The role of CCUS towards net-zero in Australia

IEA Joint EOR/GOT Symposium - Stavanger, Norway

Dominic Pepicelli | 24th November 2022

energymining.sa.gov.au

SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

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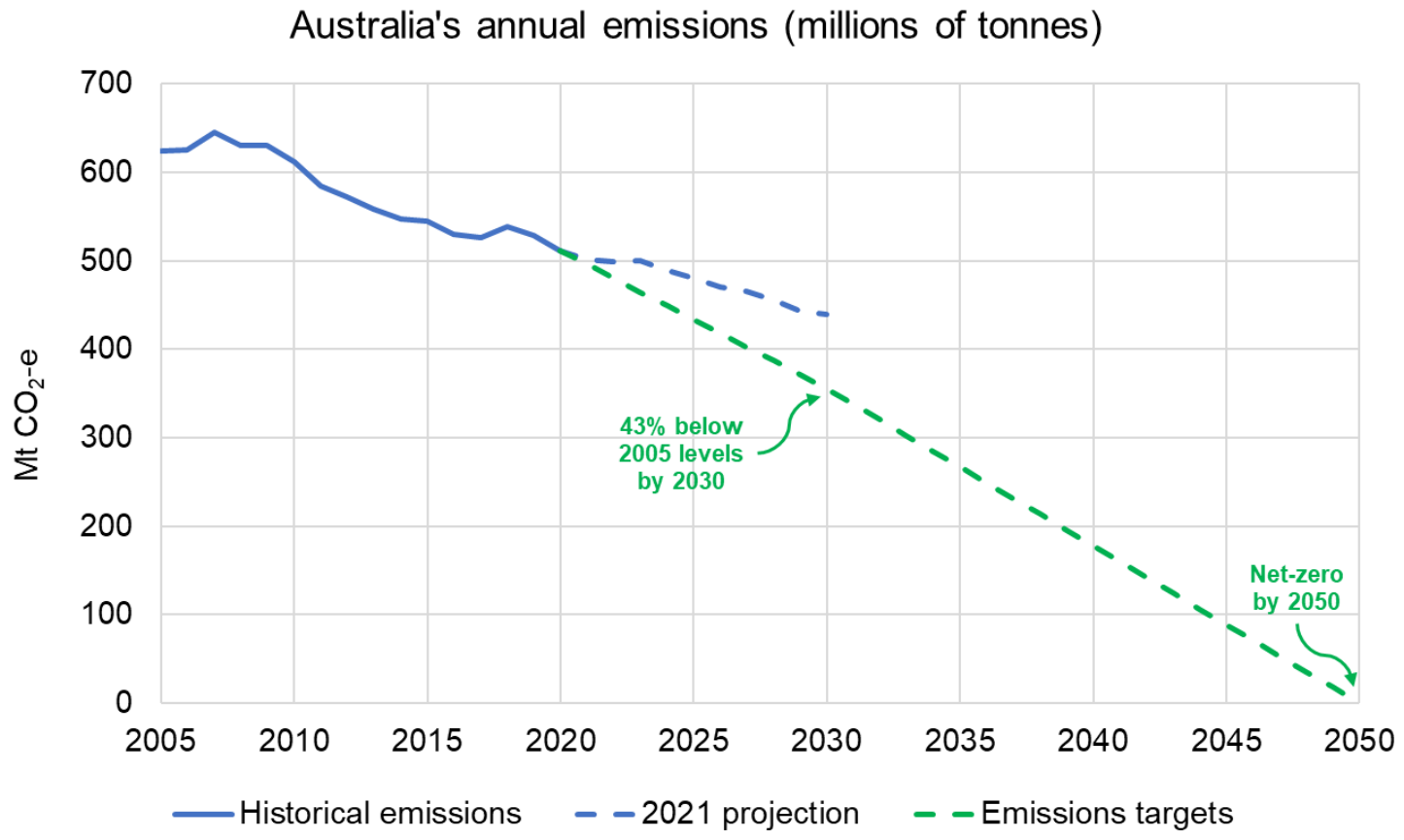
Australian Emissions Targets

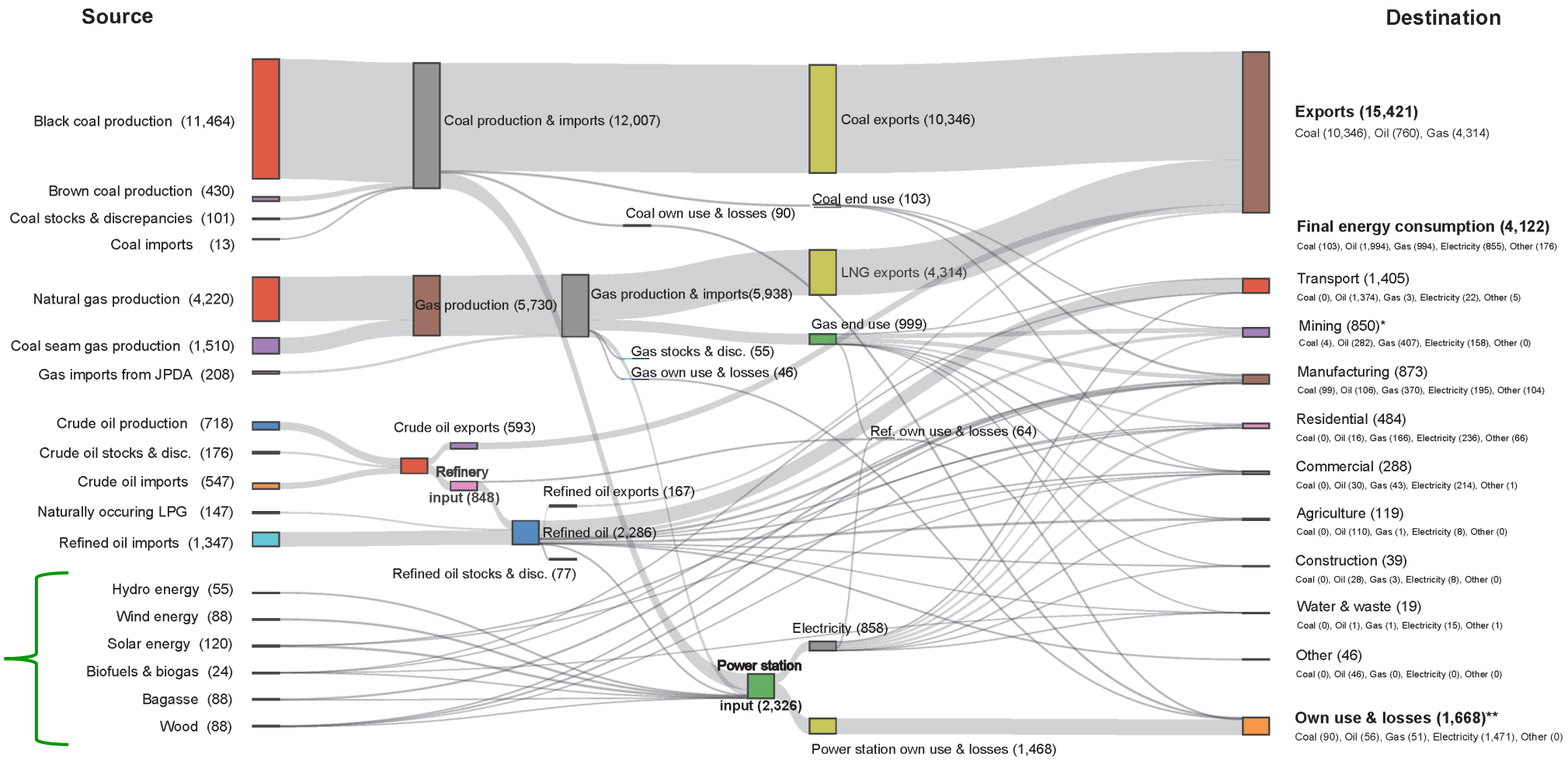
- On 8 September 2022 the Australian Government legislated emissions reduction targets:
  - 43% below 2005 levels by 2030
  - Net-zero by 2050

- Projections show steady decline, but need more rapid reduction in emissions to meet 2°C scenarios.



Data sourced from Australia's emissions projections 2021 (DISER, 2021)

Australian Energy Flows 2020-21 (Petajoules)



2.4% of energy production

8% of energy consumption

Primary energy production	+	Imports	−	Exports	−	Stocks change & discrepancies	=	Primary energy supply	−	Own use & losses	=	Final energy consumption
18,952 PJ		2,114 PJ		15,421 PJ		- 145 PJ		5,790 PJ		1,668 PJ		4,122 PJ

NOTES: Numbers may not add due to rounding. JPDA = Joint Petroleum Development Area. * includes LNG plant own use of gas. ** Conversion plants own fuel use & losses, and transmission losses.

