



# Hydrogen and future fuels

## Recent progress, current status and emerging requirements

David Norman, CEO

APGA Convention - October 2023

# About Future Fuels Cooperative Research Centre

Long term, industry-led collaboration between 100 industry, all State governments and six academic organisations, co-funded by the National Government



Australian Government  
Department of Industry,  
Science and Resources

AusIndustry  
Cooperative Research  
Centres Program



Resources Safety & Health  
Queensland



# Industry led, outcomes focused research

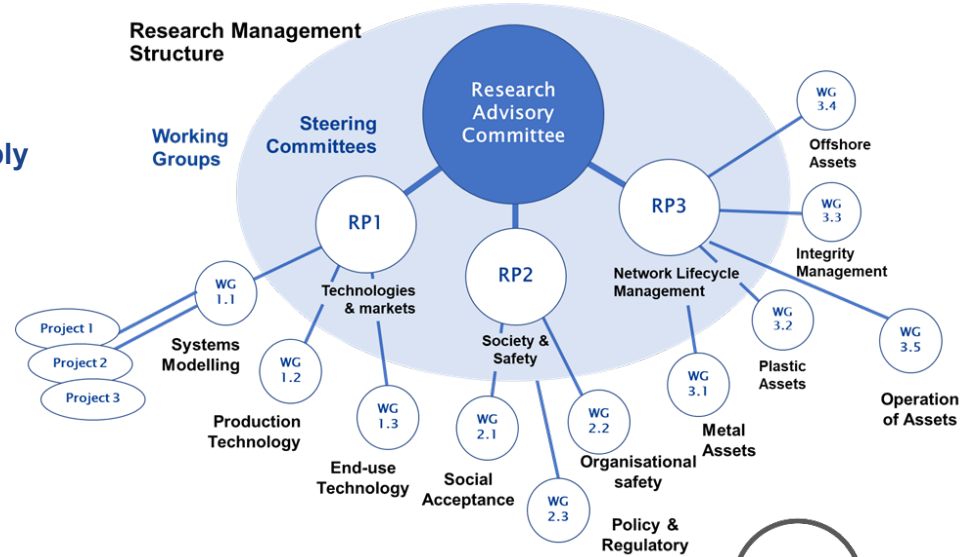
Trusted voice of evidenced-based knowledge

Over 110 projects and 45 PhD scholarships

covering:

- **Future Fuel Technologies, Systems and Markets**
- **Social Acceptance, Public Safety, Security of Supply and Policy & Regulatory Changes**
- **Network Lifecycle Management**

- 10** Focused Working Groups
- 10** Detailed Research Roadmaps
- 210** Industry Specialists
- 150** Researchers



# Steels: research and tensile testing in hydrogen

- Hydrogen embrittlement
- Tensile strain
- Fracture initiation and propagation
- Hydrogen Pipeline Code of Practice
- APA Parmelia Gas Pipeline – Technical Study



Image: SafeTi Lab at the University of Wollongong

# Plastics research at Deakin

Long-term sandpit and lab testing





# System Optimization – East Coast Australia

## Case study: Findings (2037)

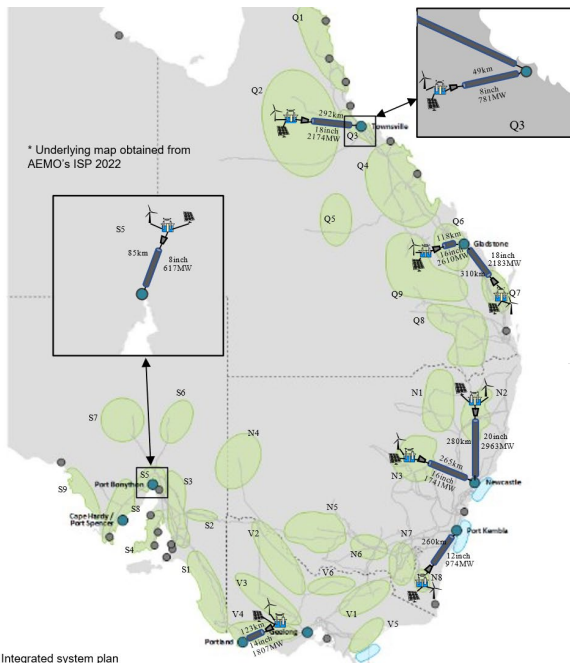
### Setup:

- Export of **3.525 Mt** of  $H_2$  per year from all NEM states (**15.851 GW** average) by 2037.

