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# CCUS in Australia

## Enabling industrial-scale emission abatement in the Asia Pacific

**Dr Matthias Raab**
Chief Executive Officer

APEC conference, Kobe, Japan
11 October 2023

# CO2CRC is a world leader in applied CCUS research

We do research and commercially relevant demonstrations in CCUS applications.

We build and operate first of a kind plant and equipment.

We develop industry led technology options to accelerate commercial deployment.

We own and operate the Otway International Test Centre in South-West Victoria, Australia.


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# Global collaboration between industry and academia

Trained over 60 PhDs

Published more than 450 peer-reviewed journal papers

Between 40 – 180 researchers participating in our research program at any one time


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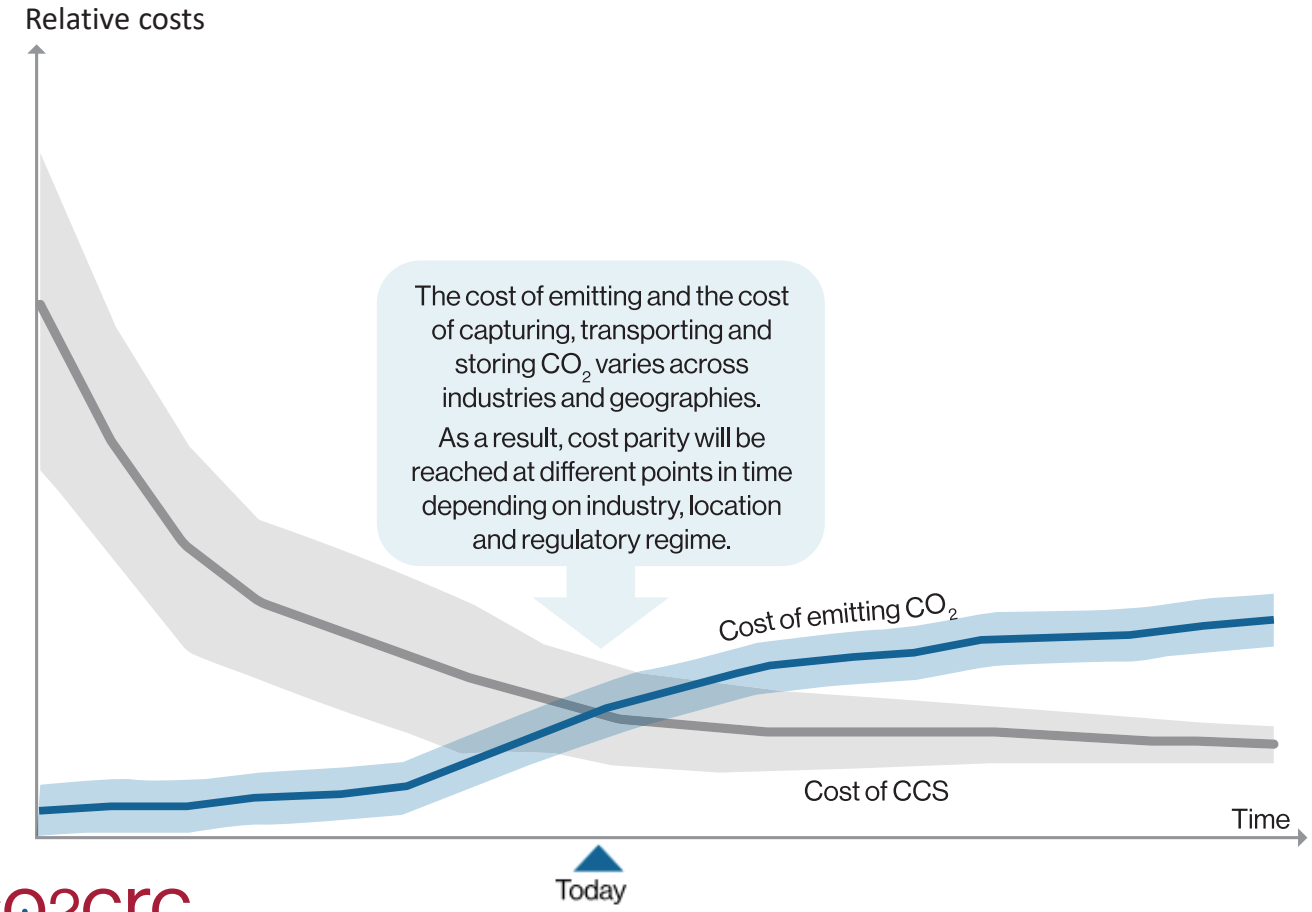
# Recognising economic value of CCS

## Cost of emitting $CO_2$ vs cost of CCS




**Cost of emitting**

- $CO_2$ tax, quotas or both
- Regulations and targets
- Indirect costs/ "License to operate"