SOURCE: Australian Energy Statistics 2022, Table A, Table F, and Table Q

Global Energy Supply

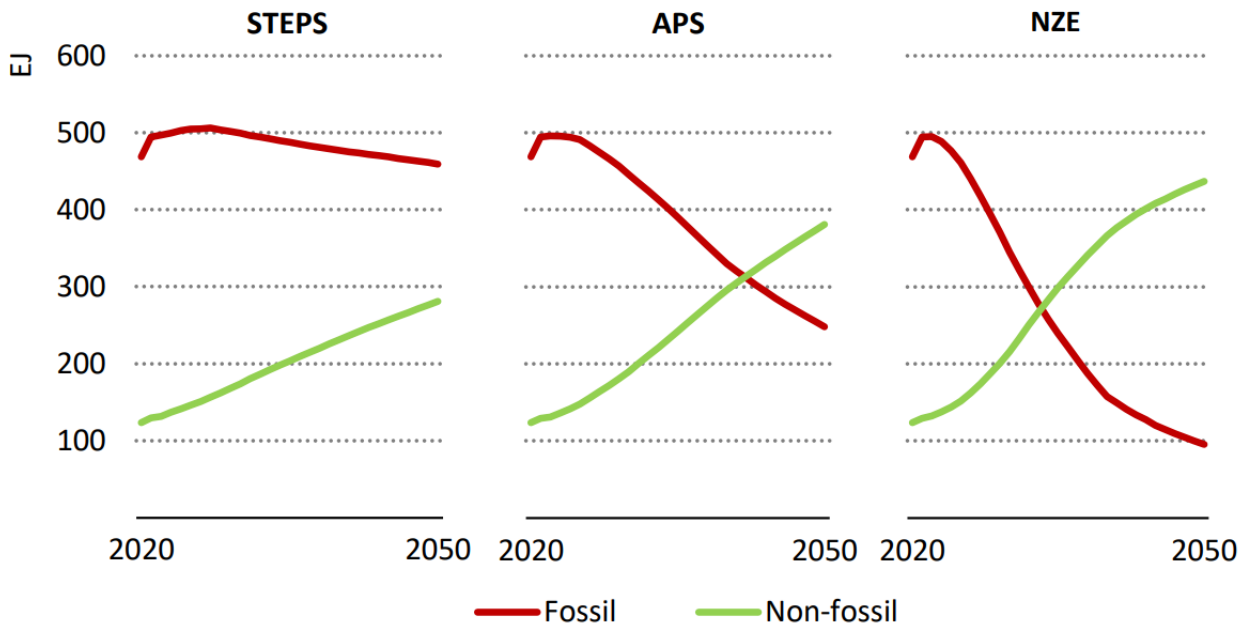
- Fossil fuels projected to remain a significant part of energy supply to 2050.

Stated Policies Scenario (STEPS) – today's policy setting trajectory.

Announced Pledges Scenario (APS) – assumes that all aspirational targets announced by governments are met on time and in full, including their long-term net zero and energy access goals.

Net Zero Emissions by 2050 (NZE) – International Energy Agency 2021 Scenario

Figure 1.17 ▷ **Fossil and non-fossil energy supply by scenario, 2020-2050**

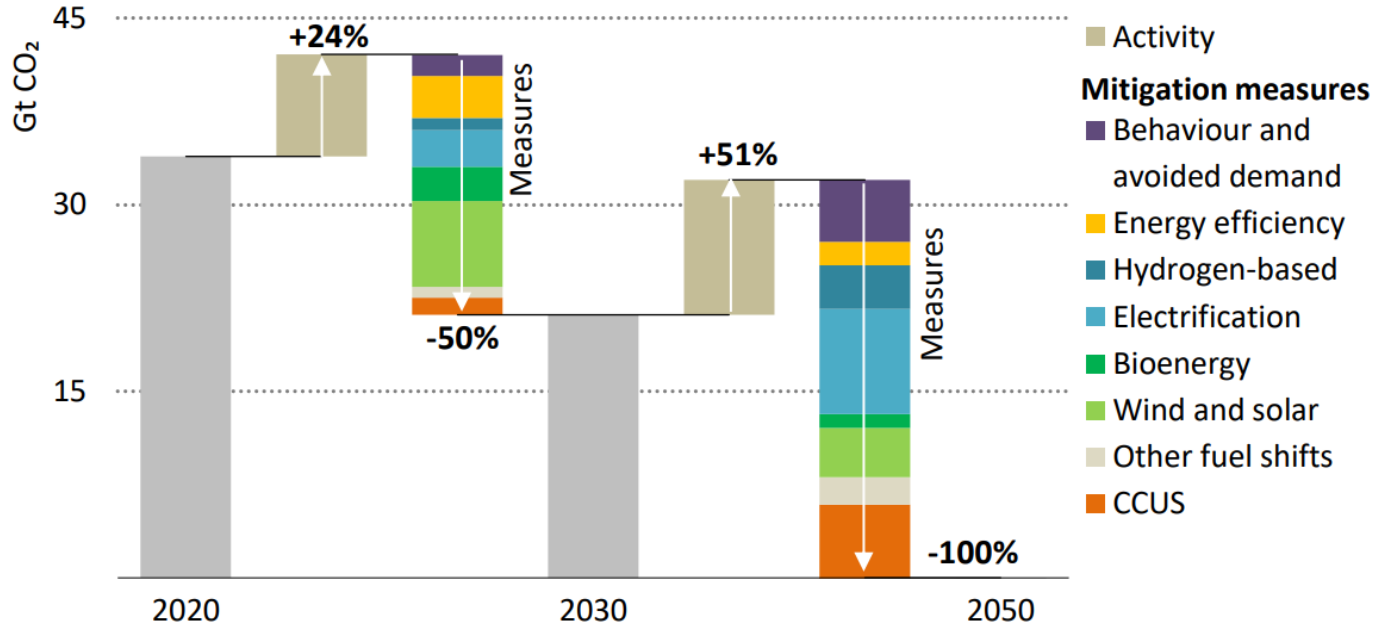


IEA (2022), World Energy Outlook, IEA, Paris

IEA Net Zero by 2050 Scenario

- A range of technologies must to work together in order to reach net zero by 2050.
- CCUS accounts for approximately 18% of emission reductions from 2030 to 2050 under the IEA's Net Zero by 2050 Scenario (NZE).

Figure 2.12 ▷ Emissions reductions by mitigation measure in the NZE, 2020-2050

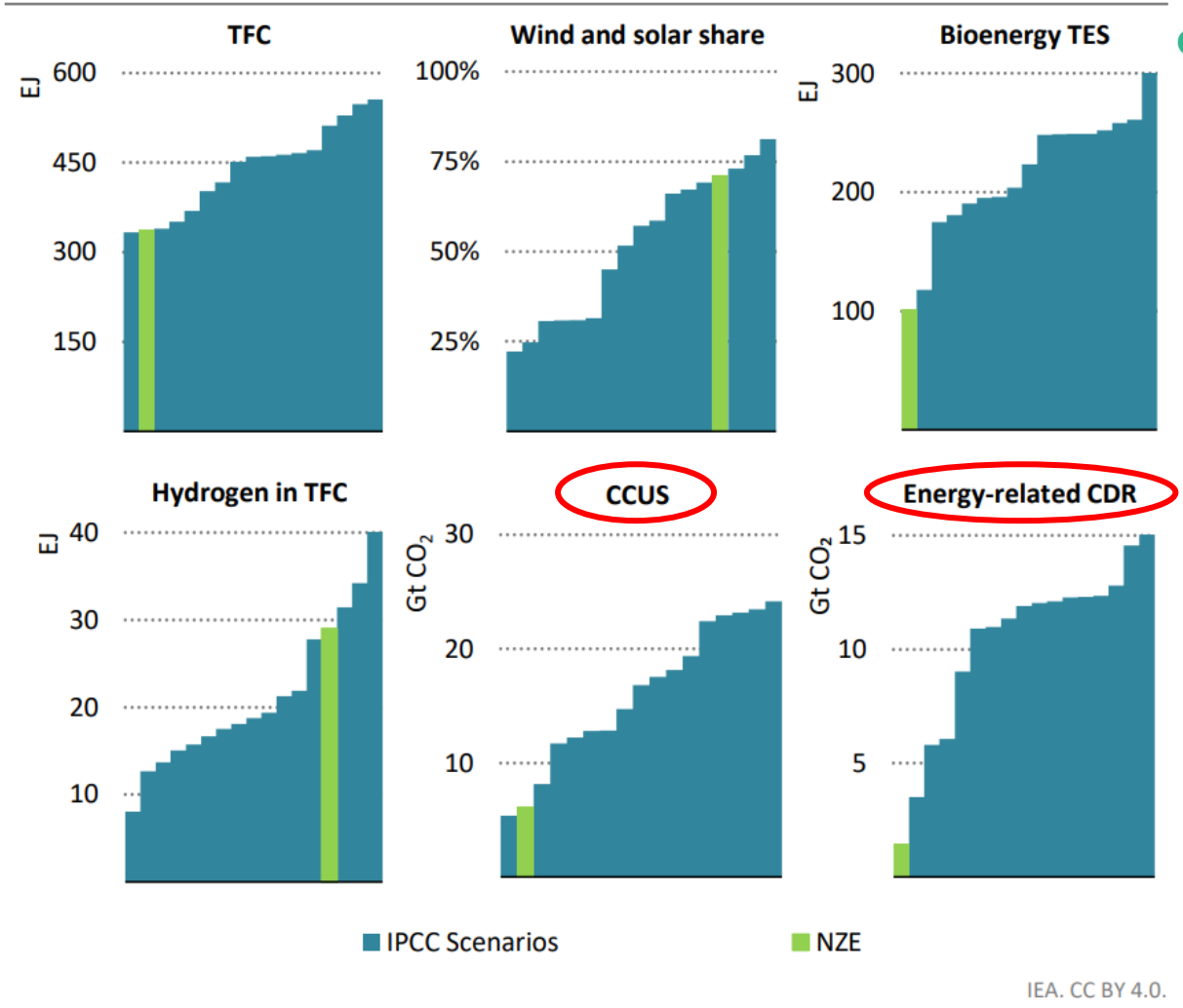


IEA (2021), Net Zero by 2050, IEA, Paris

IPCC Scenarios

- CCUS – the scenarios assessed by the IPCC have a median of around 17 Gt CO_2 captured using CCUS in 2050, more than double the level in the NZE.
- CDR (Carbon Direct Removal) – CO_2 emissions captured and stored from BECCS and DACS in the IPCC scenarios have a median of 12 Gt CO_2 captured in 2050, compared to 1.5 Gt CO_2 in NZE.