### Results:

- Pipelines:
  - NPV = **1.999B \$AUD**
- HVAC:
  - NPV = **0.0B \$AUD**
- HVDC:
  - NPV = **0.0B \$AUD**

REZ: Renewable energy zones. NEM: National electricity market. AEMO: Australian Energy Market Operator. ISP: Integrated system plan



Designing a *cost-effective* transport infrastructure needs to address:

- Transport electricity **and/or** molecules?
- Should electrolyzers and VRE hubs be **co-located**?
- What *drivers* and *conditions* affect investment decisions?
- How do multiple networked infrastructures interact?

## Case study: REZ and green $H_2$

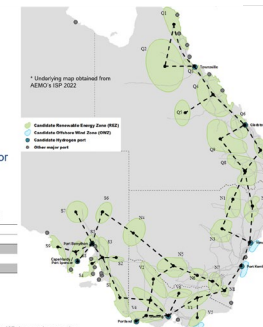
Uses  $H_2$  superpower scenario AEMO's ISP 2022:

- Connects candidate REZ through provisional corridors to candidate  $H_2$  export ports.
- Uses VRE traces and hydrogen export demands for years (epochs) 2027, 2032, and 2037.

Table 1. Hydrogen export demand across the three considered epochs

Unit	Epoch		
	2027	2032	2037
Mt/year	300	1,100	3,300
mTP	75	400	1,320
MM	300	4,400	10,000

\* An entry of 148,850 Mt/yr and a density of 0.0903 kg/m<sup>3</sup> are used for hydrogen.



VRE: Variable renewable energy. REZ: Renewable energy zones. AEMO: Australian Energy Market Operator. ISP: Integrated system plan

# Whole of Energy System Modelling

How to make net zero happen  
Mobilisation report  
Public launch | 12 July 2023

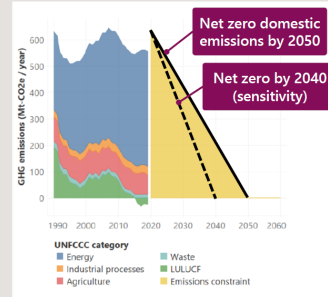
**NET ZERO AUSTRALIA**



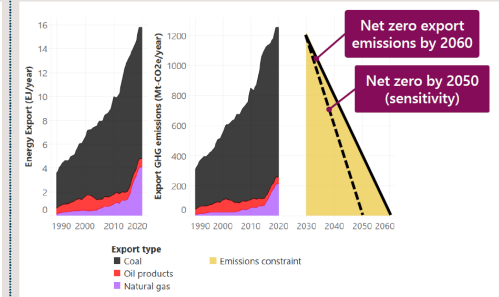
Logos for the University of Queensland, The University of Technology Sydney, and Princeson University are visible at the bottom left, along with the 'nous' logo at the bottom right.