**Cost of CCS**

- Cost of capturing
- Cost of transportation
- Cost of storing

*Modified after Rystad Energy and analysis*

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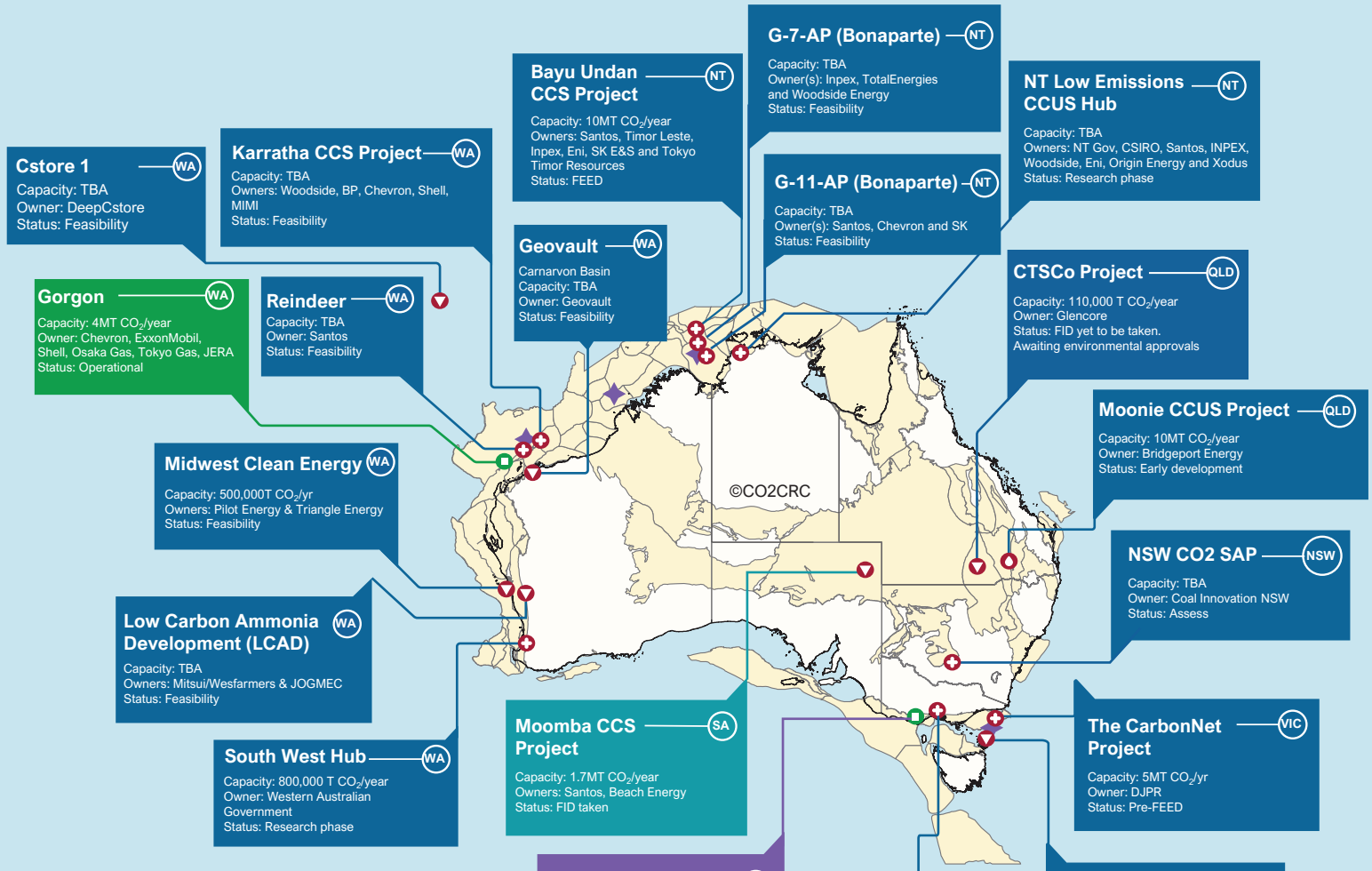
# CCUS Projects in Australia 2023




**Cstore 1** (WA)
Capacity: TBA
Owner: DeepCstore
Status: Feasibility

**Karratha CCS Project** (WA)
Capacity: TBA
Owners: Woodside, BP, Chevron, Shell, MIMI
Status: Feasibility

**Bayu Undan CCS Project** (NT)
Capacity: 10MT $CO_2$/year
Owners: Santos, Timor Leste, Inpex, Eni, SK E&S and Tokyo Timor Resources
Status: FEED

**G-7-AP (Bonaparte)** (NT)
Capacity: TBA
Owner(s): Inpex, TotalEnergies and Woodside Energy
Status: Feasibility

**NT Low Emissions CCUS Hub** (NT)
Capacity: TBA
Owners: NT Gov, CSIRO, Santos, INPEX, Woodside, Eni, Origin Energy and Xodus
Status: Research phase

**G-11-AP (Bonaparte)** (NT)
Capacity: TBA
Owner(s): Santos, Chevron and SK
Status: Feasibility

**Geovault** (WA)
Carnarvon Basin
Capacity: TBA
Owner: Geovault
Status: Feasibility

**Gorgon** (WA)
Capacity: 4MT $CO_2$/year
Owner: Chevron, ExxonMobil, Shell, Osaka Gas, Tokyo Gas, JERA
Status: Operational

**Reindeer** (WA)
Capacity: TBA
Owner: Santos
Status: Feasibility

**CTSCo Project** (QLD)
Capacity: 110,000 T $CO_2$/year
Owner: Glencore
Status: FID yet to be taken. Awaiting environmental approvals