Figure 3.6 ▷ Comparison of key indicators for the selected IPCC scenarios and the IEA NZE Scenario in 2050



Notes: IPCC = Intergovernmental Panel on Climate Change.
CCUS = carbon capture, utilisation and storage; CDR = carbon direct removal; TES = total energy supply; TFC = total final consumption. Energy-related CDR includes CO_2 captured through bioenergy with CCUS and direct air capture with CCUS and put into permanent storage. Wind and solar share are given as a percentage of total electricity generation. Only 17 of the 18 scenarios assessed by the IPCC report hydrogen use in TFC.
BECCS = bioenergy equipped with CCUS; DACS = direct air capture and storage.

IEA (2022), World Energy Outlook, IEA, Paris

Importance of CCUS

"A delay in the development of other CCUS technologies would have a major impact on the prospect of getting to net-zero emissions in 2050. For example, CCUS is the only scalable low-emissions option to remove CO_2 from the atmosphere and to almost eliminate emissions from cement production. If progress in these technologies were delayed and could not be deployed at scale, then achieving net-zero emissions by 2050 would be vastly more difficult."

International Energy Agency (IEA), 2021

"Carbon capture, use and storage (CCUS) technology is an essential step towards mitigating climate change"

"Countries need to include CCUS in long-term strategies and commence retrofitting existing infrastructure."

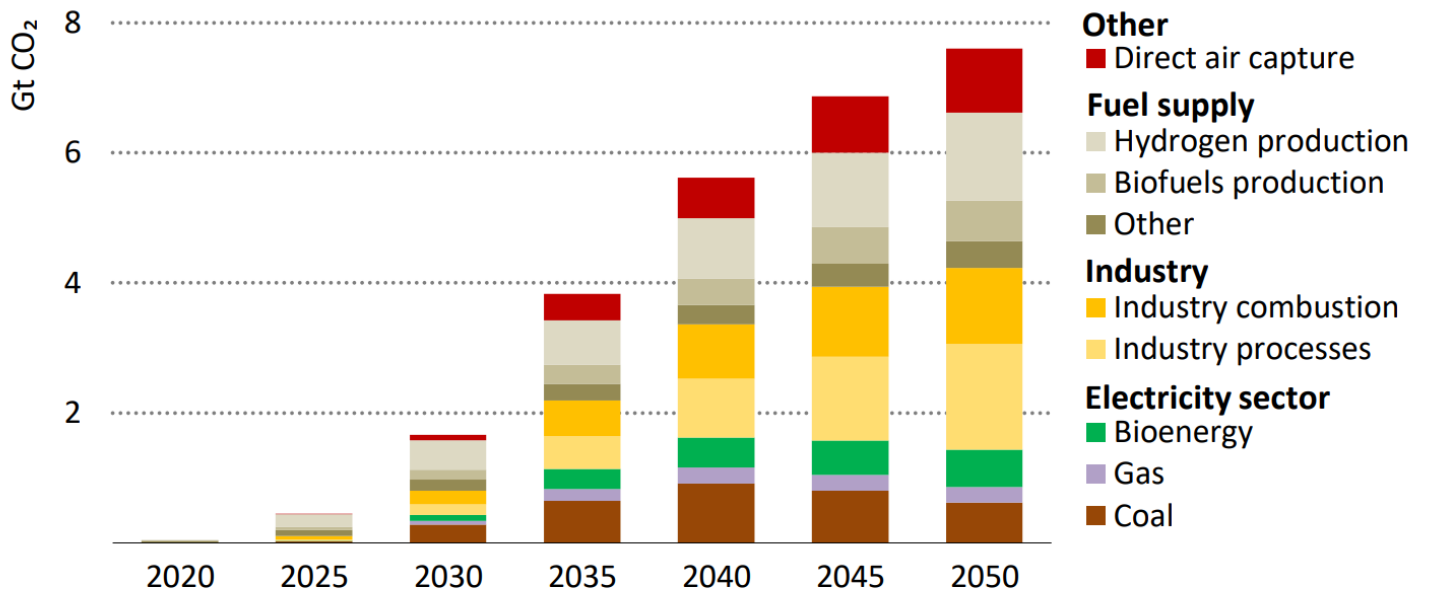
"CCUS allows UNECE member States to establish a pathway to carbon neutrality and stay within their emission targets."

United Nations Economic Commission for Europe (UNECE), 2021

Growth in CCUS

- Under updated 2022 NZE, by 2030 **1.2 Gt** CO_2 per year is captured globally, rising to **6.2 Gt** CO_2 in 2050 (of which 95% is geologically stored and 5% used for synthetic fuels).
- Negative emission technology (DAC and BECCS) account for **1.5 Gt** CO_2 by 2050.
- In 2022, only **0.045 Gt** CO_2 per year is captured and stored from ~35 commercial CCUS facilities.

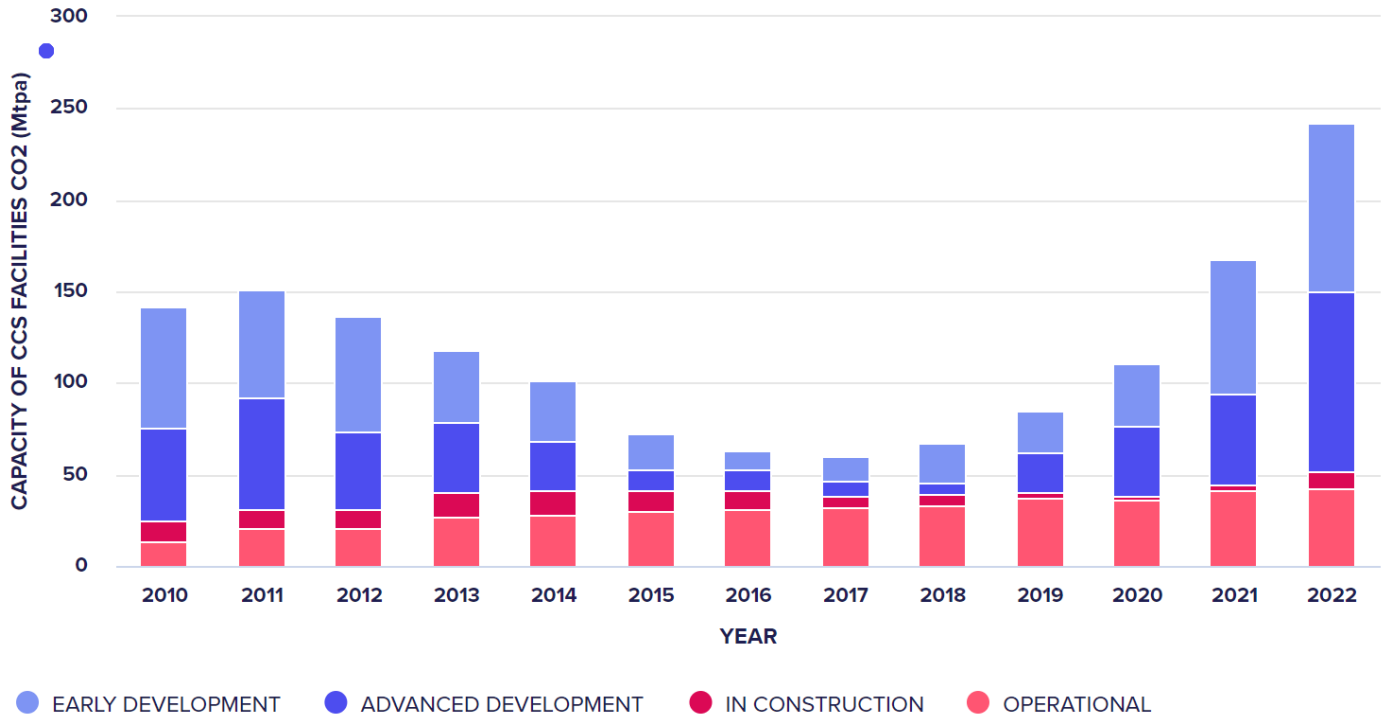
Figure 2.21 ▷ Global CO_2 capture by source in the NZE



