CSIRO

Australia's Pre-eminent National Science Organization

Australia's Energy Transition to Net Zero Emissions

Role of CSS and Hydrogen Production

Overview: Storage, Projects and Australian Government Initiatives.

Dr Damian Barrett, Research Director Energy Resources, CSIRO

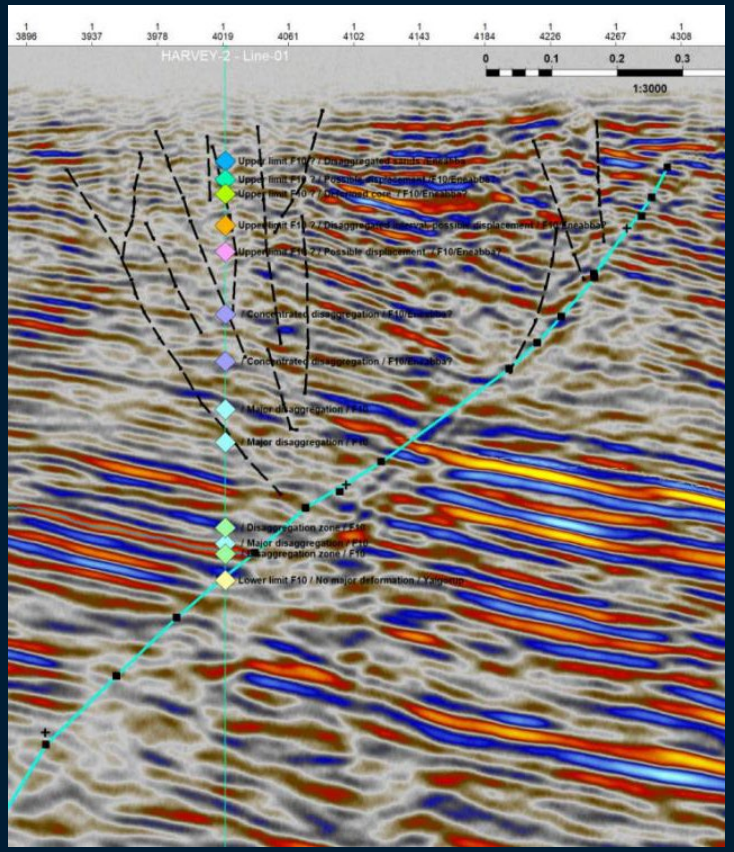
CSIRO

CSIRO: Australia's National Science Agency

- CSIRO
  - Science & Industry Research Act (1949)
  - Role is 'innovation catalyst'
  - Research for Australian industry
  - Independent & international best practice
  - State/Commonwealth Govts., industry and society

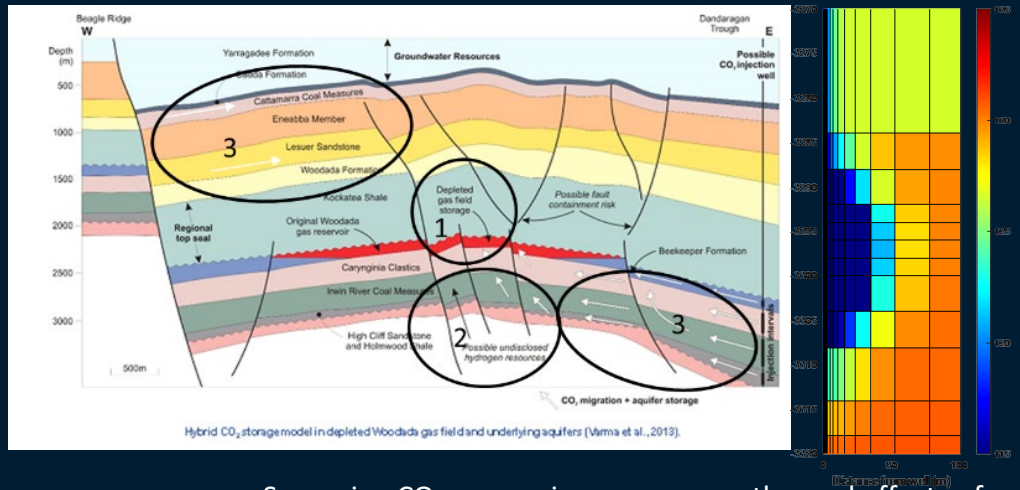
- Strong Japanese collaborations
  - HESC: Liquid H_2 ortho-para conversion
  - CSIRO – JOGMEC Extended 5 year MoU
  - INPEX – Osaka Gas: e-methane
  - Mitsui OSK Lines: Decarbonize operations