**Moonie CCUS Project** (QLD)
Capacity: 10MT $CO_2$/year
Owner: Bridgeport Energy
Status: Early development

**Midwest Clean Energy** (WA)
Capacity: 500,000T $CO_2$/yr
Owners: Pilot Energy & Triangle Energy
Status: Feasibility

**NSW CO2 SAP** (NSW)
Capacity: TBA
Owner: Coal Innovation NSW
Status: Assess

**Low Carbon Ammonia Development (LCAD)** (WA)
Capacity: TBA
Owners: Mitsui/Wesfarmers & JOGMEC
Status: Feasibility

**Moomba CCS Project** (SA)
Capacity: 1.7MT $CO_2$/year
Owners: Santos, Beach Energy
Status: FID taken

**The CarbonNet Project** (VIC)
Capacity: 5MT $CO_2$/yr
Owner: DJPR
Status: Pre-FEED

**South West Hub** (WA)
Capacity: 800,000 T $CO_2$/year
Owner: Western Australian Government
Status: Research phase

**CO2CRC Otway International Test Centre** (VIC)
Capacity: Research facility
Owner: CO2CRC
Status: Research project

**Otway CCS Hub**
Capacity: 200,000 T $CO_2$/year
Owner: Beach Energy
Status: Feasibility

**The SEA CCS Hub** (VIC)
Capacity: 2MT $CO_2$/yr
Owner: ExxonMobil & Woodside
Status: Feasibility

1 Operational project

1 Final investment decision taken

17 Projects in feasibility

## Legend

- Operational
- CO2-EOR
- CCS
- Storage hub
- Offshore CCS permits
- Geological Basins

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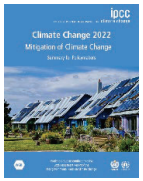
# Carbon Capture & Storage is Necessary

- ✓ Carbon capture and storage (CCS) is necessary for the global emissions reduction targets to be met according to the IPCC, IEA and DOE
- ✓ CCS is safe, reliable and permanent; CCS has been in operation for decades, with multiple case studies of success
- ✓ There are no technical barriers that exist to prevent the required rollout of CCS
- ✓ CCS is a key enabler for a future hydrogen economy
- ✓ So… CCS IS necessary, but not everywhere is suitable for CCS
- ✓ Offshore Australia has vast potential for geological carbon storage, something that our major trading partners lack (London Protocol)




Key Findings on CCS[1]

*Carbon capture and storage (including DACCS and BECCS**) is central** to IPCC mitigation pathways*

*There is **no scenario** which involves the increased use of future energy globally **that does not require CCS***

*Even with the most optimistic uptake of renewable energy, annual storage using **CCS will need to be 3 gigatons, nearly 75 times the current storage levels** (other more realistic IPCC scenarios require much more storage)*

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[1]Soure: IPCC's Working Group III's (WGIII) Contribution to the Sixth Assessment Report, https://report.ipcc.ch/ar6wg3/