IEA (2021), Net Zero by 2050, IEA, Paris

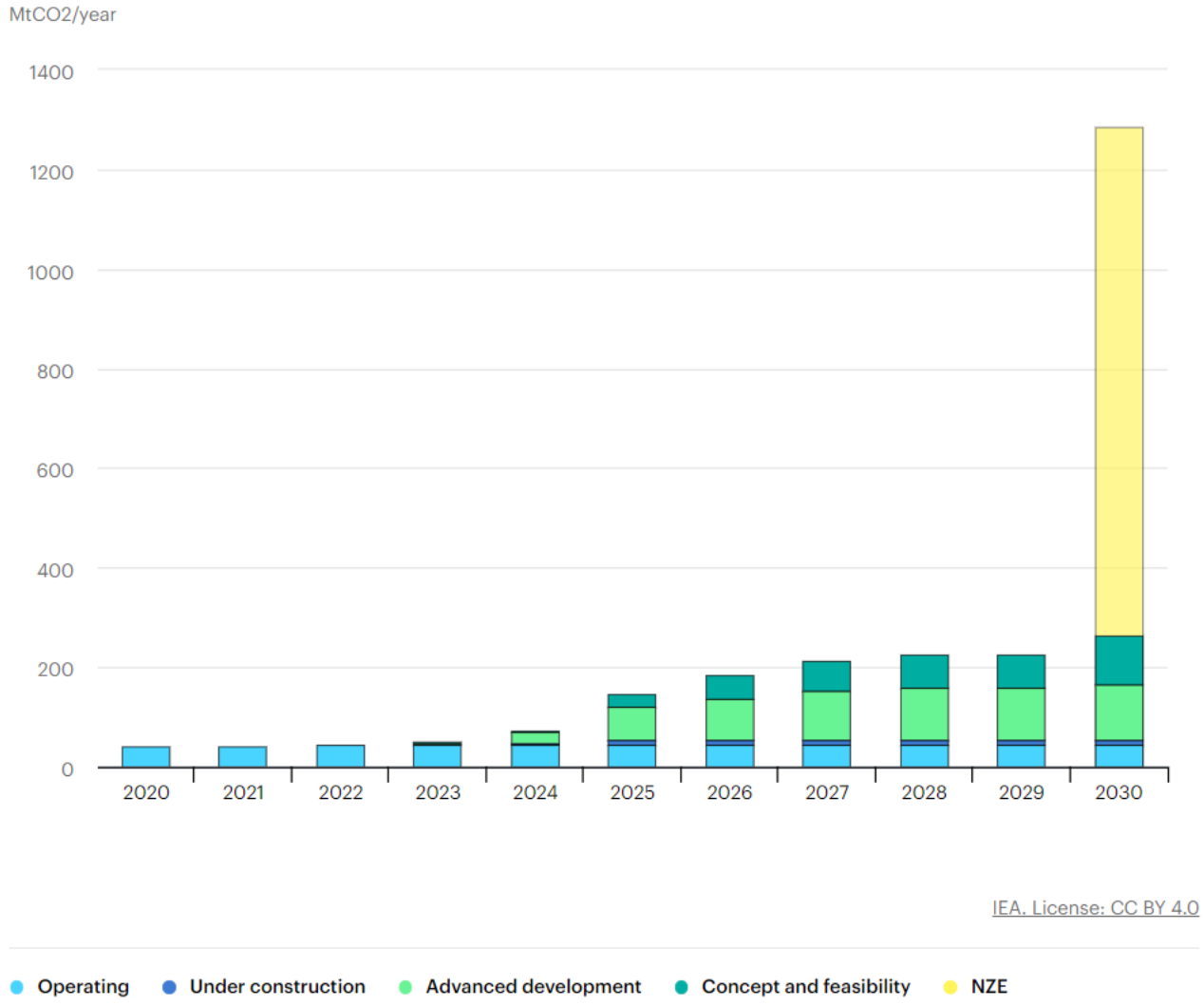
CCUS Facilities Worldwide

- Approximately 4x increase in capacity of all CCUS facilities in development, under construction and operating since 2017.



CCUS Facilities Worldwide

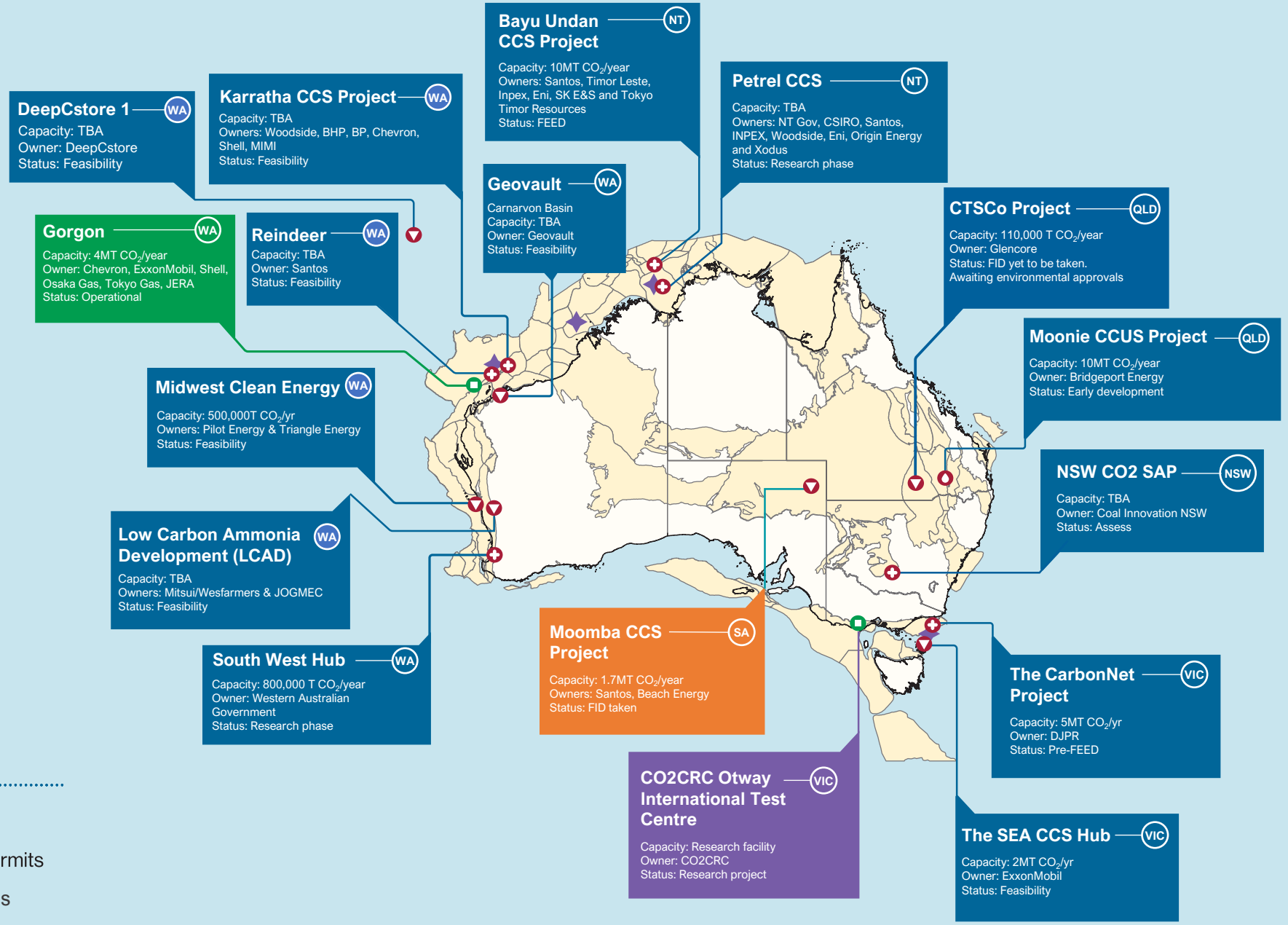
- Approximately 4x increase in capacity of all CCUS facilities in development, under construction and operating since 2017.
- However, need almost 30x increase in current operating capacity under the NZE scenario by 2030.



IEA (2022), Carbon Capture, Utilisation and Storage, IEA, Paris

Australia

CCUS Projects 2022



1 Operational Project

1 Under Construction

14 Projects in feasibility

Legend

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

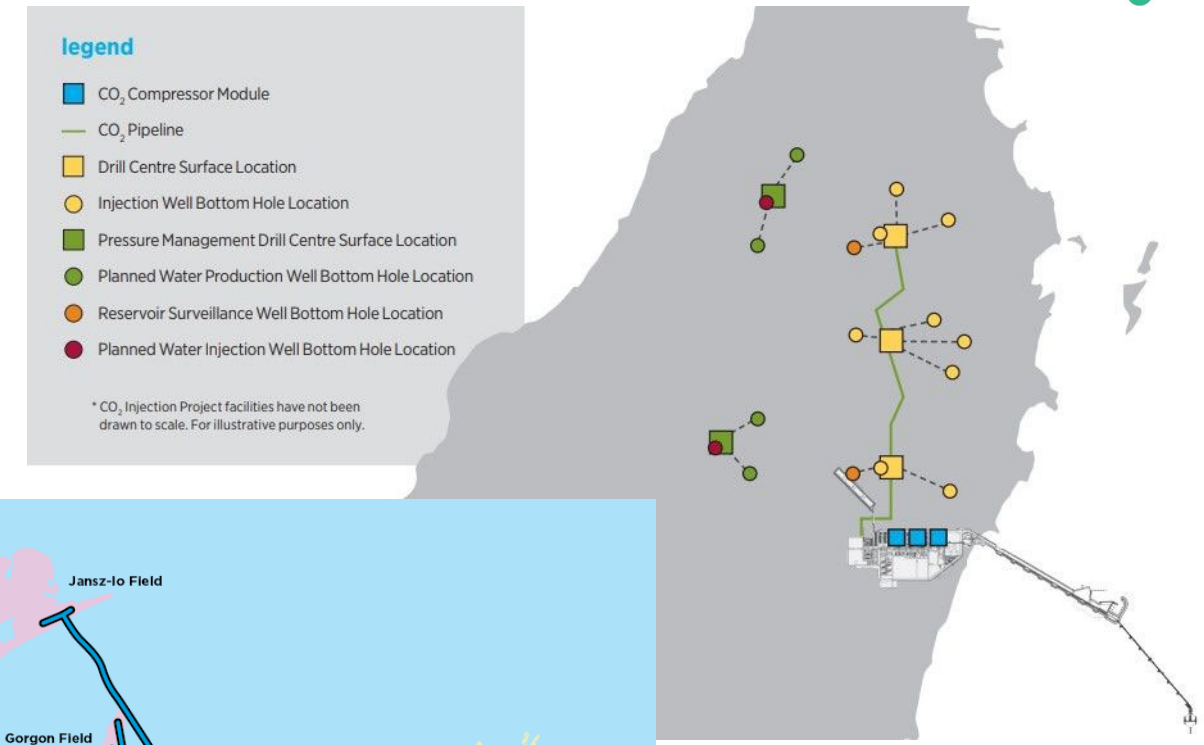
CCUS Facilities – Top Operational or in Construction