CSIRO CCS Expertise



Ricard et al 2023

CSIRO & Mitsui E&P Australia



Dance et al 2023

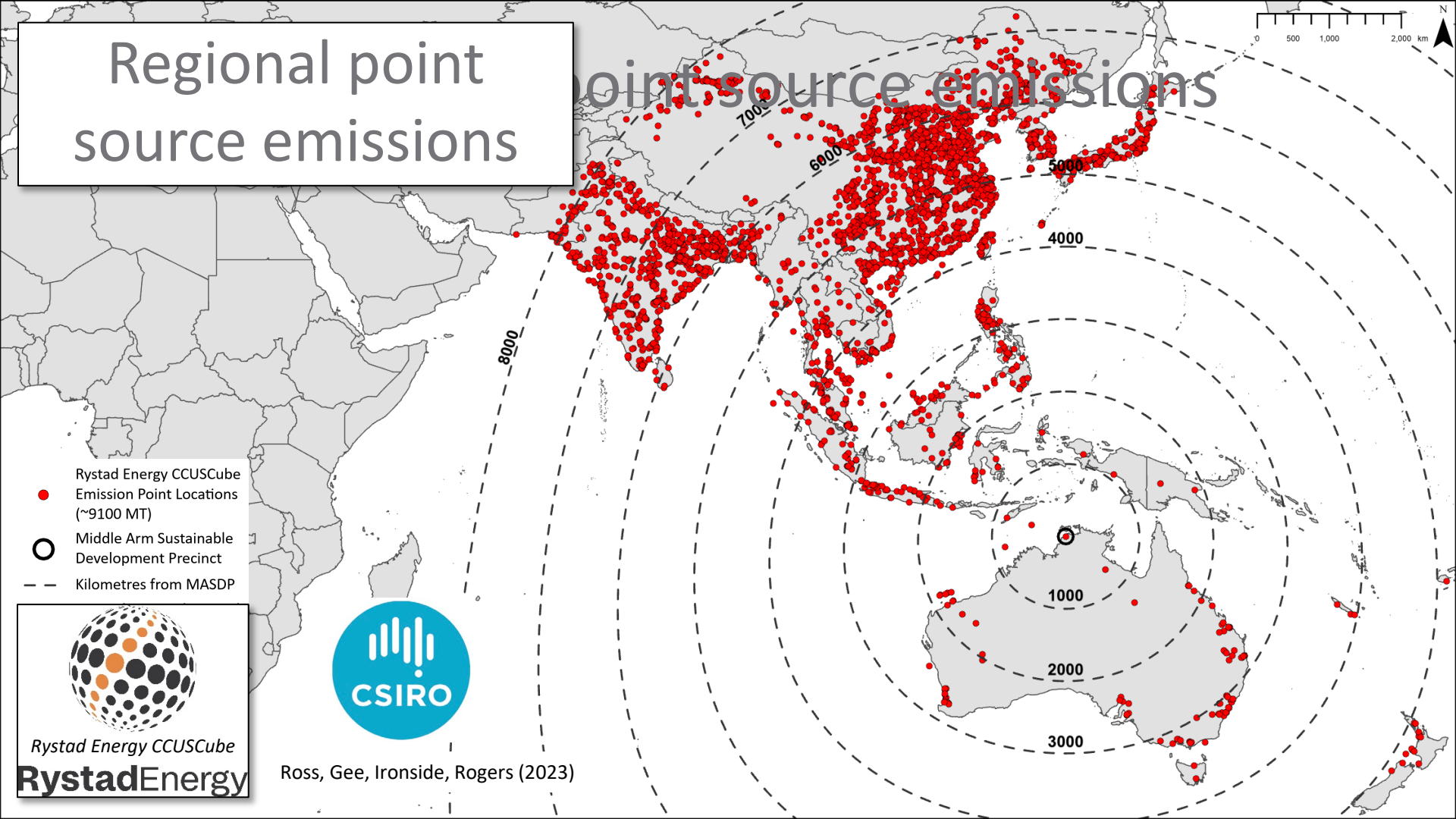
Screening CO_2 reservoir processes on thermal effects of high-pressure CO_2 injection

