

Negative Emissions Agenda

ANU Climate Update 2023

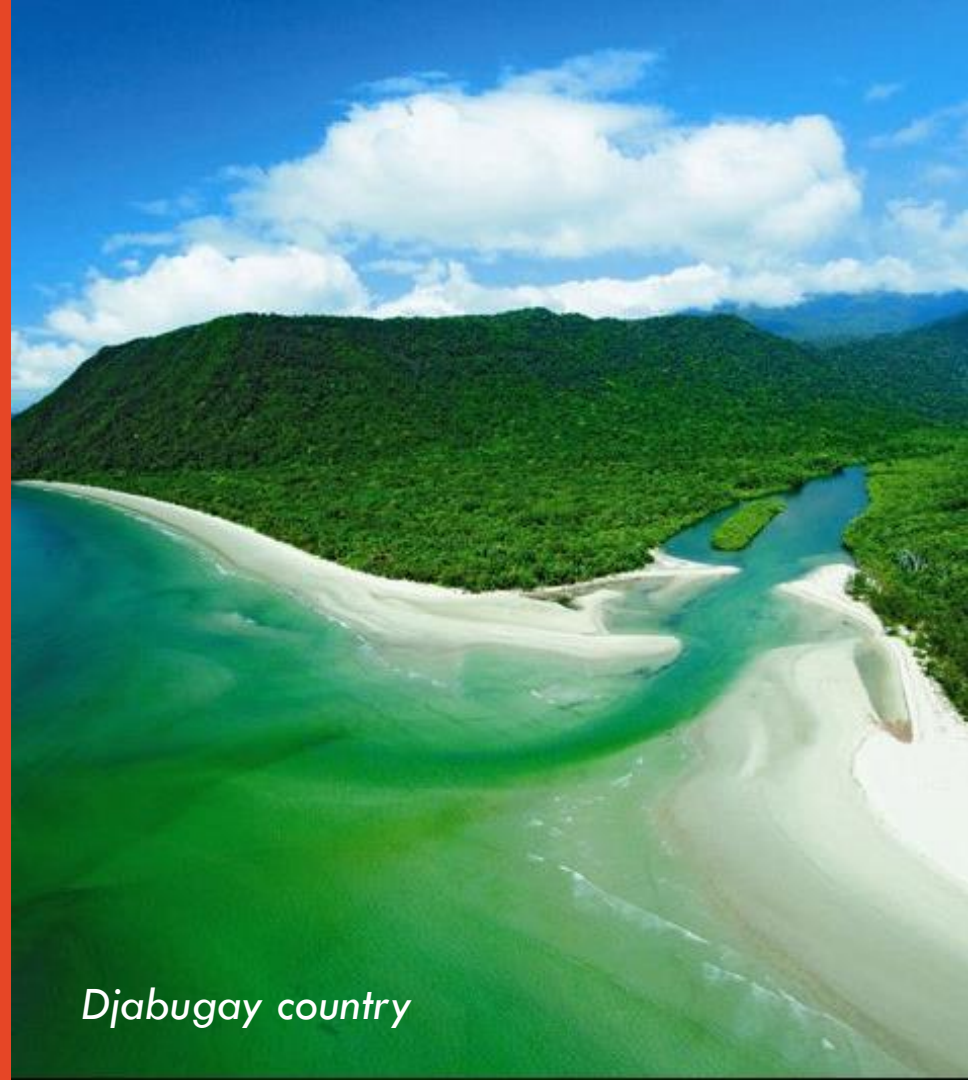
6th February 2023

Prof. Deanna D'Alessandro
Director, Net Zero Initiative
Faculty of Engineering

With special thanks to Mr Brett Cooper,
Southern Green Gas



THE UNIVERSITY OF
SYDNEY



Djabugay country

Net Zero to Negative Emissions

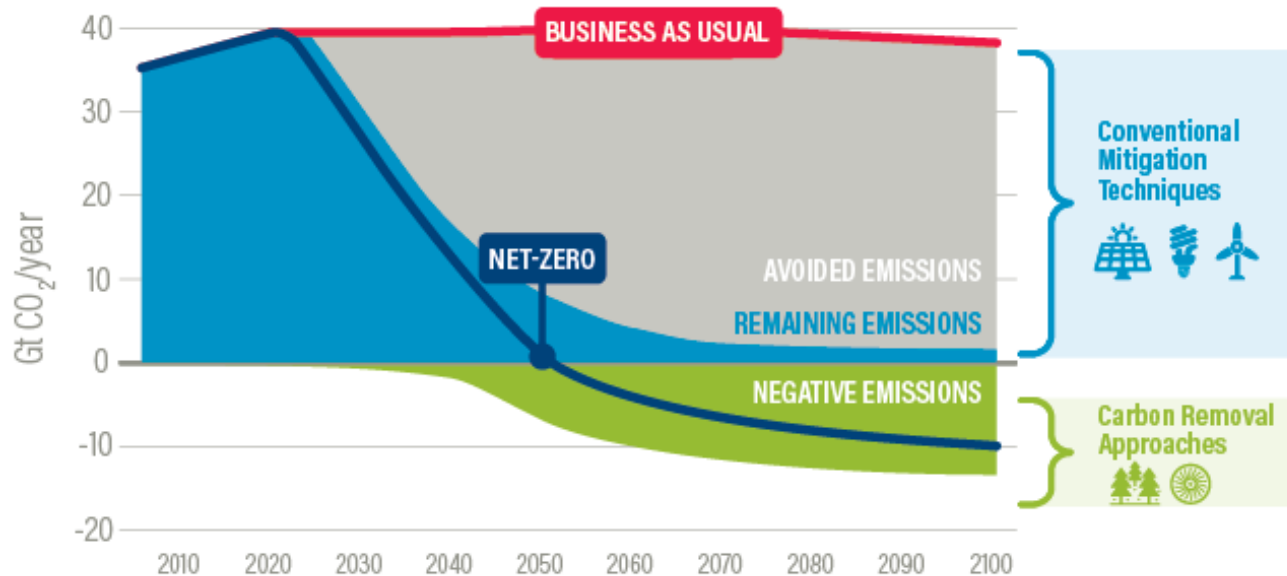
All pathways that limit global warming to 1.5-2 °C must involve Negative Emissions to address historical emissions of greenhouse gases.



<https://www.ipcc.ch/>

Negative Emissions are “essential”

Staying Below 1.5 Degrees of Global Warming



“Climate Intervention: Negative Emissions Technologies and Reliable Sequestration,” 2018, National Academies of Sciences, Engineering, and Medicine, <http://www.nationalacademies.org/>

Portfolio of solutions

BIOCHEMICAL APPROACHES
e.g. Bioenergy with Carbon
Capture & Storage (BECCS)



GEOCHEMICAL APPROACHES
e.g. enhanced mineral
weathering



NEGATIVE EMISSIONS

TERRESTRIAL
SOLUTIONS
e.g. soil carbon
sequestration, biochar,
afforestation,
reforestation, improved
agricultural practices



CHEMICAL APPROACHES
e.g. Direct Air Capture
and storage (deep saline
aquifers, basalts)



OCEAN-BASED
SOLUTIONS
e.g. restoring blue carbon
in coastal ecosystems,
seaweed cultivation, ocean
alkalinity enhancement



Technology Readiness?



Sixth Assessment Report, April 4th 2022

<https://www.ipcc.ch/>

NATURAL

Forestry/Agricultural/Ocean

- Less costly
- Closer to deployment
- More vulnerable to reversal

TECHNOLOGICAL

Energy/Industry

- More costly ←
- Greater R&D needs ←
- Longer duration and permanent ←

Challenges



Sixth Assessment Report, April 4th 2022

<https://www.ipcc.ch/>

NATURAL

- Effects on biodiversity, food security and use of land/water
- Changing Earth's reflectivity
- Verify measurements

TECHNOLOGICAL

- Competition with land or use of renewable energy to decarbonise other activities
- High cost
- Some concepts relatively untested (e.g. Ocean Alkalinity Enhancement)

Strong International Momentum & Demand

Direct Air Capture (DAC)

Examples



Climeworks' "Orca", Iceland
4000 tonnes CO₂ p.a.