# Global Total Primary Energy Supply in the Net Zero (NZE) Scenario

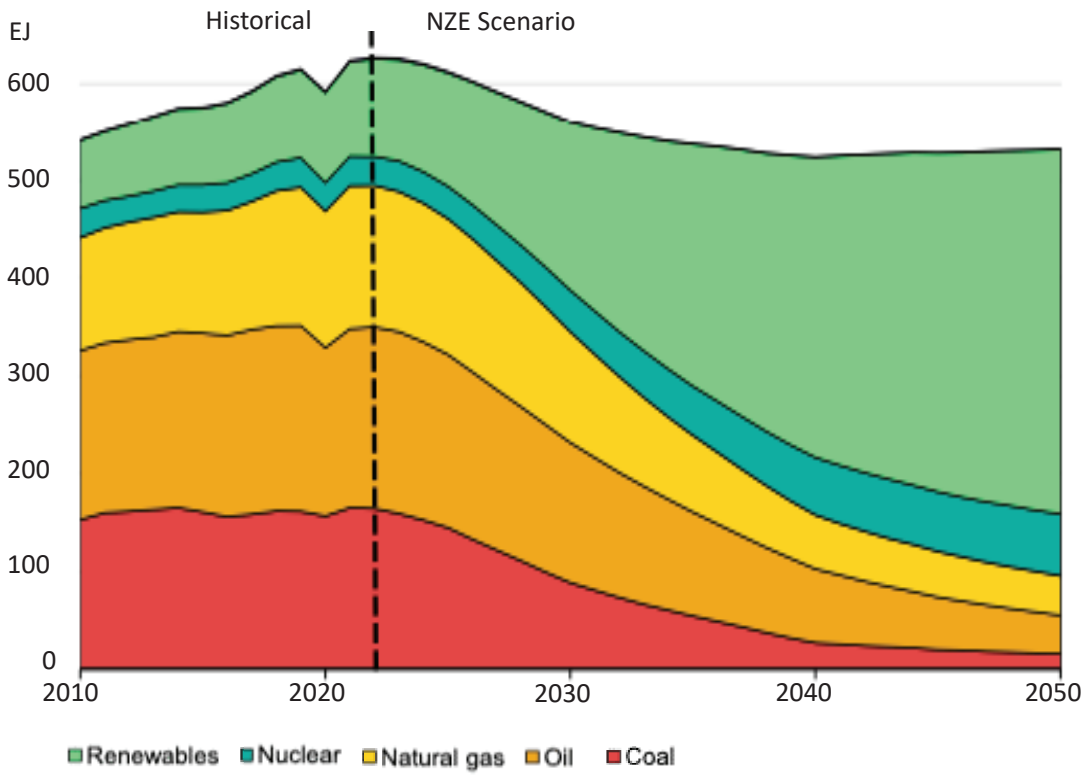


*Figure modified after IEA Energy Technologies Perspectives 2023*

NZE Scenario – sets out a pathway to stabilize global average temperatures at 1.5°C above pre-industrial levels. This scenario achieves global net zero energy sector CO2 emissions by 2050 without relying on emissions reductions from outside the energy sector (i.e. land clearing).

*"Carbon capture, utilisation and storage (CCUS) plays an increasingly important role: $CO_2$ capture grows from around 0.04 Gt in 2021 to 1.2 Gt in 2030 and 6.2 Gt in 2050, with industry and fuel transformation sectors accounting for more than 40%, direct air capture (DAC) for around 5%, and power and heat generation for the rest by then."*

**IEA**, *Energy Technologies Perspectives 2023*

**The role of CCS will be significantly larger if the decline of fossil fuels is slower**

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# How Do We Get to Net Zero and What are the Challenges?

- We need to rollout multiple CCS projects with large-scale storage (multi-Mt/a) around and across Australia
- This roll-out needs to be done quickly to meet Net Zero
- However, the current project cycle takes ~9 years due to cumbersome regulatory processes, which only allows for three full project cycles between now and 2050
- How many large (>4Mt/a) CCS projects are in place or being planned?
  - How many are needed to meet Net Zero?

# Existing and Planned Large Australian CCS Projects/Hubs

- By 2032, if all of the projects below are online, we could potentially have up to **31 to 35 Mtpa** stored in these projects:
  - SEA CCS (2 Mt/a)
  - CarbonNet (6 Mt/a)
  - Moomba (1.7 Mt/a; soon to store)
  - Gorgon (1.7-4 Mt/a; storing now))
  - Bonaparte (G-7-AP) (10Mt/a)
  - Bayu-Undan (10Mt/a)
- This is quite optimistic, and most of these projects will not store $CO_2$ before 2030


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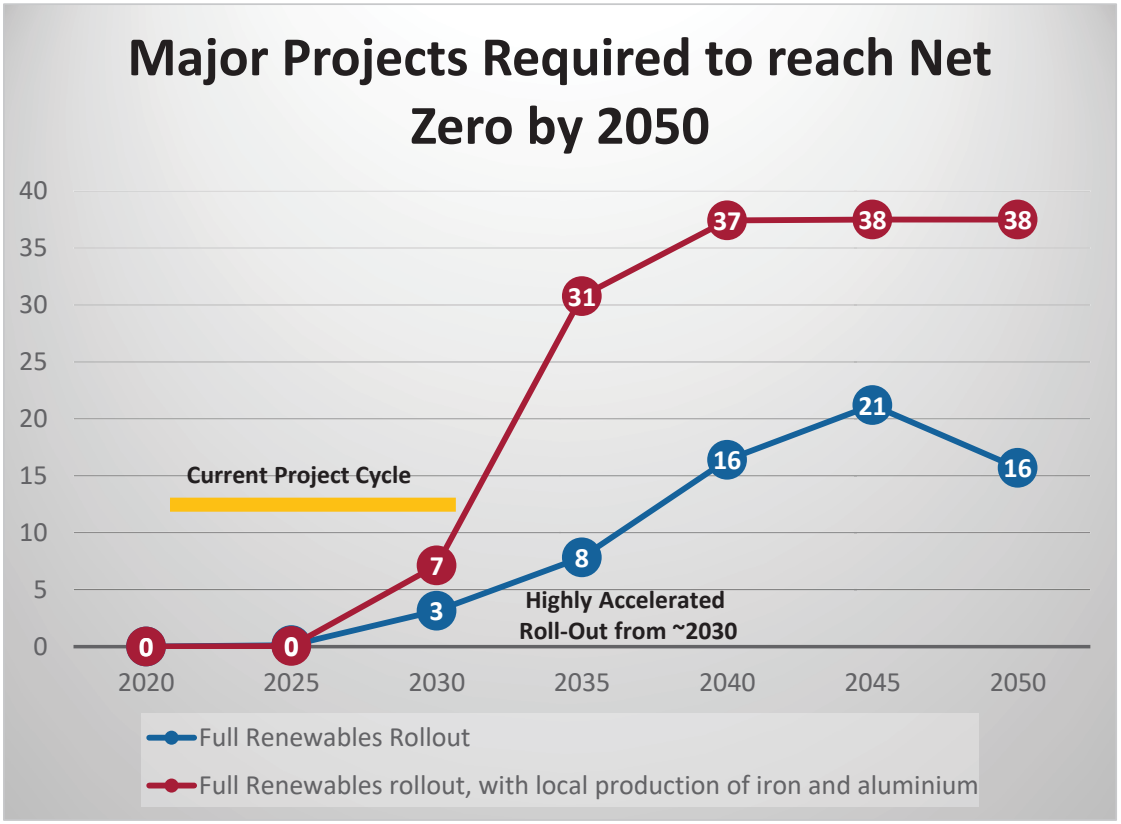
# Number of Major Projects (>4Mtpa) to get to Net Zero