## We model linear reductions to net zero

Domestic emissions

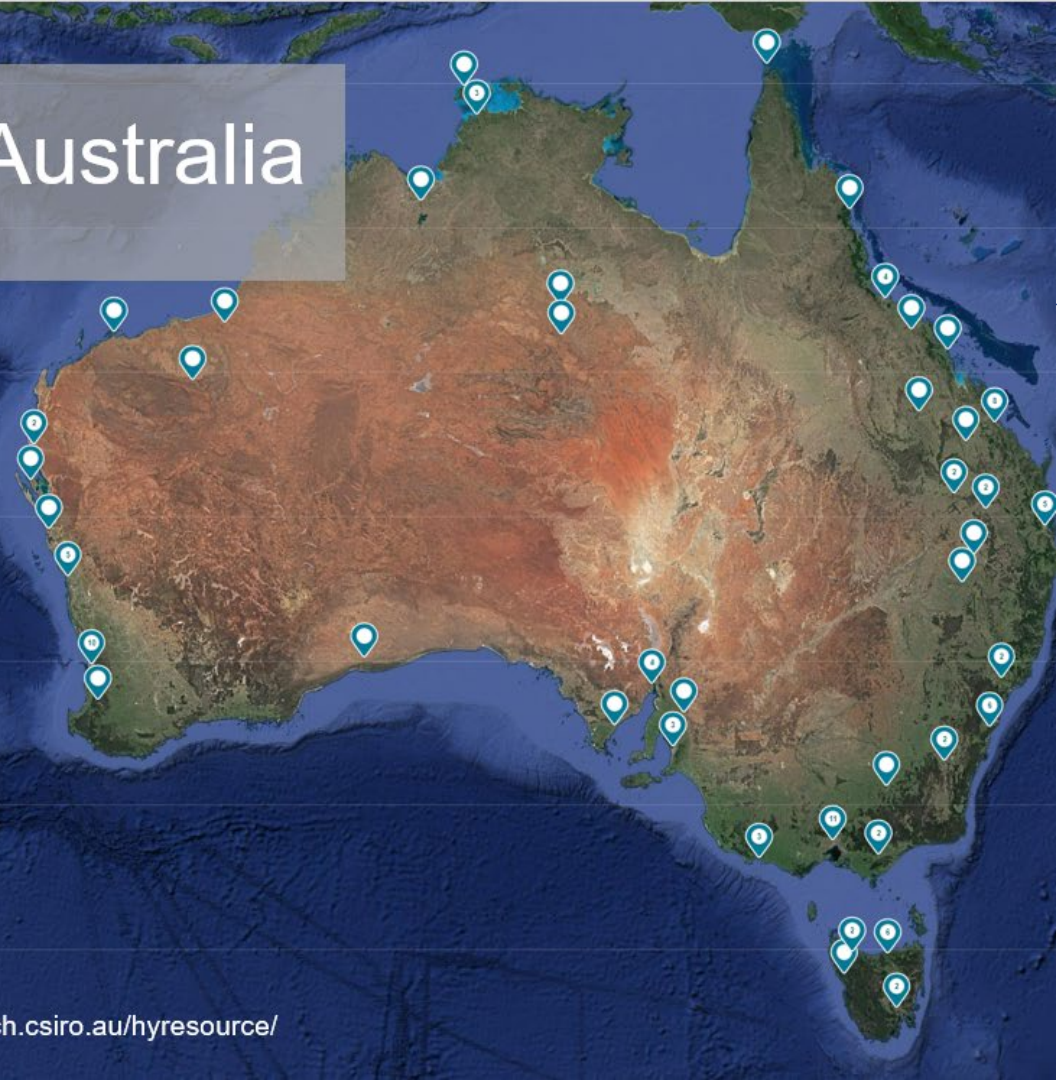


Fossil fuel energy export emissions



# Hydrogen projects in Australia

107 projects already active



Source: [HyResource](https://research.csiro.au/hyresource/)

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



# Current Project examples

**Delivering the Vision | Hydrogen Park South Australia**



Launched 19 May 2021 by the South Australian Premier

An Australian-first supplying networks and industry

Targeting expanded blending and refuelling

- An Australian-first project of type and scale
- Australia's largest electrolyser - 1.25MW
- A 5% renewable H<sub>2</sub> blend to >700 homes via the existing network
- Pure hydrogen supplied to industry via tube trailers
- Potential for refuelling
- Building new industry and jobs for Australians

A \$14.5m project enabled by a \$4.9m grant from the SA Government Renewable Technology Fund

Australian Gas Infrastructure Group

**The Yurt Renewable Hydrogen Facility**



Located in Karemulla, Western Australia, it will include a 10 MW electrolyser powered by 16 MW of solar PV and supported by an 8 MWh battery energy storage system, generating renewable hydrogen for use in Yara Australia's ammonia facility.