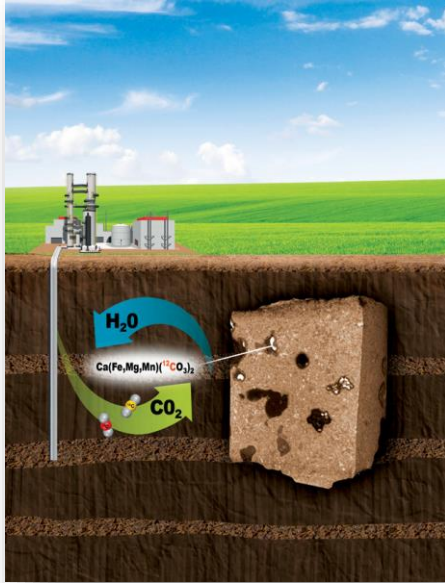
<https://climeworks.com/co2-removal>



Biden administration DAC Hubs (US)
\$3.5 billion investment with
bipartisan support

◆◆ **Frontier**
Advance Market Commitment
(US\$1 billion)

Long Duration Carbon Removals: Mineral Carbonation



CO₂ to stone

<https://www.carbfix.com/>



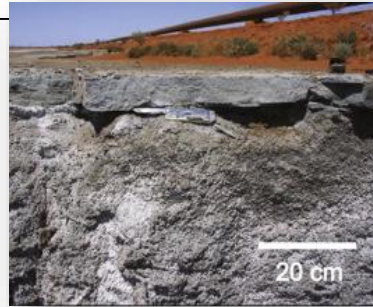
International Journal of Greenhouse Gas Control

Volume 25, June 2014, Pages 121–140



Offsetting of CO₂ emissions by air capture in mine tailings at the Mount Keith Nickel Mine, Western Australia: Rates, controls and prospects for carbon neutral mining

Siobhan A. Wilson^{a, b}, Anna L. Harrison^b, Gregory M. Dipple^b, Ian M. Power^b,
Shaun L.L. Barker^c, K. Ulrich Mayer^b, Stewart J. Fallon^d, Mati Raudsepp^b, Gordon Southam^e



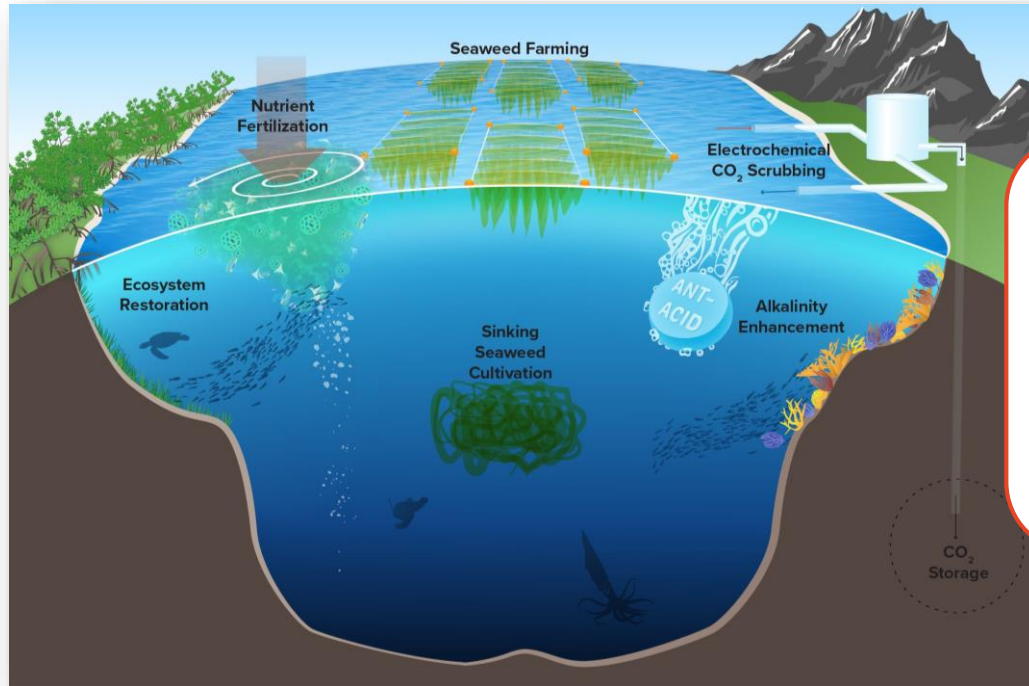
Challenges

Injectivity rates

Yet to unlock potential

MRV (measurement, reporting, verification)