CSIRO & RITE Japan

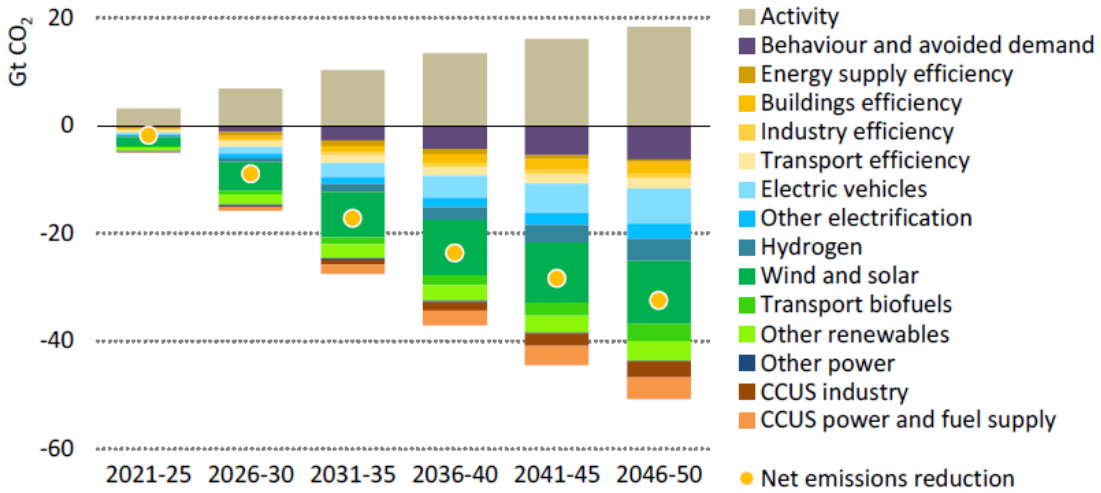
DTS, DAS and DSS monitoring of fluid injection experiments within a fault zone.

Global GHG Emissions and Role of Carbon Capture and Storage

Regional point source emissions



IEA Anticipated global demand for CCS



International Energy Agency (2021), Net Zero by 2050, IEA, Paris

Predicted global requirement for removal of 6.970 GT CO_2 per annum by 2050 through CCUS *(IEA 2021)*

G7 Ministers' Meeting: Climate, Energy & Environment

GHG Emissions ←→ Energy Security ←→ Energy Affordability

- *"To achieve net zero, the deployment of carbon dioxide removal (CDR) processes with robust social and environmental safeguards… have an essential role to play in counterbalancing residual emissions from sectors that are unlikely to achieve full decarbonization...*

- *…We recognize the need for monitoring and analyzing the potential for and expanding geologic storage infrastructure and planning for CO_2 transport, including the potential for regional Carbon dioxide Capture and Storage (CCS) hubs in line with social acceptance."*

