of approximately 4 km below sea level.

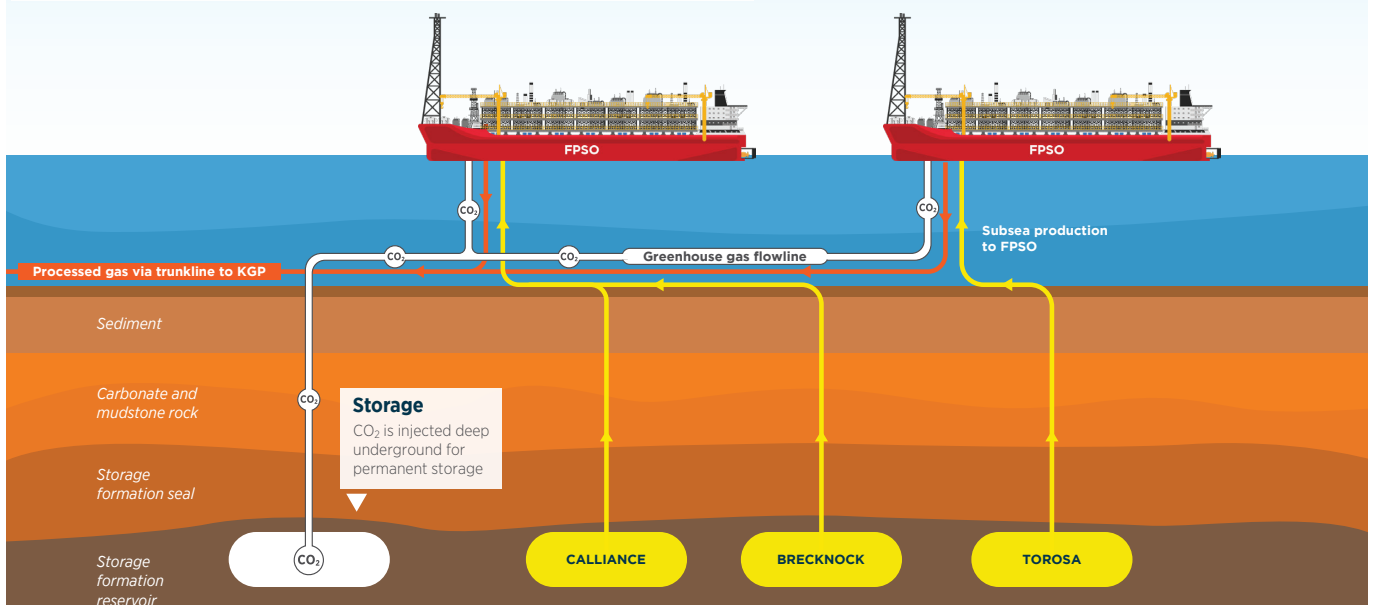
It is expected that three injection wells will be sufficient to provide the required CO<sub>2</sub> injection capacity, but Woodside is seeking approval to develop up to seven wells to ensure the system is highly reliable in the event of unforeseen circumstances.

The Browse CCS system is expected to be operational a few months after the Browse to NWS Project offshore production facilities have started up and have achieved steady state production, as CO<sub>2</sub> is required to commission the system. There may be brief periods over the life of the project where the Browse CCS system is unavailable. During these periods the CO<sub>2</sub> that cannot be injected will be released into the atmosphere.

Subject to the project proceeding and regulatory approvals being obtained, the indicative timeframes for the proposed Browse CCS Project will align with the broader Browse development, with operations continuing for 30+ years followed by any ongoing monitoring; and decommissioning.

### PROPOSED BROWSE CCS SYSTEM

**Floating, Production, Storage and Offloading (FPSO)** is a moored floating facility, with processing equipment onboard for the separation and treatment of condensate, water and gas that arrives from the reservoirs. FPSOs are also equipped with systems to store and then transfer condensate to tankers for shipment.



Schematic for illustrative purposes only. Not to scale.