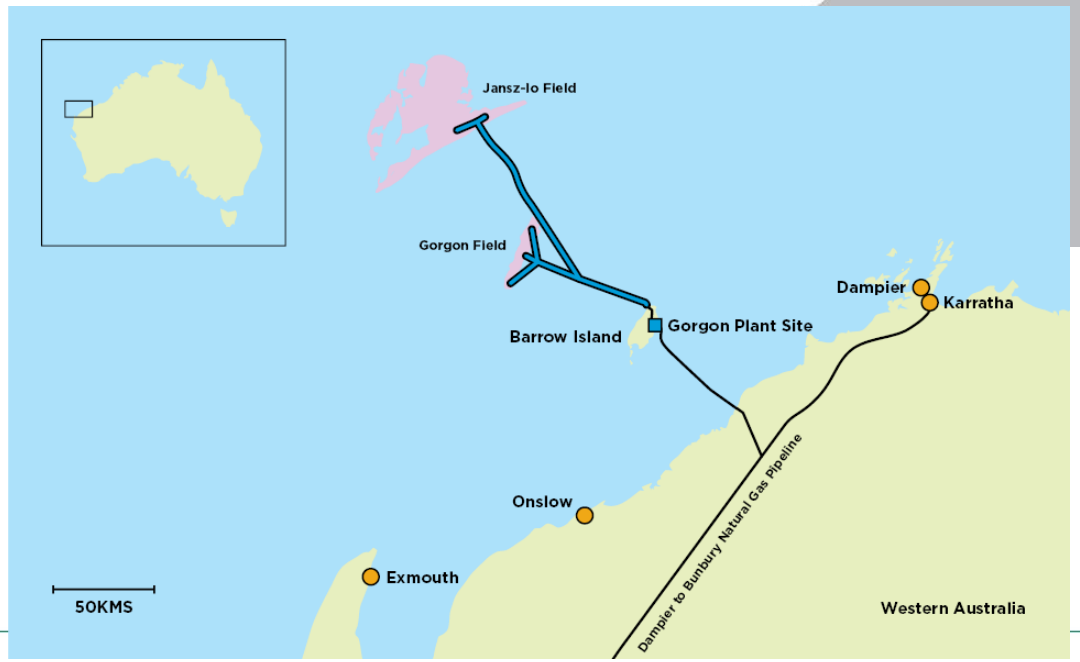
FACILITY	COUNTRY	FACILITY STATUS	OPERATIONAL DATE	FACILITY INDUSTRY	CAPTURE CAPACITY (Mtpa CO2)	FACILITY TYPE
SHUTE CREEK GAS PROCESSING PLANT	USA	Operational	1986	Natural Gas Processing	7	Enhanced Oil Recovery
PETROBRAS SANTOS BASIN PRE-SALT OIL FIELD CCS	Brazil	Operational	2011	Natural Gas Processing	7	Enhanced Oil Recovery
LOUISIANA CLEAN ENERGY COMPLEX	USA	In Construction	2026	Various	5	Dedicated Geological Storage
CENTURY PLANT	USA	Operational	2010	Natural Gas Processing	5	Enhanced Oil Recovery
GORGON CARBON DIOXIDE INJECTION	Australia	Operational	2019	Natural Gas Processing	4	Dedicated Geological Storage
GREAT PLAINS SYNFUELS PLANT AND WEYBURN-MIDALE	USA	Operational	2000	Synthetic Natural Gas	3	Enhanced Oil Recovery
QATAR LNG CCS	Qatar	Operational	2019	Natural Gas Processing	2.2	Dedicated Geological Storage
SANTOS COOPER BASIN CCS PROJECT	Australia	In Construction	2024	Natural Gas Processing	1.7	Dedicated Geological Storage
ALBERTA CARBON TRUNK LINE (ACTL) WITH NORTH WEST REDWATER PARTNERSHIP'S STURGEON REFINERY CO2 STREAM	Canada	Operational	2020	Oil Refining	1.6	Enhanced Oil Recovery
NORTHERN LIGHTS - STORAGE	Norway	In Construction	2024	Various	1.5	Dedicated Geological Storage
QUEST	Canada	Operational	2015	Hydrogen Production	1.3	Dedicated Geological Storage
NORTH FIELD EAST PROJECT (NFE) CCS	Qatar	In Construction	2025	Natural Gas Processing	1	Under Evaluation
SLEIPNER CO2 STORAGE	Norway	Operational	1996	Natural Gas Processing	1	Dedicated Geological Storage
AIR PRODUCTS STEAM METHANE REFORMER	USA	Operational	2013	Hydrogen Production	1	Enhanced Oil Recovery
BOUNDARY DAM 3 CARBON CAPTURE AND STORAGE FACILITY	Canada	Operational	2014	Power Generation	1	Various
ILLINOIS INDUSTRIAL CARBON CAPTURE AND STORAGE	USA	Operational	2017	Ethanol Production	1	Dedicated Geological Storage
SINOPEC QILU-SHENGLI CCUS	China	Operational	2022	Chemical Production	1	Enhanced Oil Recovery
COFFEYVILLE GASIFICATION PLANT	USA	Operational	2013	Fertiliser Production	0.9	Enhanced Oil Recovery
UTHMANIYAH CO2-EOR DEMONSTRATION	Saudi Arabia	Operational	2015	Natural Gas Processing	0.8	Enhanced Oil Recovery
ABU DHABI CCS (PHASE 1 BEING EMIRATES STEEL INDUSTRIES)	United Arab Emirates	Operational	2016	Iron and Steel Production	0.8	Enhanced Oil Recovery
SNOHVIT CO2 STORAGE	Norway	Operational	2008	Natural Gas Processing	0.7	Dedicated Geological Storage

Gorgon Carbon Capture and Storage

- 7 million tonnes injected since start-up in August 2019 to October 2022.
- Injection capacity of 4 Mtpa from the Gorgon LNG plant.
- Predicted lifespan of more than 40 years.

- Injection into the Dupuy saline aquifer 2.5km below Barrow Island.
- Pressure management via water production and injection into overlying Barrow Group formation.

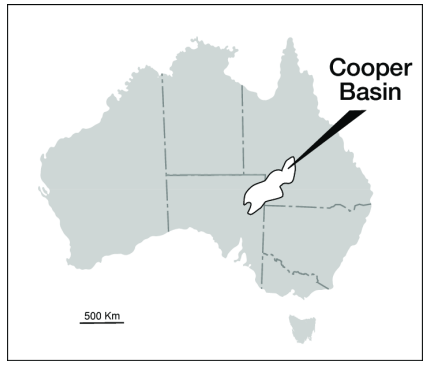


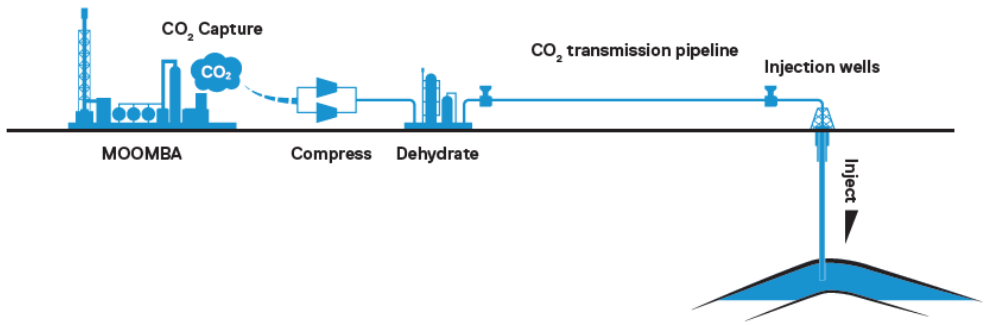


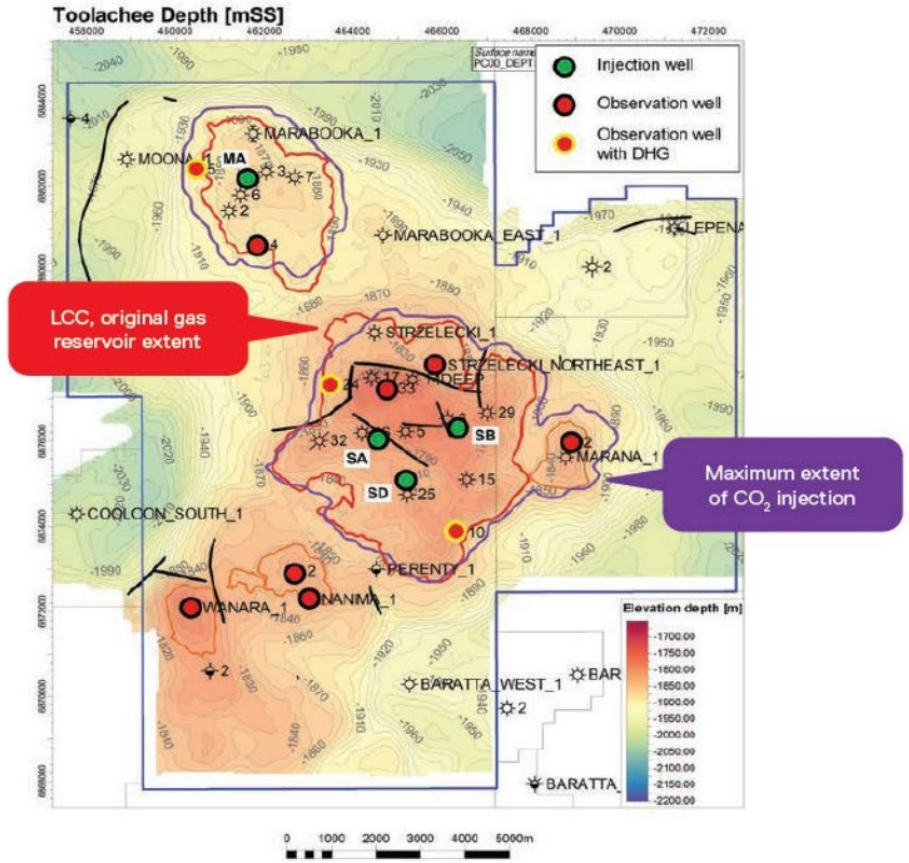
Source: Chevron Australia Pty Ltd.