Long Duration Carbon Removals: Ocean Storage



Challenges

Rate of carbon removal
Potential risks to ecosystems
Longevity

National Academies of Sciences, Engineering, and Medicine. 2022. *A Research Strategy for Ocean-based Carbon Dioxide Removal and Sequestration*. Washington, DC: The National Academies Press.

<https://doi.org/10.17226/26278>

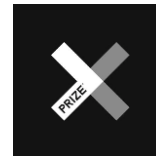
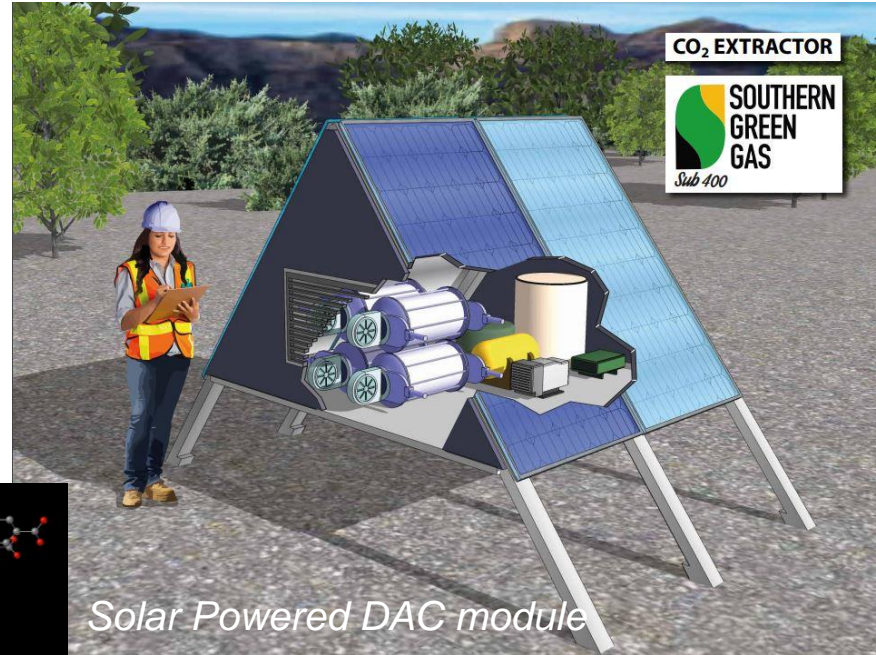
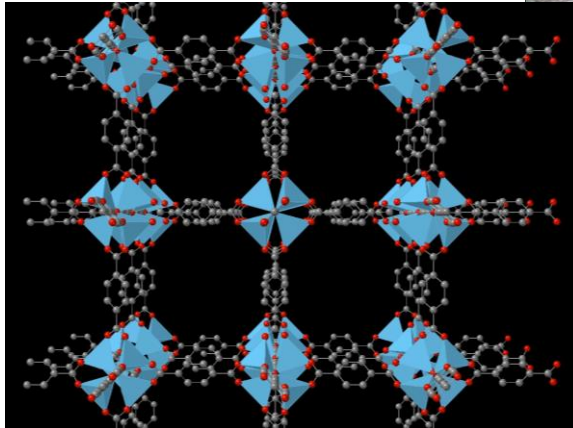
Negative Emissions: A New Industry for Australia

- Essential to enable us to reach Net Zero
- New regional manufacturing sector
- Transitioning and creating jobs in regional and rural Australia
- Co-benefits for local communities
- New billion dollar export industry



Case Study: Direct Air Capture (DAC) in Australia

Scientific & technical challenges of DAC met using 3D printed Metal-Organic Framework adsorbents



Musk Foundation XPRIZE in
Carbon Removals
Student Team Award

Direct Air Capture is a Platform Technology for Sustainable Carbon Hubs across Regional Australia