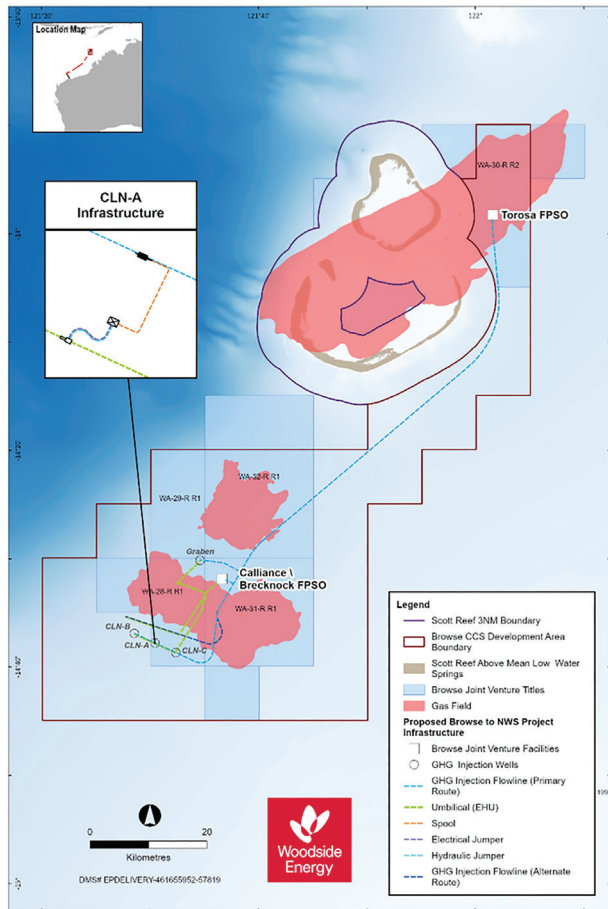
The Browse CCS system will be designed to reduce the carbon intensity of Browse LNG as an energy source as well as reducing reliance on carbon offsets to meet net GHG emissions requirements.

<sup>1</sup>The Calliance Storage Formation interval has a proven ability to contain and trap hydrocarbons, as the interval is currently holding Brecknock, Calliance, and Torosa natural gas fields. The fields were first discovered by humans in the 1970s, and subsurface data indicates the traps have held the pressurised natural gas for millions of years.

## GHG storage formation

The Calliance Storage Formation into which CO<sub>2</sub> from the Browse fields is proposed to be injected is within GHG Assessment Permit (G-8-AP). This permit was granted to Woodside in 2022.

It is centred on the Calliance structure, which has a proven ability to trap and contain hydrocarbons over geological timeframes, providing a formation which is a highly suitable location for the permanent storage of carbon dioxide.<sup>1</sup>



Proposed Browse CCS development area and key infrastructure locations

## Summary of Key Activities

The inclusion of the Browse CCS system as part of the proposed Browse to NWS Project would involve:

- drilling and completion of up to seven CO<sub>2</sub> injection wells
- installation and commissioning of the CO<sub>2</sub> injection flowlines and subsea infrastructure
- monitoring migration of the CO<sub>2</sub> plume using seismic survey techniques
- operations and maintenance of the subsea CCS project infrastructure
- decommissioning of project infrastructure at the end of project life

## Environmental approvals

The proposed Browse to the NWS Project is currently being assessed against State and Commonwealth environment legislation. The environmental referrals outlining the scope of these activities submitted in 2018 did not include CCS.

The BJV intends on seeking environmental approval for the Browse CCS system in line with relevant required regulations.

## Environmental Impacts and Management

Woodside prioritises safety and has a strong track record of undertaking activities in an environmentally responsible manner.

In conjunction with leading Australian academic and research organisations, Woodside and the BJV have invested more than A\$50 million in environmental research and studies over three decades to better understand the offshore marine environment in the vicinity of the Browse resources. This includes programs to build understanding on whale, turtle, other marine life, and fish species in the region, as well as long-term monitoring of coral and fish communities at Scott Reef.

This knowledge has been used to inform a detailed assessment of the potential impacts and risks associated with the proposed Browse CCS system. The CO<sub>2</sub> injection planned for the Calliance Storage Formation will occur approximately 50 km to the south of Scott Reef.

As part of the impact and risk assessment process for Browse CCS, management and mitigation measures have been identified and proposed to reduce the level of impact and risk to an acceptable level and protect the environment.

## Frequently Asked Questions

### 1. What is CCS?

Carbon capture and storage is a mature technology which represents a proven solution to abate large-scale project or industrial emissions. Globally, CCS has been successfully used for decades, in particular in support of enhanced oil recovery, but is now being utilised for permanent emissions storage<sup>1</sup>. The skills and capabilities required to store carbon dioxide in geological formations are similar to those needed to find and produce oil and gas.

The Global CCS Institute notes there are 30 CCS facilities in operation around the world, with another 11 in construction and 153 under consideration.

<sup>1</sup> IPCC, 2022. "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change" Summary for Policymakers paragraph C.4.6.

### 2. Does CCS work?

Carbon capture and storage is a well-understood technology that has been in use since the early 1970s. As noted by the International Energy Agency, the CCUS facilities currently in operation around the world have a collective capacity to capture more than 40 MtCO<sub>2</sub> each year.

CCS has a key role to play in meeting the world's emissions reduction requirements. As noted in a 2022 report from the Intergovernmental Panel on Climate Change, CCS is one of a suite of solutions that can help deliver net-zero and net-negative emissions.

### 3. How much CO<sub>2</sub> could be sequestered in the Browse CCS system Storage Formation?

Feasibility studies indicate the proposed Storage Formation within Calliance (G-8-AP) could be utilised for sequestration of the majority of Browse Reservoir CO<sub>2</sub>. Subsurface studies indicate the proposed Storage Formation may have the capacity to store approximately 4 million tonnes of CO<sub>2</sub> per year.