Moomba Carbon Capture and Storage

- First phase operational in 2024 with injection rate of 1.7 Mtpa from processing plant into depleted fields.
- 1.7 Mtpa represents approximately 7% of South Australia's total emissions.
- Future phases target injection of 20 Mtpa from other industrial sources.
- Direct air capture trials planned at Moomba.
- Potential for low-carbon hydrogen production.



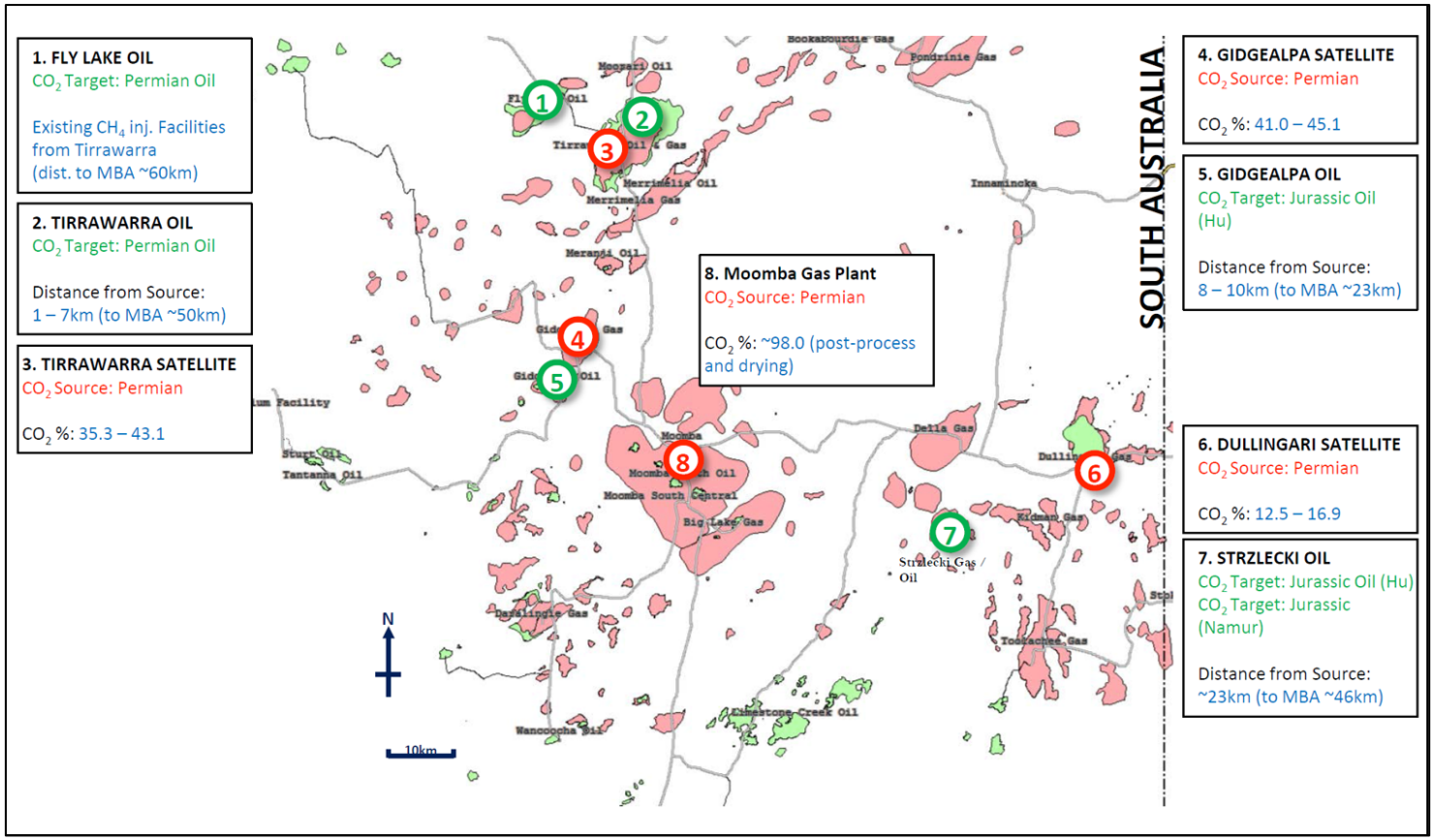




Source: Santos Ltd.

Cooper Basin CO_2 EOR Potential

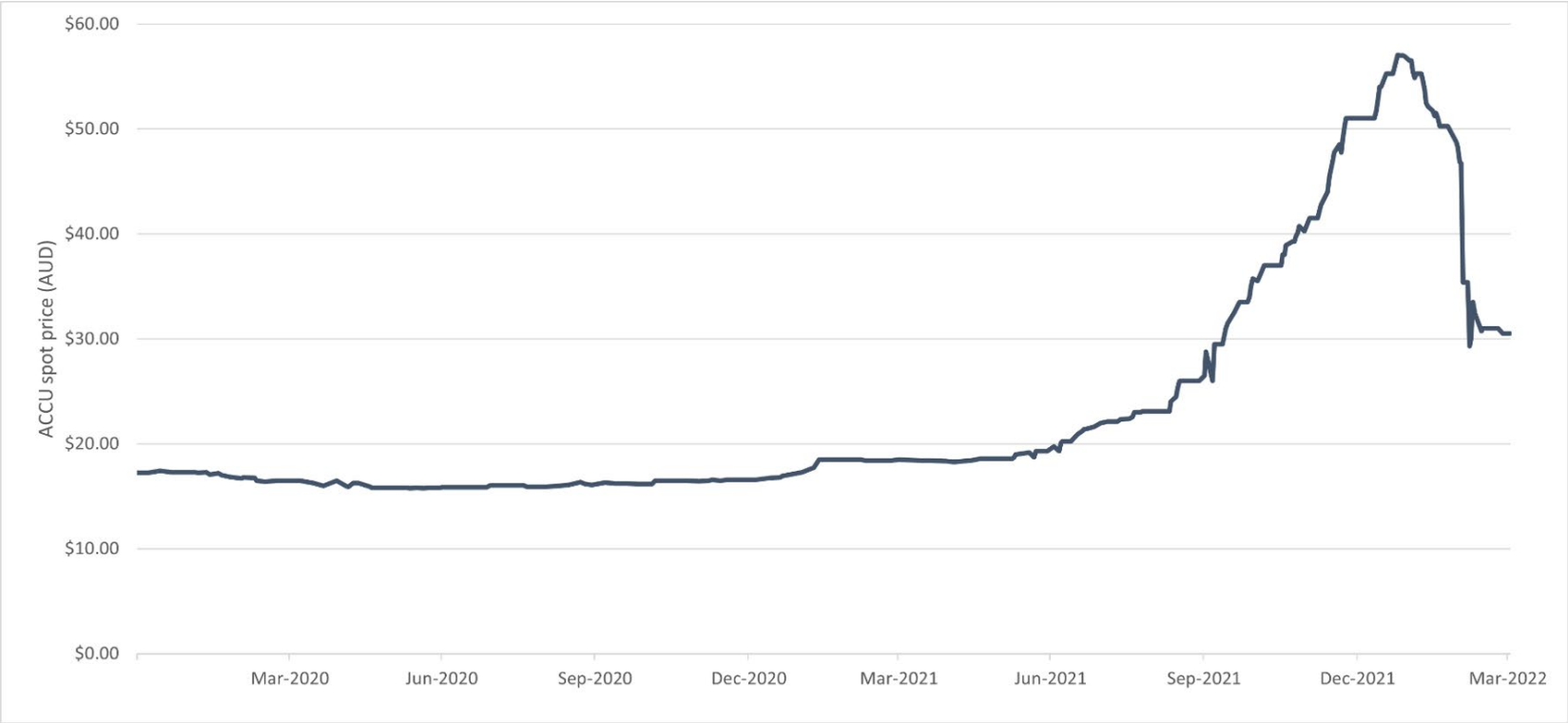
- Cooper and Eromanga basins well suited to CO_2 EOR.
  - Deep reservoirs and light oil.
- Co-located with high CO_2 gas fields.
- Report published on department website analysing oil miscibility with CO_2.



Source: Santos Ltd.