Data from Net Zero Australia Report 2023

- The longer the delay, *the more complex and difficult is the Net Zero challenge*
- Blue line is most optimistic, *red line is realistic*
- The average required number of projects is between ~20 and 40 from 2045, with 40 being more realistic; *majority of the projects will be required from 2032 after existing project cycle*
- Regulatory delay results directly in emissions that are higher than otherwise possible – *it really does matter*

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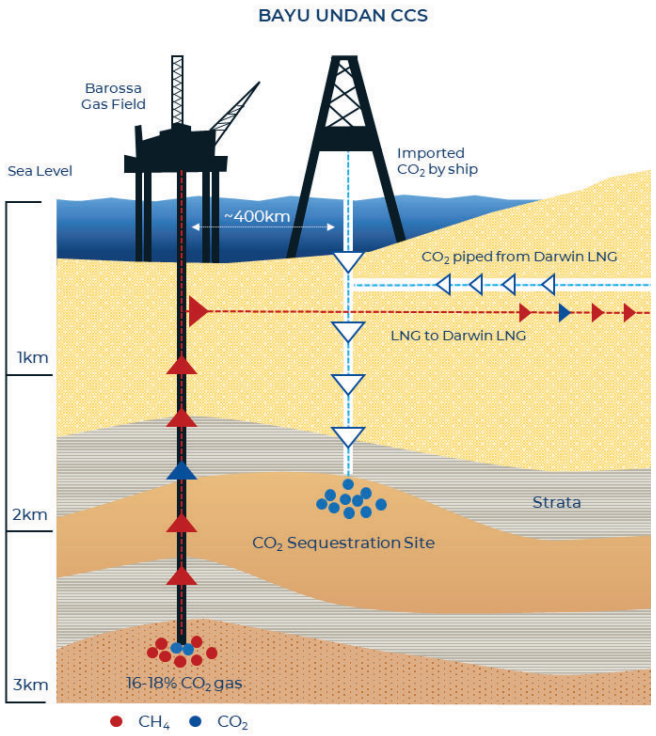
# Summary

- To get to Net Zero, CCS is essential and will require a major project roll-out, which will have to accelerate dramatically after the current project cycle ends in ~2032
- To deliver on Net Zero, CCS projects will require a greatly accelerated regulatory process so that the project cycle can be shortened from the existing 9 years
- **CO2CRC leads** the **CCS Regulatory Affairs Task Force** and is working with industry and government to provide the required improvements in government regulation and allow companies to deliver on their Net Zero commitments

# The Barossa / Darwin LNG / Bayu-Undan Project




- The Barossa Gas Field has high (16-18%) concentrations of naturally occurring $CO_2$
- Gas produced from the Barossa Gas Field will be **transported via pipeline** to Darwin LNG
- The Darwin LNG facility will separate the Methane ($CH_4$) from the $CO_2$
- The $CO_2$ will be transported via Pipeline from Darwin LNG to the **Bayu-Undan depleted gas field** and injected into the reservoir for permanent geological storage

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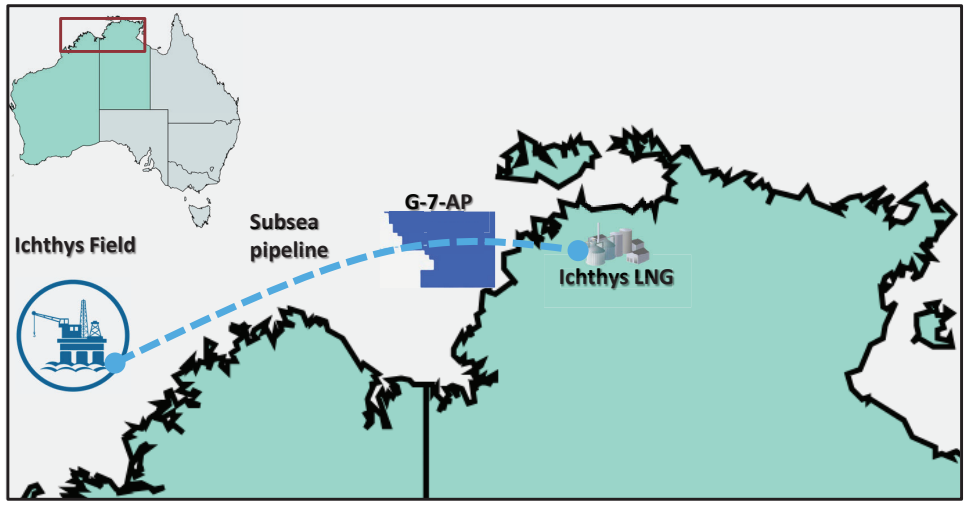
# The Barossa / Darwin LNG / Bayu-Undan Project