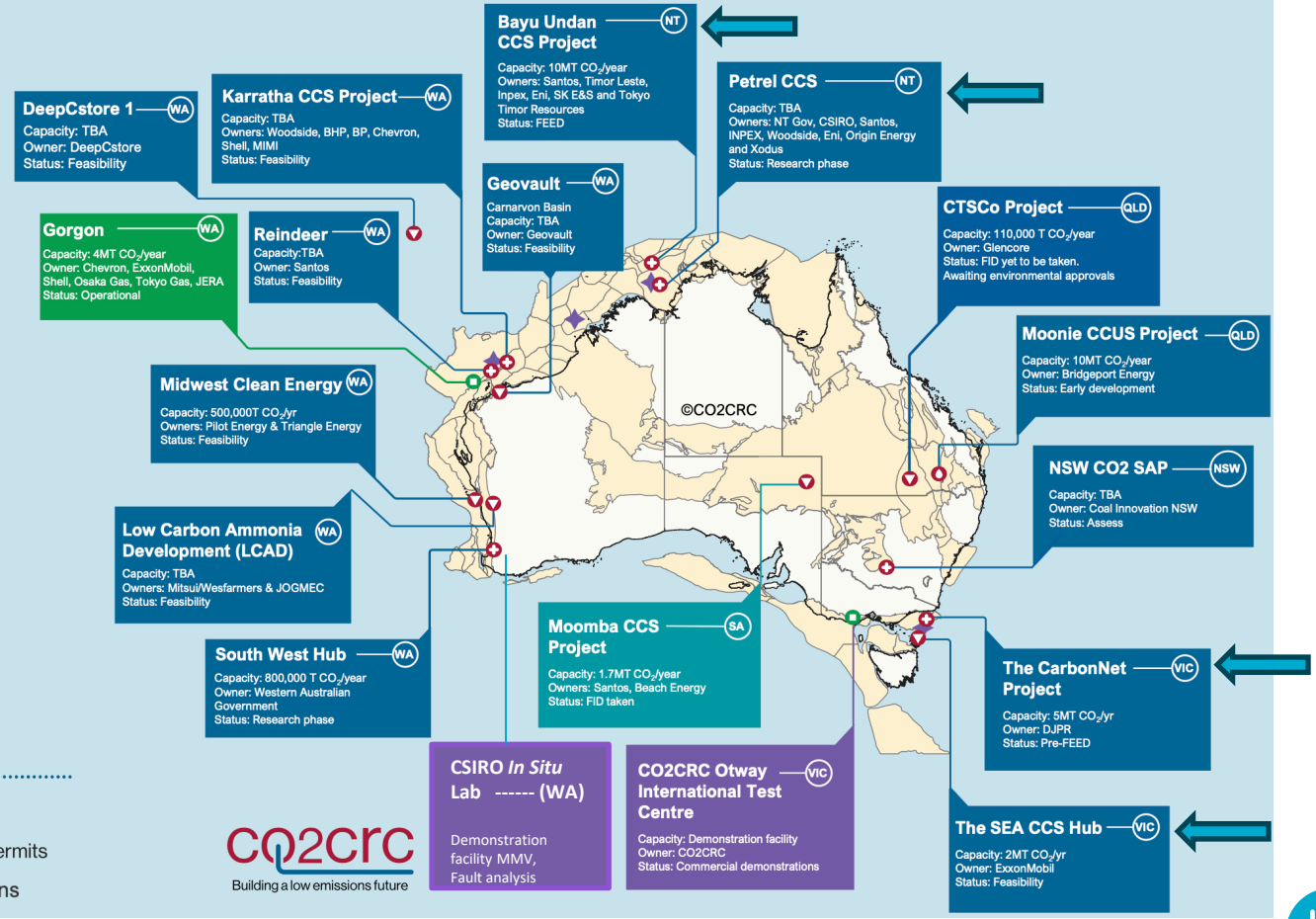
Why Carbon Capture and Storage?

- Proven, Permanent, Safe, Reliable, Immediate, Scale
  - Long term carbon emissions reduction
  - Associated climate benefits
  - Energy Price benefits
  - Energy security benefits.

- 25 years of CSIRO research on CO_2 capture, liquefaction, pumping and storage
  - Safe, Reliable, Permanent, Scale
  - Transparent, authenticated and certain carbon credits
  - Deep cuts in emissions because targeted at the biggest emitters.
  - MMV methods are mature and established.