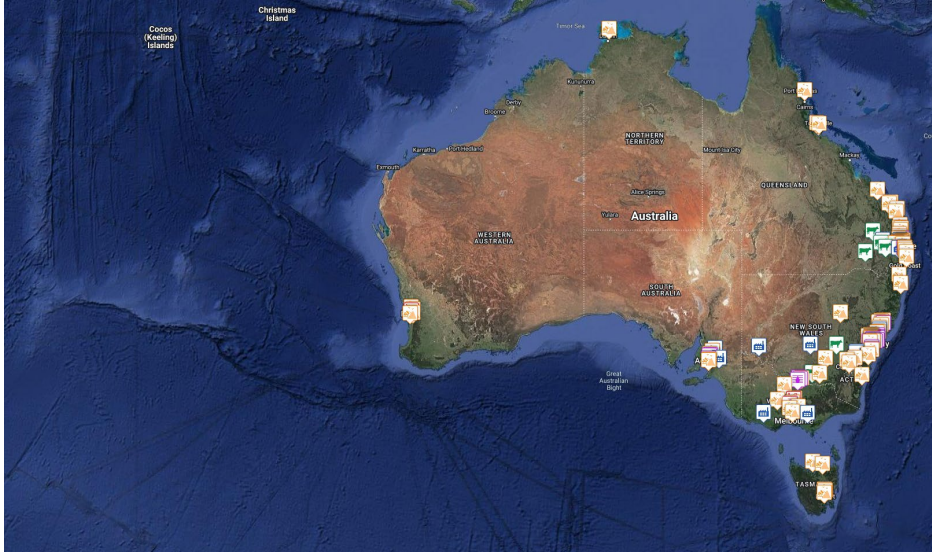
**Key**

- 10 MW electrolyser
- 16 MW solar plant
- 8 MWh battery storage



# Biogas / Biomethane

Over 240 biogas plants active - 1 exporting to the gas grid



Natural Gas Substitution and challenge to meet increasing net-zero timelines  
Biomethane potential and EU 2030 targets – RePowerEU to 35BCM, by 2030

Source USQ/Bioenergy Australia

# International Situation - UK Progress

## FutureGrid

A high-pressure hydrogen test facility built from decommissioned assets to demonstrate the National Transmission System (NTS) can transport hydrogen. Testing will commence in April 2023, with 2%, 5%, 20% and 100% concentrations of hydrogen being tested to demonstrate how a future hydrogen system will operate.

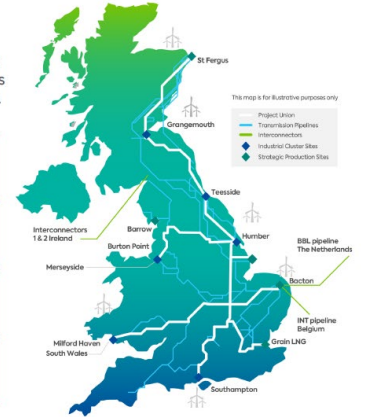


## Project Union

Project Union will connect, enable net zero and empower a UK hydrogen economy, repurposing existing transmission pipelines to create a hydrogen 'backbone' for the UK by the early 2030s.