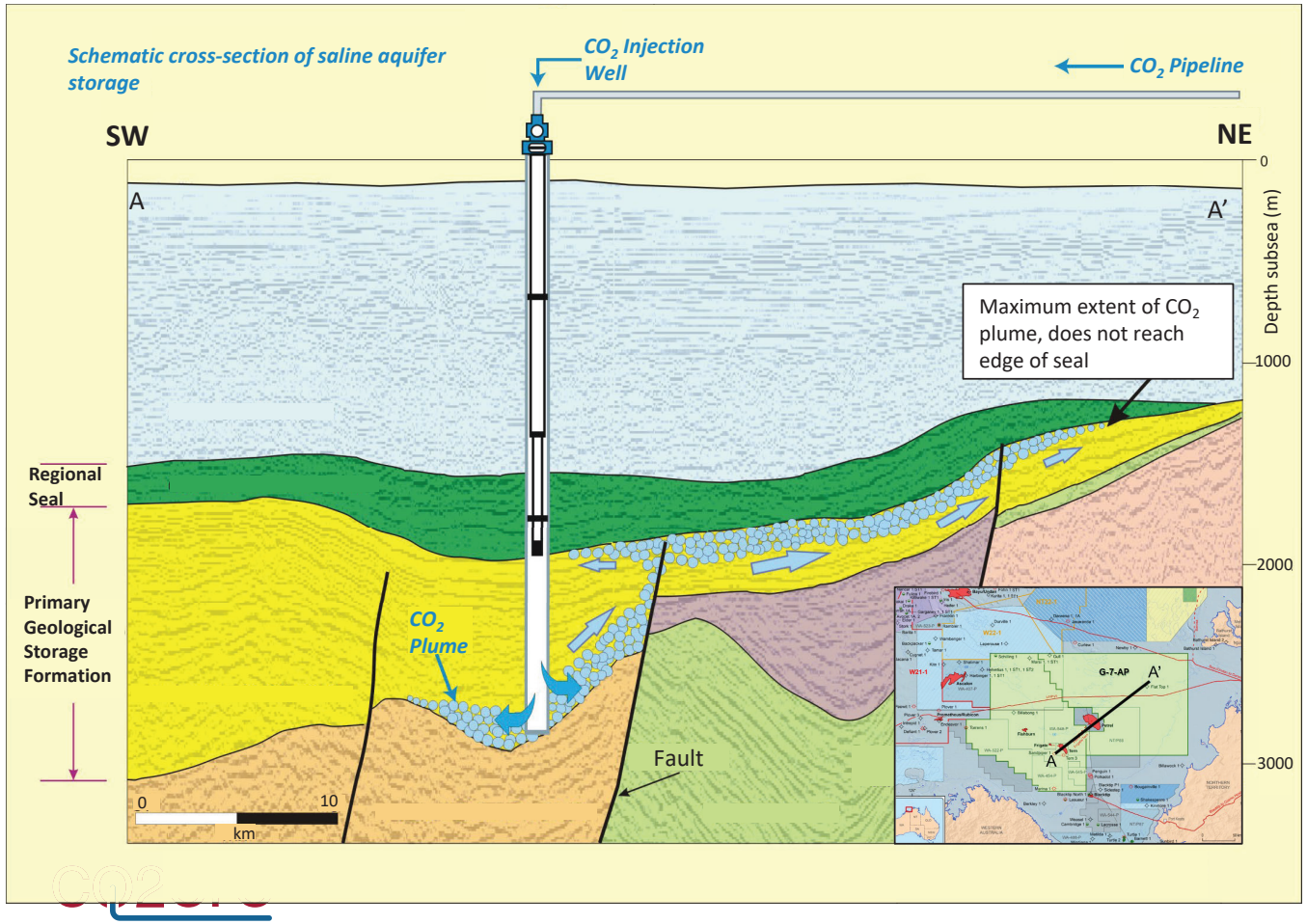

- This project will involve repurposing the Bayu-Undan offshore facilities reservoir (located in Timor Leste waters) into a geological $CO_2$ storage hub (BU CCS) with a maximum capacity of 10 MTPA$^+$
- New $CO_2$ transport and import facilities will be required
- Because Bayu-Undan is located in Timor-Leste, moving $CO_2$ from Australia to Timor-Leste will trigger the London Protocol

# Ichthys Project




- Ichthys LNG is expected to produce up to 9.3 million tonnes of LNG and 1.65 million tonnes of LPG per annum, along with more than 100,000 barrels of condensate per day at peak.
- The Ichthys Field is estimated to contain more than 12 trillion cubic feet of gas and 500 million barrels of condensate.
- **CCS will be essential** to ensure Ichthys meets the requirements of the Safeguard Mechanism

# Ichthys Project / Ichthys LNG / Bonaparte CCS




- INPEX awarded GHG Assessment Permit (G-7-AP) in the Petrel Sub-basin of Bonaparte Basin
- Geological storage site in large **Saline Aquifer**
- Storage site substantially **larger than required** for Ichthys LNG emissions alone