Australian Policies

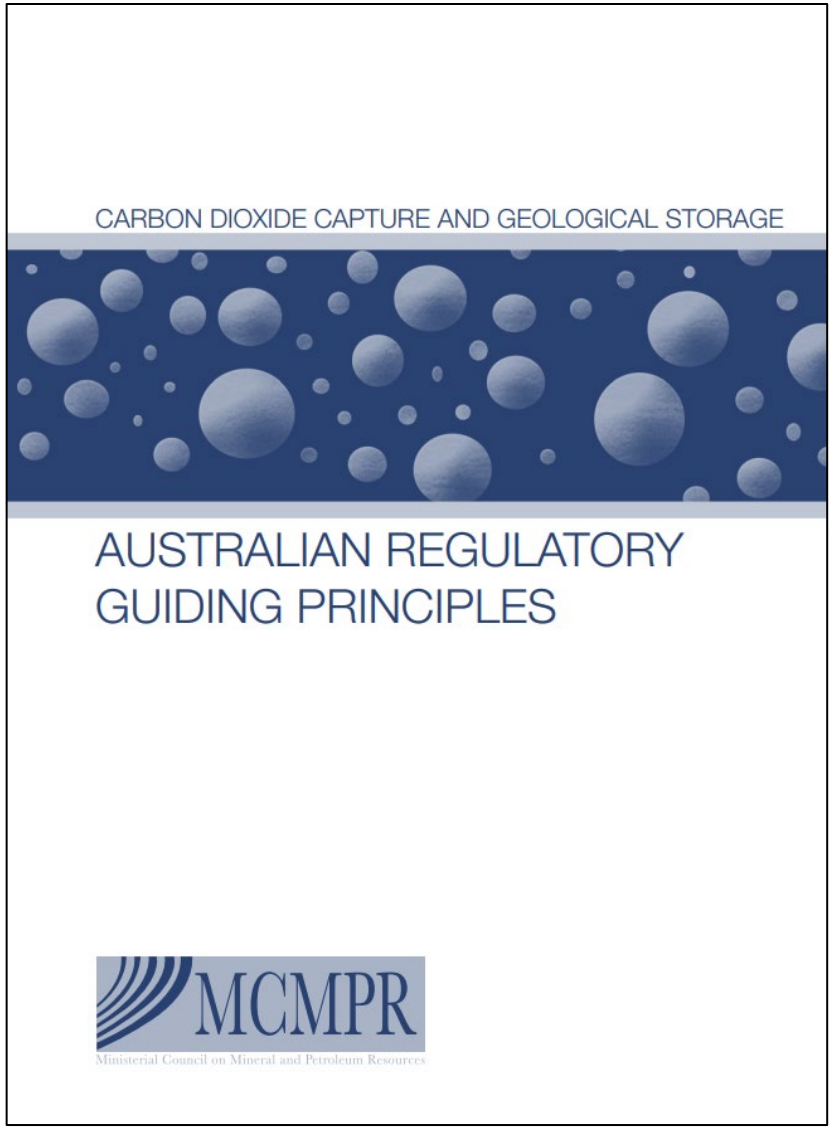
- CCS eligible for Australian Carbon Credit Units (ACCUs) from 1 October 2021.



Clean Energy Regulator (2022), Australian Government

Australian Legislation

- The Australian Government developed regulatory guiding principles for CCS in 2005.
- In 2022, jurisdictions including South Australia, Queensland, Victoria and offshore Commonwealth waters have legislation in place to licence and regulate CCUS, with other states and territories currently developing legislation.



Regulatory Framework

- Underground resources in Australia belong to the Crown.
- Objective/risk based regulatory framework.
    1. Licensing
    2. Environmental assessment (including consultation)
    3. Activity assessment and approval
- Adopt relevant international and national standards.

ISO/TC 265 standards portfolio

Carbon capture

ISO/TR 27912 CO_2 capture systems, technologies and processes

ISO 27919-1 Performance evaluation methods for post-combustion CO_2 capture integrated with a power plant

ISO 27919-2 Evaluation procedure to assure and maintain stable performance of post-combustion CO_2 capture plant integrated with a power plant

ISO/TR 27922 Overview of CO_2 capture technologies in the cement industry

ISO XXXX Performance evaluation of CO_2 capture connected with a CO_2 intensive plant

ISO XXXX Performance index and standard test method of absorption solvent performance for CO_2 capture

Transportation

ISO 27913 Pipeline transportation systems [proposed for revision]

ISO/TR XXXX CO_2 shipping and trans-shipping

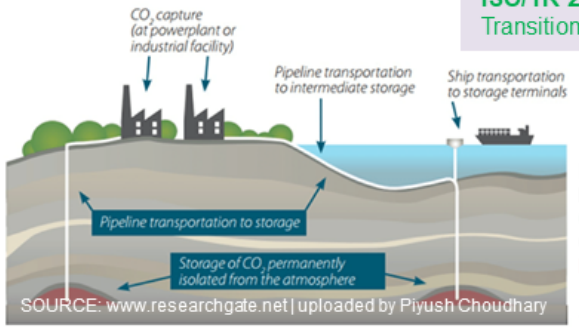
Underground storage

ISO 27914 Geological storage [proposed for revision to include quantification and verification]

ISO 27916 CO_2 storage using enhanced oil recovery (CO_2-EOR)

ISO/TR 27923 Geologic storage of CO_2 injection operations and infrastructure

ISO/TR 27926 CO_2-EOR - Transitioning from EOR to storage



Key
Black: Published document
Green: Document under preparation
Grey: New proposed project
Red: Project cancelled

Status: June 2021

Overarching aspects

ISO 27917 Vocabulary — Cross cutting terms

ISO/TR 27925 Flow assurance

ISO/TR 27918 Lifecycle risk management for integrated CCS projects

ISO/TS 27924 Risk management for integrated CCS projects

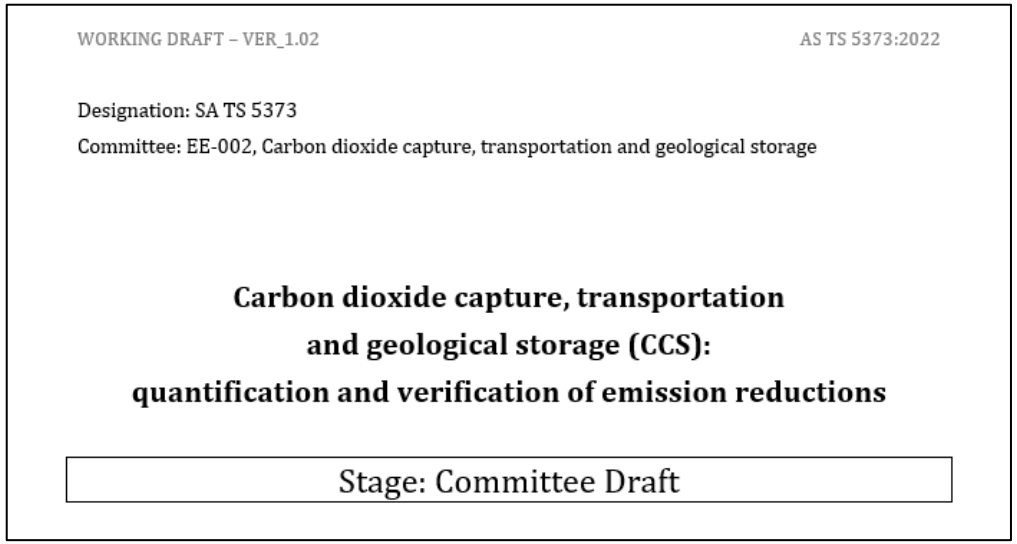
ISO/TR 27915 Quantification and verification

ISO 27920 Quantification and verification

ISO/TR 27921 CO_2 stream composition

Monitoring and Verification

- Demonstration of long term containment via a monitoring and verification plan that is project specific.
- Developed in accordance with recognised standards.
- Required for:
  - Ongoing compliance.
  - Closure and licence relinquishment.
  - Federal Australian Carbon Credit Units (ACCUs).



https://www.energymining.sa.gov.au/industry/energy-resources/regulation/projects-of-public-interest/cooper-basin-carbon-storage

Conclusions

- Australia requires more rapid emission reductions to meet net-zero by 2050.
- CCUS will play an important role among a range of technologies that must to work together to meet 2°C scenarios.
- CCUS requires a step-change in growth to meet capacity required by IEA and IPCC net-zero scenarios.
- Australia contains the largest dedicated carbon storage project in the world (Gorgon) and by 2024 will also have the 3rd largest (Moomba).
- Australia will continue to enable CCUS through policy and leading practice regulation.

Contacts

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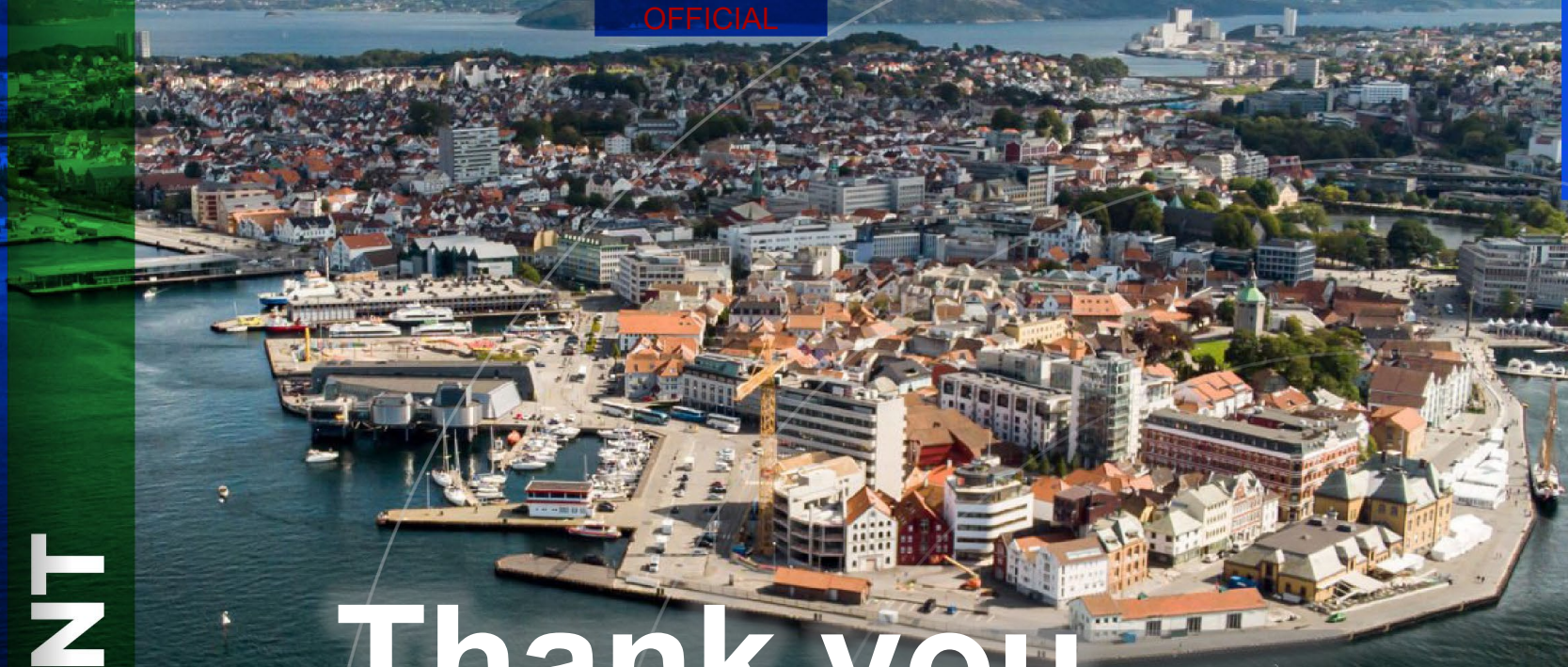