- ✓ Repurpose ~2,000 km of the NTS through a phased approach in line with Government's cluster prioritisation and green hydrogen development
- ✓ Connect cross GB supply, demand and strategic storage sites, enabling growth of a UK hydrogen economy
- ✓ Use existing infrastructure to deliver a low carbon future, reducing environmental impact of new construction
- ✓ Enable early and affordable market growth of a low carbon hydrogen economy to achieve net zero

National Gas Transmission |  
HyNTS Compression | Beta Phase Interview Presentation

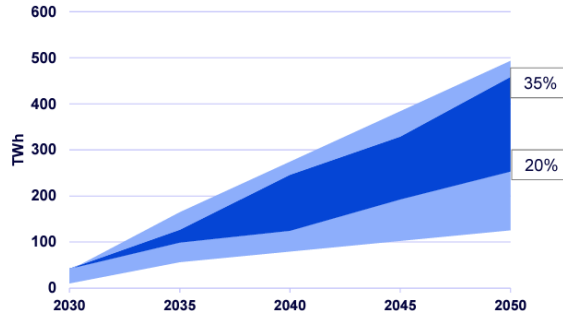


# UK: Hydrogen Net Zero Investment Roadmap

## Hydrogen will play a crucial role in future of the UK's energy system

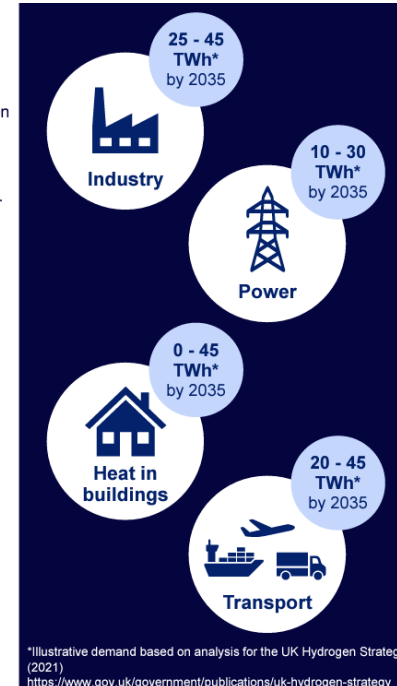
- Our ambition for up to 10GW of low carbon hydrogen production capacity by 2030 will help to create a thriving hydrogen economy in the UK, supporting the deep decarbonisation of key UK sectors, particularly in 'hard to electrify' industries, and can provide greener, flexible energy across power, heat, transport, and potentially heat in buildings.
- Our drive for renewables makes hydrogen especially valuable for energy security and independence by providing flexibility and energy storage: excess renewable electricity can be used to produce hydrogen, which can be stored over time and used to generate electricity when there is less sun or wind to power the grid.
- Analysis for the UK Hydrogen Strategy shows that low carbon hydrogen could play a key role in UK energy system potentially becoming comparable in scale to existing electricity use by 2050.

Hydrogen demand could be 20-35% of UK final energy consumption by 2050



% = hydrogen as proportion of total energy consumption in 2050.

Source: Central range – illustrative net zero consistent scenarios in CB6 Impact Assessment. Full range – based on whole range from UK Hydrogen Strategy Analytical Annex. Final energy consumption from ECUK (2019).



\*Illustrative demand based on analysis for the UK Hydrogen Strategy (2021)  
<https://www.gov.uk/government/publications/uk-hydrogen-strategy>



# European Hydrogen Backbone grows



- 2023 announcements:
- Norway to Germany
  - Denmark to Germany
  - Spain to France
  - Italy-Austria-Germany

# EU Support for Hydrogen

- Clean H2 Partnerships 2021 – 9 Hydrogen Valleys
- EU Green Deal – Fit for 55 and RePowerEU –
  - 20MT Hydrogen by 2030, Half by imports – H2 Global
- European Hydrogen Bank
  - announced in 2022 (Euro 3Bln)
- Addressing the Chicken And Egg Dilemma
  - Transport Example in Europe

## EU nations agree to install hydrogen fuelling stations in all major cities and every 200km along core routes

New regulation for the deployment of alternative fuels infrastructure (AFIR) agreed by Council of ministers and European Parliament late last night

28 March 2023 8:51 GMT *UPDATED 28 March 2023 10:12 GMT*

By **Leigh Collins**

EU states have agreed to build hydrogen fuelling stations in all major cities and at least every 200km along the core Trans-European Transport Network (TEN-T) after the Council of ministers and the European Parliament reached political agreement on the new Regulation for the deployment of alternative fuels infrastructure (AFIR) late last night.