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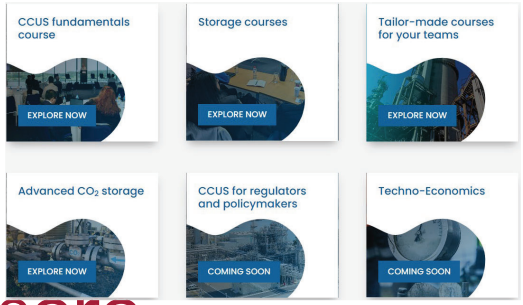
# In Summary

- CCS is a proven suite of technologies
- Elements of a robust storage site:
  - Trapping, compression, seal and storage formation, no adverse impacts
- CCS is mandatory for future LNG

# International Educational Opportunities in CCS

- **CO2CRC Education**: Essentials to detailed technical specialist level; bespoke courses can be tailored to individual needs
- **CO2CRC Symposium**: Shaping the Next Decade of CCS
  - 20-23rd November
  - Learn more about Australian CCS projects, CCS technology and the regulatory and policy landscape locally and globally
- CO2Tech: proposal reviews through to detailed technical evaluations





CO2Tech
A CO2CRC Company

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# Collaboration to accelerate CCUS technology advancements

- Australia, Japan and Korea have ambitious 2030 emission reduction targets, CCUS is a key technology
- Development of **offshore $CO_2$ monitoring techniques**
- Execution of **field trials** at CO2CRC's Otway International Test Centre for improving $CO_2$ injection
- Progress **transboundary CCS** projects between Korea, Japan and Australia
- Development of **carbon credit methodology** for transboundary CCS
- Review of **domestic and international legal challenges** for transboundary CCS projects

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# Breakthrough technologies

# Otway International Test Centre

## Key Success Factors

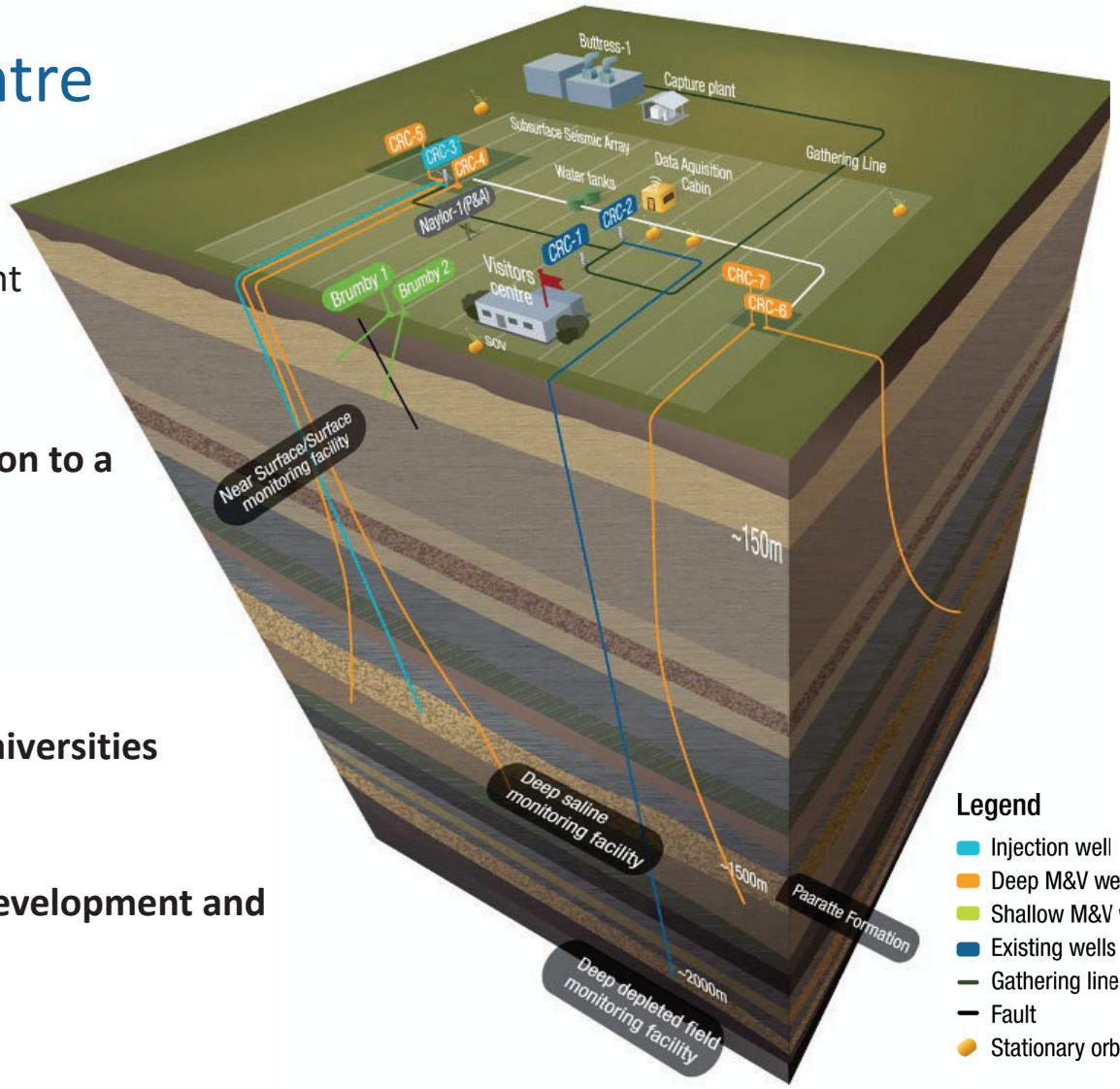
**At scale investment** - Long term Government and Industry funding