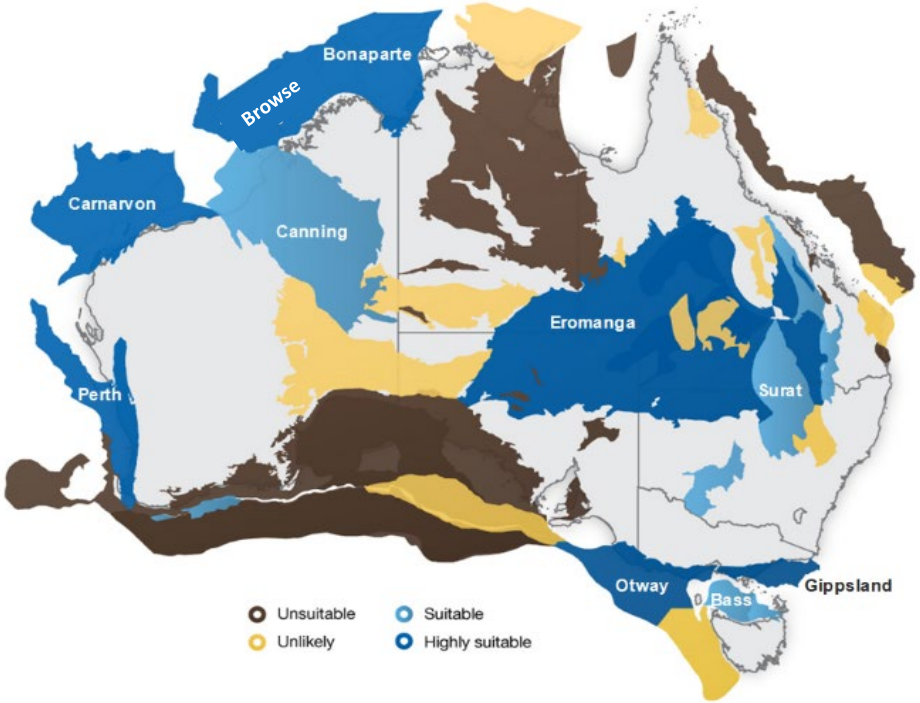
Carbon Capture and Storage in Australia

CCUS Projects in Australia 2023



Reference

CO_2 Storage Potential



Carbon Storage Task Force (2009)

Australian CO_2 Storage Potential is Significant

- Carbon Storage Taskforce (2009)
- Eastern Australia
  - Injection rate 200 Mt CO_2-e/year: 70 – 450 years
- Western Australia
  - Injection rate of 100 Mt CO_2-e/year: 260 1120 years
- GCCSI/CSIRO Australian Storage
  - 5 – 15 Gt CO_2 storage in depleted reservoirs
  - >200 Gt CO_2 storage in saline aquifers
- GCCSI/CSIRO Western Australia Storage
  - Bonaparte, Browse, Canning, N&S Carnarvon, Perth: >200 Gt CO_2 storage

Australian Government Policy Position on Carbon Capture and Storage

Australian Govt Policy Position: CCS

- Nationally Determined Contribution: -43% (2005) by 2030. Net Zero by 2050.
- Safeguard Mechanism (2023)
  - Applies to facilities emitting more than 100,000 tonnes of CO_2 per year.
  - Sets trajectory of emissions baseline to achieve the Australian NDC.
  - Facilities may purchase accredited ACCUs to reduce net emissions
- Safeguard Transformation Scheme
  - AUD$600m to assist trade-exposed sectors decarbonise
  - Critical Inputs to Clean Energy Industries Program: Cement, lime, alumina and aluminium.
- Commonwealth Government Sectoral Plans
  - Electricity and Energy, Industry, Built Environment, Agriculture and Land, Transport and Resources.
- Powering the Regions Fund
  - AUD$1.9bn for near term GHG emissions abatement.
- Carbon Capture Technologies Program: AUD$65m
- Carbon Capture Use and Storage Development Fund: AUD$50m

Australian Govt Initiatives: CCS

- Publicly stated position on Carbon Capture and Storage:

  "*Part of a portfolio of technologies to reduce emissions and to achieve net zero*"

- Focus of Government funds: 'Hard to abate' sectors
  - No Australian Government funds will be allocated to oil and gas companies to support CCS activities.