# US: Inflation Reduction Act

A hydrogen game changer

- **\$393 billion (USD) in new spending and tax breaks to boost clean energy**
- **Tax incentive of up to \$3 per kg of clean hydrogen**
- **'Bipartisan Infrastructure Law' provides \$22bn of funding for hydrogen development**
- **Just announced –**
- **7 winning Hydrogen Hubs, for \$7Bln**



***Biden Administration Awards \$7 Billion for 7 Hydrogen Hubs Across the U.S.***

Clean hydrogen could help fight climate change, but it barely exists today. Now the administration wants to build an entire industry from scratch.

# Green steel is real

Hydrogen reduced steel from [Hybrit](#) in Sweden

Source [Hybrit](#)



# Net Zero Transport

- Fuels Switch from Petroleum to Battery Electric or alternatives
- Hydrogen role for HD Trucking
- Aviation - SAF (Sustainable Aviation Fuel)
- Marine - Ammonia and Methanol



# Hydrogen - Power System Firming

Dealing with growing volume, intermittency of supply and peakiness of demand

Complimentary roles:

- Batteries
- Demand Mgt
- Hydrogen
- Nat gas
- Pumped Hydro

## 2. WHAT WOULD IT TAKE TO ACHIEVE NET ZERO

Establish a large fleet of batteries, pumped hydro, and gas-fired firming capacity with low and declining gas use

2



Gas power – installed capacity (GW), and fuel input (Petajoules / year)