Focused on **accelerating Australia's transition to a low emissions future**

**Industry led Research**

Well-established **collaboration between universities and industry**, domestically and globally

**Globally unique** test centre to **accelerate development and commercial deployment** of technologies

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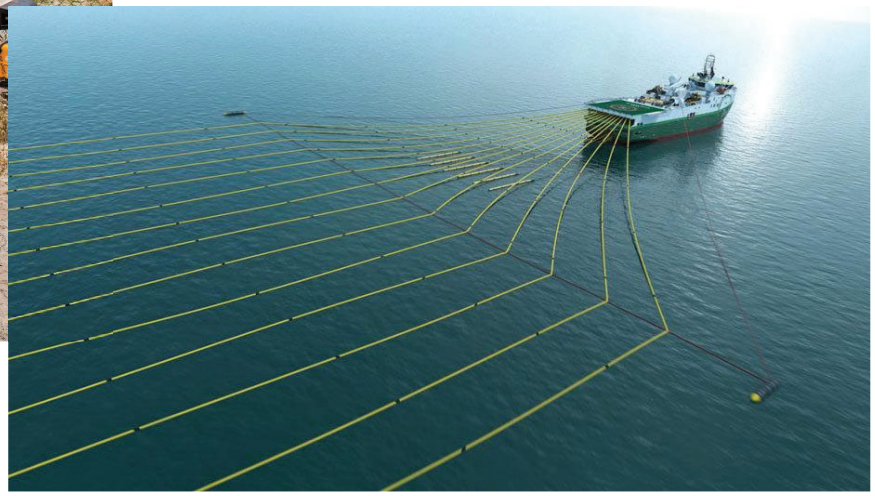
# A paradigm shift in subsurface monitoring

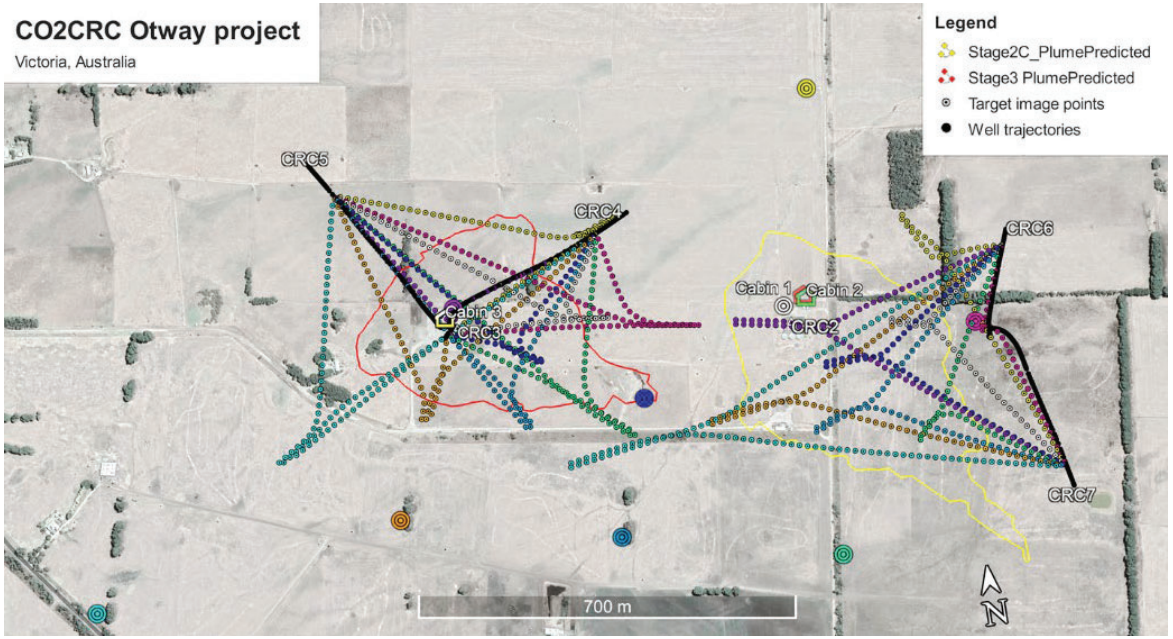

In order to see, the industry needed:



# Risk based monitoring through downhole seismic and SOV/DAS

- The system was configured to provide a new image of the plume every 2 days.

- It first detected the gas plume on the 2nd day of injection with ~300 tonnes.



# Summary

- Australia has a golden opportunity for global CCS leadership
- The CCS industry can move faster than government can approve projects
- Legislated targets are at odds with the industry's ability to get project approvals
- To achieve 43% of emission reduction by 2030, we will need 50% reduction in permitting time
- Permitting will determine the pace to net-zero
- Delays are deadly – a lack of urgency will force the status quo in emissions and deter investment
- Australia can create many win-win situations with Japan.

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CO2CRC acknowledges and appreciates the strong relationships it has with industry, community, government, research organisations, and agencies in Australia and around the world