- Offshore Petroleum and Greenhouse Gas Storage Act (2006)
  - Awarded 5 offshore permits (2022)
  - Awarded 10 offshore permits (2023)
  - Projects must ensure fit-for-purpose environmental management for offshore storage activities

- Offshore Petroleum and Greenhouse Gas Storage Activities Review
  - AUD$12m/3 years (DISR, DCCEEW, NOPTA, NOPSEMA) review Offshore Greenhouse Gas Storage Activities

Australian Govt: Cross-Border Intl. Transfers of CO_2

- ‘Sea Dumping Bill’ (2023)
  - specifies a framework how Commonwealth will regulate international transfers of CO_2.
  - Government is committed to obligations under the ‘London Protocol’.
  - These obligations will be reflected in bilateral agreements on CO_2 transfers.

- International transfers of CO_2 for storage in Australian waters
  - To assist trading partners decarbonise
  - Develop solutions for permanent removal of atmospheric GHGs
  - “Supported by robust regulations”
  - Rigorous environmental impact assessments (MMV)

- The process from here…

Hydrogen and Carbon Capture and Storage Hubs

H_2 Fuels and CCS

Hydrogen: Current Status

- ~ 0.1% global energy mix (~ 95Mt H_2)
  - 96% H_2 production: Steam Methane Reforming (2021)
  - 4% H_2 production: Electrolysis
- Costs
  - SMR: USD$1.25 - $3.50 / kg H2 (USD$0.30 / kg H_2)
  - Ammonia: ~USD$1.45 / kg + re-cracking back to H_2 USD$1.45 / kg
- Global Aspiration
  - H_2 = 15% of global energy demand (2030)
  - ~ 700 Mt H_2 (7 x production today)
  - At current electrolyser costs = USD$8.75tr
  - At current SMR costs = USD$1.25tr
- Key risks to H_2 Market
  - Cost barrier/Technological barrier
  - Infrastructure/Workforce/Skills
  - Social Acceptance

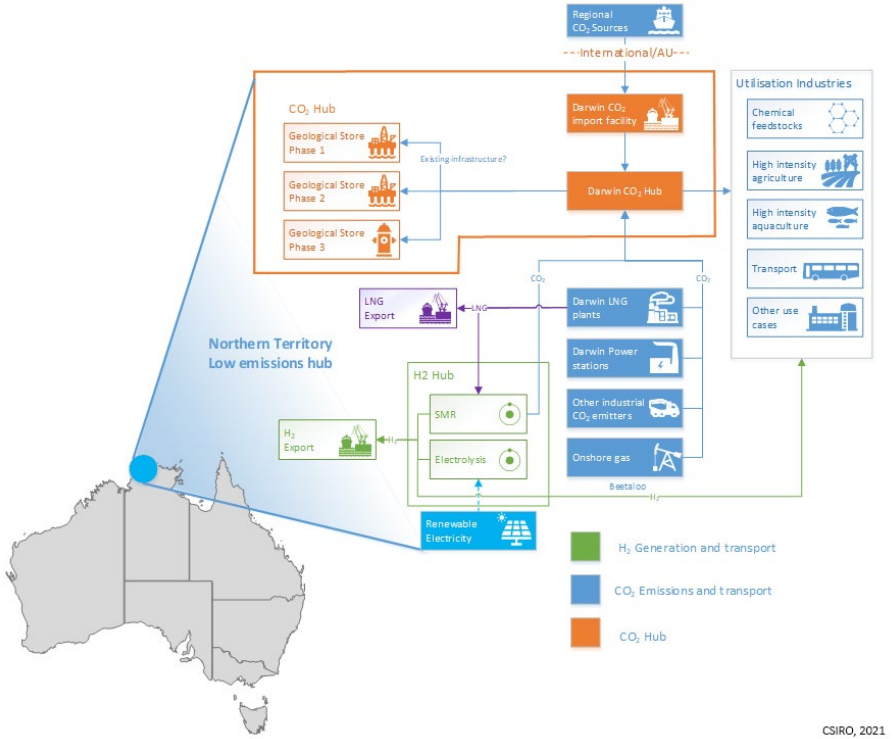
H_2 and CCS Hubs

ExxonMobil (2022)