### 4. How can you be sure that the CO<sub>2</sub> is permanently stored after it is injected and won't leak out from the reservoir?

The Calliance Storage Formation is at a depth of about 4 km below the seabed. It consists of 165-million-year-old Jurassic sedimentary rock, overlain by a thick cap rock, which forms a natural impermeable barrier. This Storage Formation has a proven ability to trap and contain hydrocarbons for millions of years<sup>1</sup> and is therefore interpreted as a highly suitable candidate for permanent storage of CO<sub>2</sub>. The Storage Formation will be monitored throughout the project.

### 5. How will you monitor the CO<sub>2</sub> once it has been injected?

Woodside would conduct regular seismic surveys to monitor the CO<sub>2</sub> once it has been injected into the Storage Formation. Vertical Seismic Profiling (VSP) is expected to be a primary form of subsurface monitoring undertaken. VSP generates a high-resolution image of the subsurface using acoustic sensors in the injection wells, requiring a smaller seismic noise source than traditional 3D or 4D seismic surveys, reducing the need for large scale acoustic receivers typically towed by seismic survey vessels. 3D or 4D seismic may be acquired concurrently with hydrocarbon monitoring activities.

## Summary of key potential impacts and mitigations/management measures.

Environment Aspect, impact risk	Mitigations and/or management measure
<b>Planned</b>	
<b>Seabed disturbance from equipment presence and installation</b>	<ul style="list-style-type: none"> <li>All CCS injection wells and pipelines are proposed in deep (&gt;350m) offshore waters in locations with no sensitive habitats.</li> </ul>
<b>Generation of underwater noise from construction equipment and subsea equipment, including seismic surveys.</b>	<ul style="list-style-type: none"> <li>Seismic survey to be conducted outside of sensitive migration periods.</li> <li>Ongoing monitoring to understand timing of presence of fauna migrating through the region.</li> <li>Process for observing for and stopping activities upon sighting of fauna.</li> </ul>
<b>Exclusion of other users from the area</b>	<ul style="list-style-type: none"> <li>Relevant fishery stakeholders and Governments maritime safety agencies to be notified of start and end dates and any exclusion zones prior to commencement of the activity.</li> <li>Commercial fishers permitted to use the Operational Area around the mobile offshore drilling unit (4 km radius) and pipelay vessel (1.5 km radius).</li> <li>No restrictions on safe use of development area when vessels are not present during the construction phase.</li> </ul>
<b>Light emissions</b>	<ul style="list-style-type: none"> <li>No permanent lighting to be installed.</li> <li>No activities planned for within 20 km of turtle nesting/interesting areas.</li> <li>Implementation of appropriate light mitigation measures in accordance with the National Light Pollution Guidelines.</li> </ul>
<b>Unplanned</b>	
<b>Hydrocarbon release from installation vessels of mobile offshore drilling units (MODU)</b>	<ul style="list-style-type: none"> <li>Comply with regulatory requirements for the prevention of vessel collisions and safety and emergency arrangements.</li> <li>Establish temporary exclusion zones and inform other marine users of project activities to reduce likelihood of a collision.</li> <li>Use appropriate refuelling procedures and equipment to prevent spills to the marine environment.</li> </ul>
<b>Marine fauna collisions</b>	<ul style="list-style-type: none"> <li>Measures will be taken to protect marine fauna such as applying speed restrictions to vessels or assigning crew to maintain watch for fauna. Animals not be approached.</li> </ul>
<b>Accidental Introduction of invasive marine species (IMS)</b>	<ul style="list-style-type: none"> <li>All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species.</li> <li>Compliance with Australian biosecurity requirements and guidance.</li> </ul>
<b>Accidental carbon dioxide release from pipeline or injection well</b>	<ul style="list-style-type: none"> <li>Calliance Storage Formation assessed as technically suitable for containment of injected CO<sub>2</sub>.</li> <li>Monitoring of to ensure integrity limits are met.</li> <li>CO<sub>2</sub> in the reservoir will be monitored (via seismic techniques) to ensure it is being contained.</li> <li>CO<sub>2</sub> pipeline designed, installed, and maintained to appropriate standards.</li> </ul>

Woodside Energy Ltd (Woodside) is Operator for and on behalf of the **Browse Joint Venture**. The participants in the Browse Joint Venture are:

- Woodside Browse Pty Ltd,
- BP Developments Australia Pty Ltd,
- Japan Australia LNG (MIMI Browse) Pty Ltd, and
- PetroChina International Investment (Australia) Pty Ltd

### Providing feedback and further information

If you would like further information or to comment on the proposed Browse development, please contact Woodside by email to [feedback@woodside.com](mailto:feedback@woodside.com) or call toll free 1800 442 977. There will be several opportunities to engage and provide feedback across phases of the project.

[www.woodside.com](http://www.woodside.com)