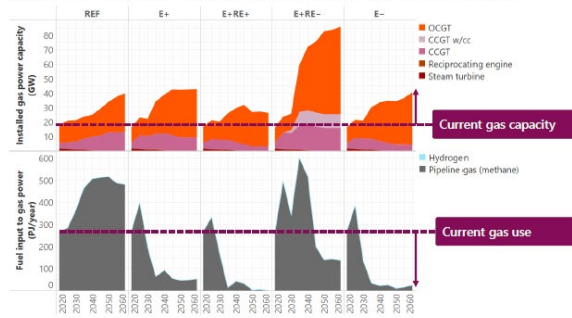


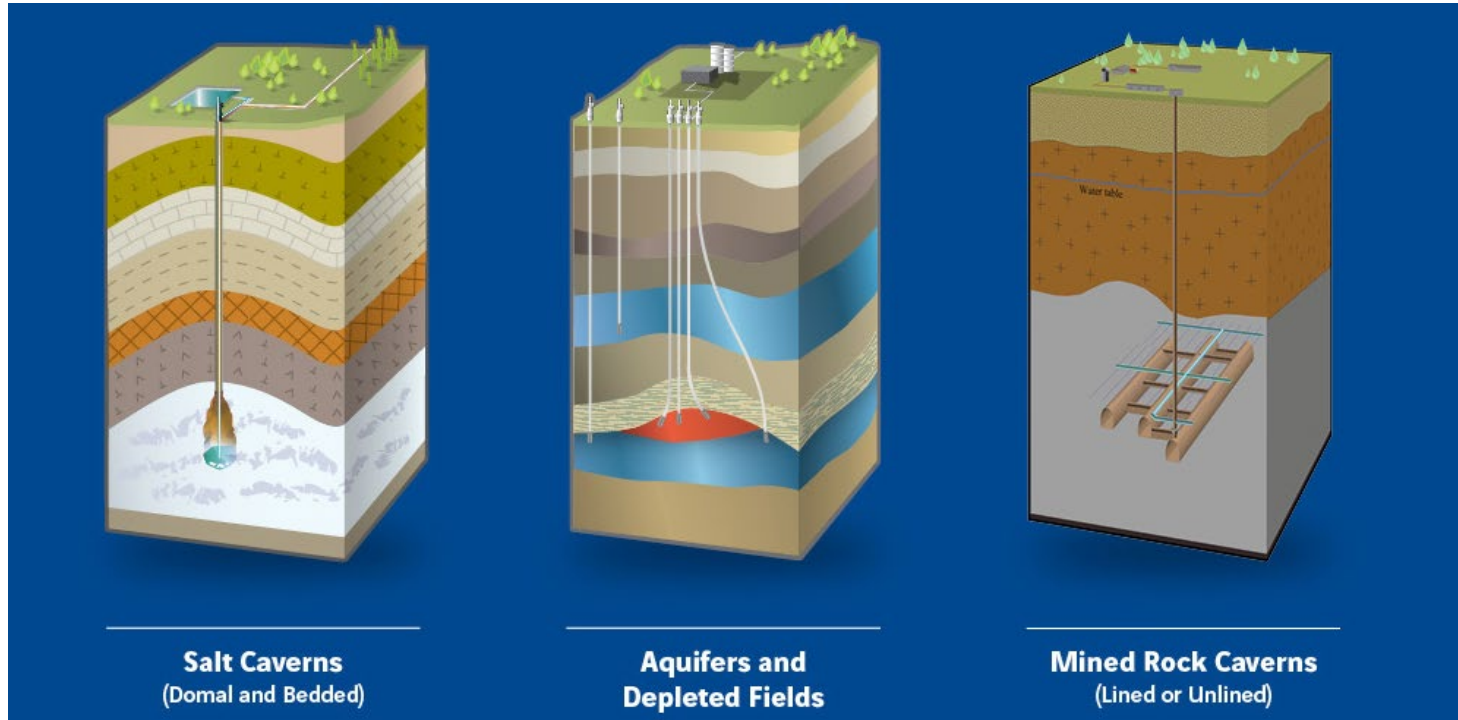
CHART 2 OF 2

A large build of **new gas turbines** would provide a **strategic reserve** in support of renewables and storage.

The expanded gas fleet would be used **sparingly** in the near term, and **rarely** in the long term (remaining emissions are offset by direct air capture with CCS).

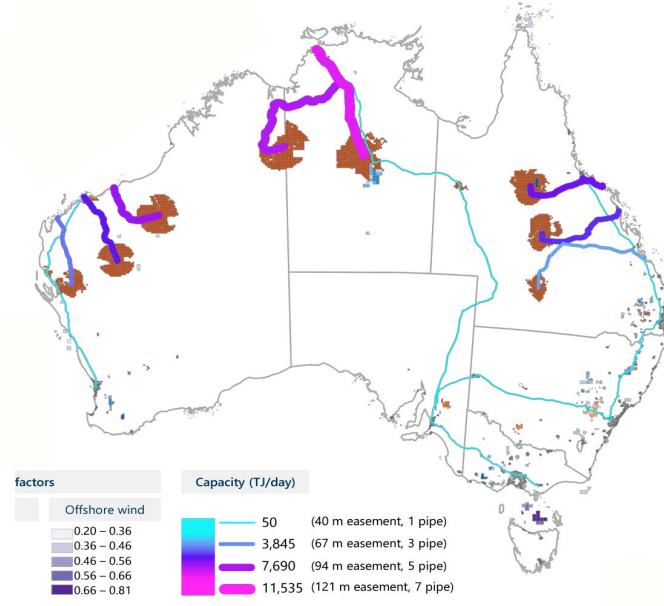
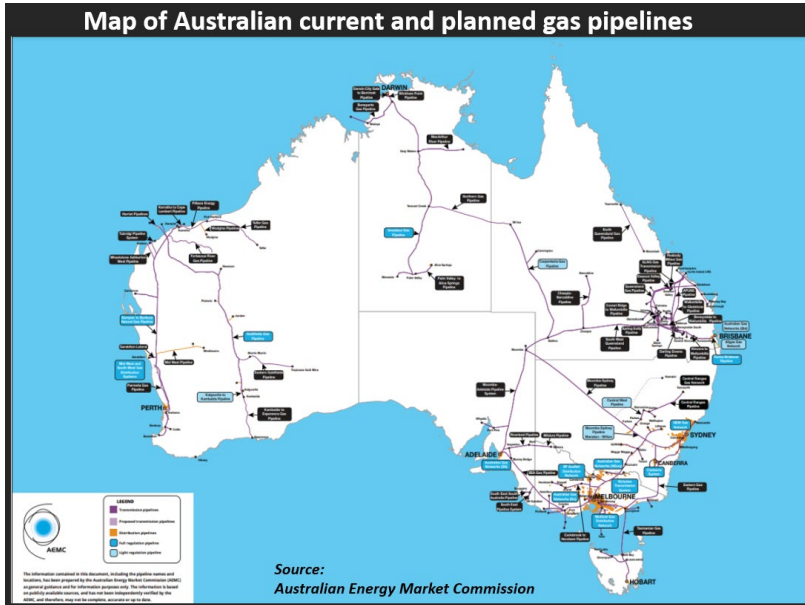
The one exception is when the renewable build is constrained (E+RE-), in which **combined cycle gas turbines with CCS** provide significant power.