Colocation: Natural Gas, CCS and H_2 Production

- Low Emissions Hub Concept
- ExxonMobil Baytown, Texas
  - Renewable Hydrogen: 3x cost of SMR H_2
  - Integrated refining and petrochemical plant with H_2 production from SMR and CO_2 capture.
  - 50% of H_2 produced: Used in refinery
  - 50% of H_2 produced: for sale as liquid H_2 (transform to NH_4?)
  - Reduced Scope 1 and 2 emissions by 30%
  - Facility is financially viable due to access to low cost feedstock
  - Existing infrastructure: Constraints on capital costs
  - Proximity of H_2 supply and H_2 use
  - Business model: Delivers sufficient internal rate of return: FID
- Role of CCS in H_2-production
  - Critical to overcoming cost and technological barriers
  - Pathway to large scale production: Infrastructure, skilled workforce, markets
  - A bridge to renewable hydrogen supply at scale

NT Low Emissions Hub



Ross, Gee, Ironside, Rogers (2023)

Concept and Business Case:

- Large gas reserves: Abundant feedstock
- Existing captured CO_2 & Significant storage (+15 Gt)
- Abundant renewable energy resources
- Proximity to international markets
- Reuse of existing infrastructure
- Economies of scale
- Cross sector coupling
  - Renewable electrification
  - Reuse of heat
  - H_2 industry development and transition of technologies
- Business Case:
  - Macro-economics, emissions and best practice
  - Local and international context and markets
  - CCUS hub technical definition and risk reduction
  - Power systems, CO_2 shipping, CO_2 utilisation
  - Economic model, business case and execution

NT Low Emissions Hub: H_2 Fuels and CCS

- Colocation of suppliers and users of H_2:
  - Cost reductions/risks sharing. Close proximity of generation and use.
- Access to critical transport infrastructure
  - Cost-effective export of H_2 derivatives and low emissions products.
- Economically viable renewable H_2 production
  - Ultra-low power generation costs, high capacity factors, short distribution networks.
  - High quality water supply.
- Economically viable SMR H_2 production
  - Lowest cost natural gas feedstock, reduced carbon capture costs, Labour/skills/technology development.
- Labour, skills and technology costs: Renewable H_2 costs >> SMR H_2 costs.
- Other factors:
  - Supply chain, geopolitics, skilled-workforce, Intellectual Property, service providers, sovereign barriers

- Costs are reduced under the Low Emissions Hub Concept: Planning & Coordination

H_2 Fuels and CCS

Australian Government Initiatives:

- National Hydrogen Strategy (2019)
  - Pathways to generation of clean H_2 and H_2 markets.
  - Strongly supported *renewable* Hydrogen Hub Concept
    - 10 Hydrogen Hubs in Australia
    - Large-scale demand for H_2 fuel
    - Cost effective infrastructure
    - Promote economies of scale and efficiencies
    - Foster innovation
- State of Hydrogen Report (2022)
  - Australia: AUD$127 bn hydrogen and ammonia projects
  - Government support for all projects (2022): AUD$5 bn in value
  - Government support for Hydrogen Hubs AUD$1.02bn
- Review of National Hydrogen Strategy (2023)
  - Hydrogen Head-Start Program: AUD$2 bn
  - Guarantee of Origin
  - >50MW of electrolyser
  - Located in Australia
  - Identify the Commercial Case for produced hydrogen or ammonia.

https://research.csiro.au/hyresource/

CO_2 injection at CSIRO's In Situ Laboratory, Harvey Western Australia

Thank you

RITE CCS Technical Workshop

Dr Damian Barrett | January 2024