# Underground Hydrogen Storage



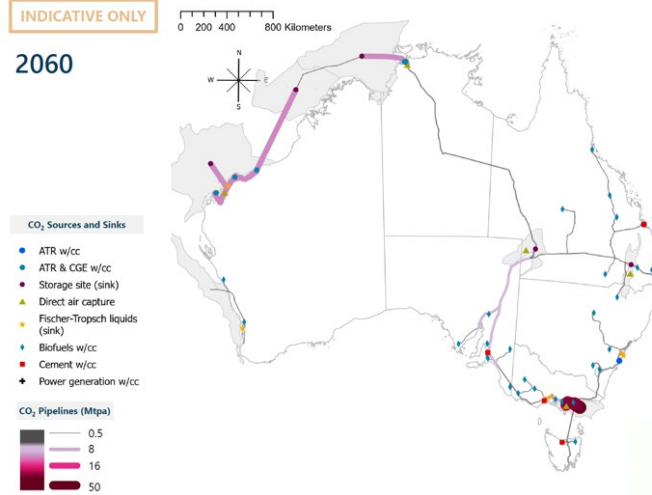
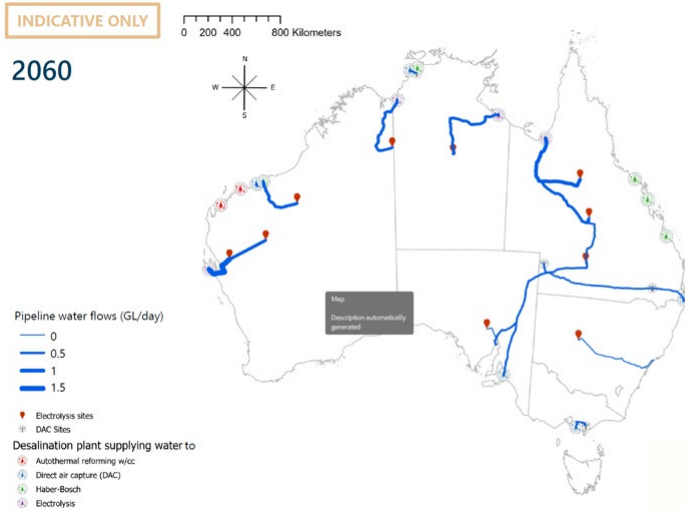
Source: Geostock-Sandia

# Infrastructure: Today and adding Net-Zero





# Water and CO2 Pipelines



# Energy Transition Infrastructure

The new CRC bid for 2025

**Energy infrastructure delivery:** Developing new critical technologies and materials to reduce costs and increase security

**People and processes:** Engaging with communities on the benefits and impacts of the transition

**Enhanced planning and modelling:** Improve planning, modelling, permitting and regulatory approval processes



# Enabling the decarbonisation of Australia's energy networks



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