Technology Collaboration Programme by iea

Thank you

eor Enhanced Oil Recovery

¡THANKS!

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Enhanced Oil Recovery

Technology Collaboration Programme by iea

Backup Slides

SOUTH AUSTRALIA

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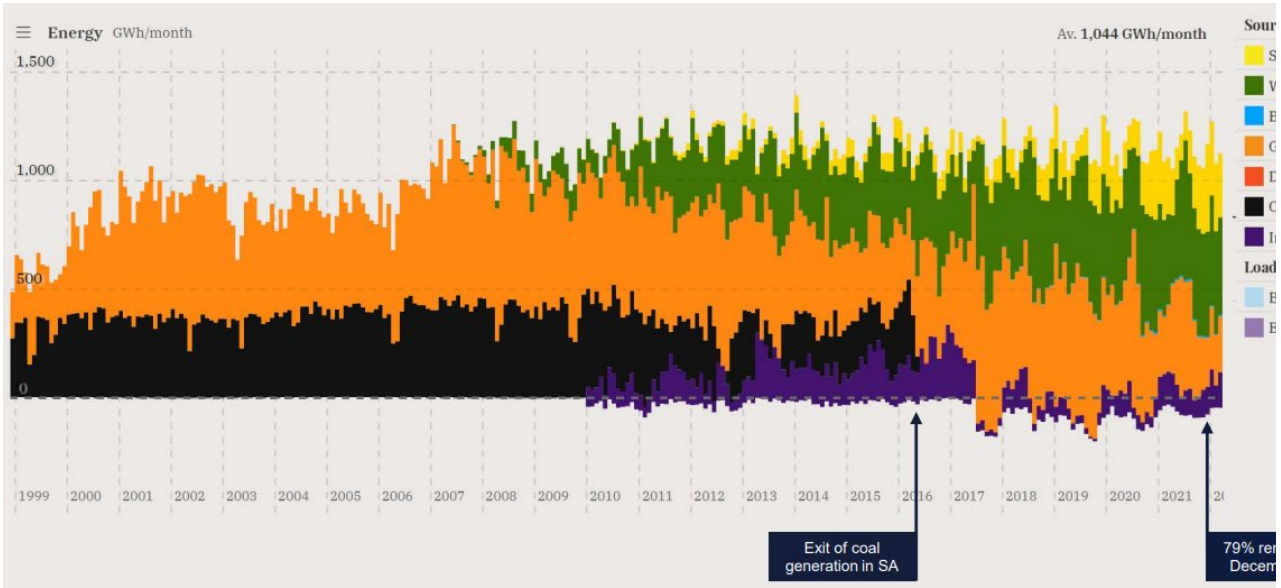
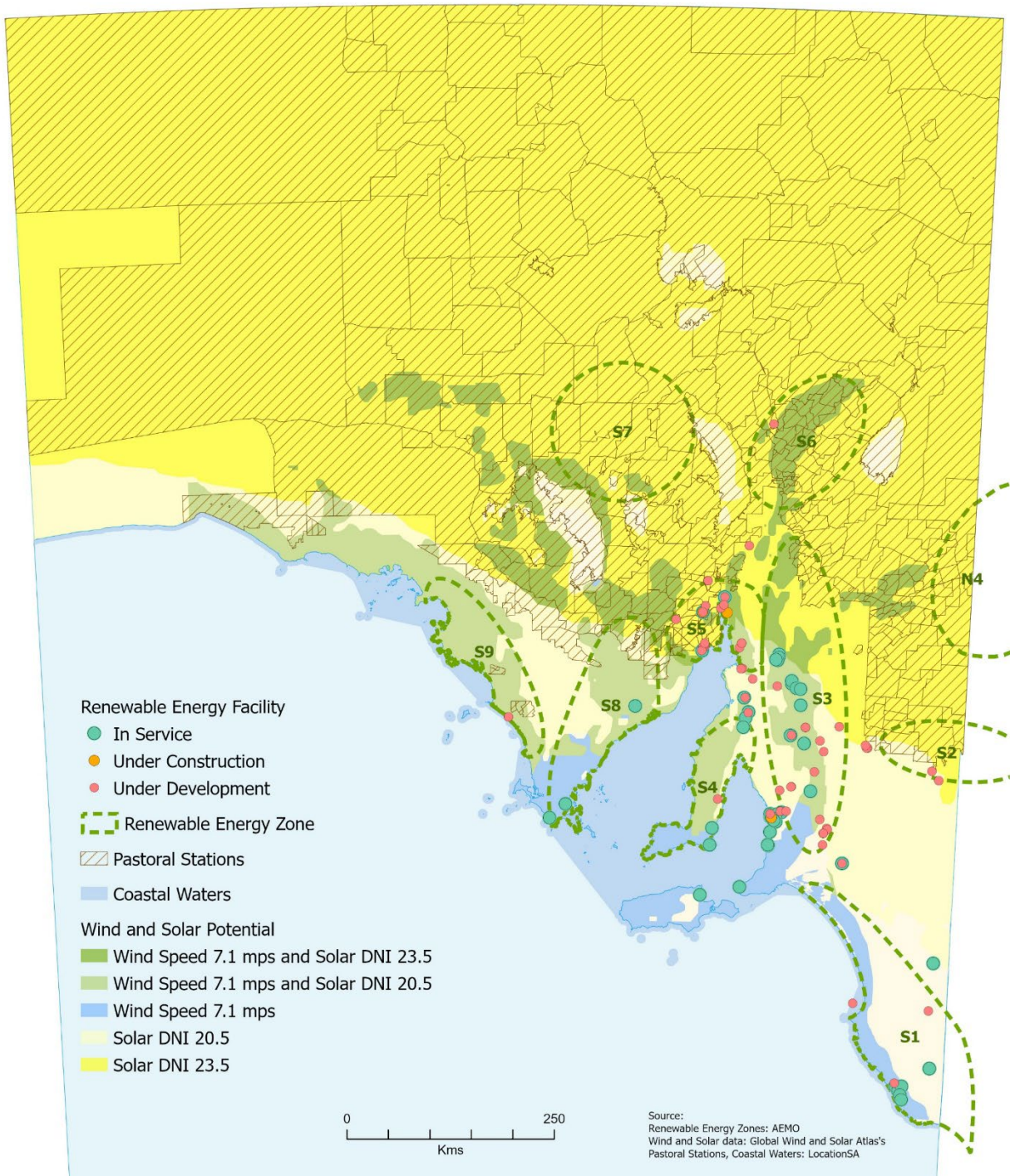
Renewable energy in SA

- 68% electricity from renewable energy
- 22 wind farms, 3 solar farms
- World's highest rooftop uptake per capita
- 4 grid scale batteries
- Australia's largest hydrogen electrolyser





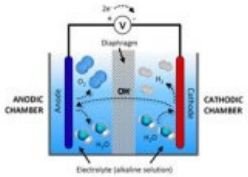
Hydrogen in SA

- **South Australian Government's hydrogen power plant commitment:**
  - $593 million in capital funding
  - 250 MWe electrolyser
  - 200 MW hydrogen fuelled power plant
  - Hydrogen storage facility
  - Operational by Dec 2025

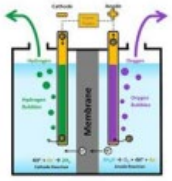
- Hydrogen and Renewable Energy Generation Act in development.

Hydrogen electrolyser
250MWe

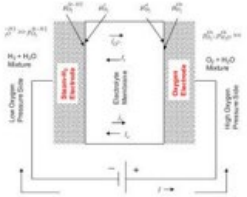
Alkaline:



PEM:



Solid Oxide:



Hydrogen gas storage

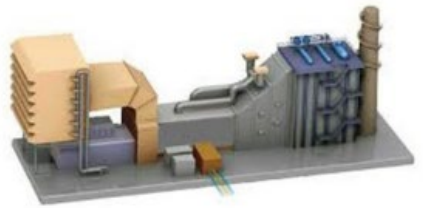
Line-packed pipeline:

Gaseous H2 sphere:

Liquified H2 sphere:

Hydrogen power plant
200MW

Gas turbine:



Fuel Cell:

IPCC Mitigation Pathways

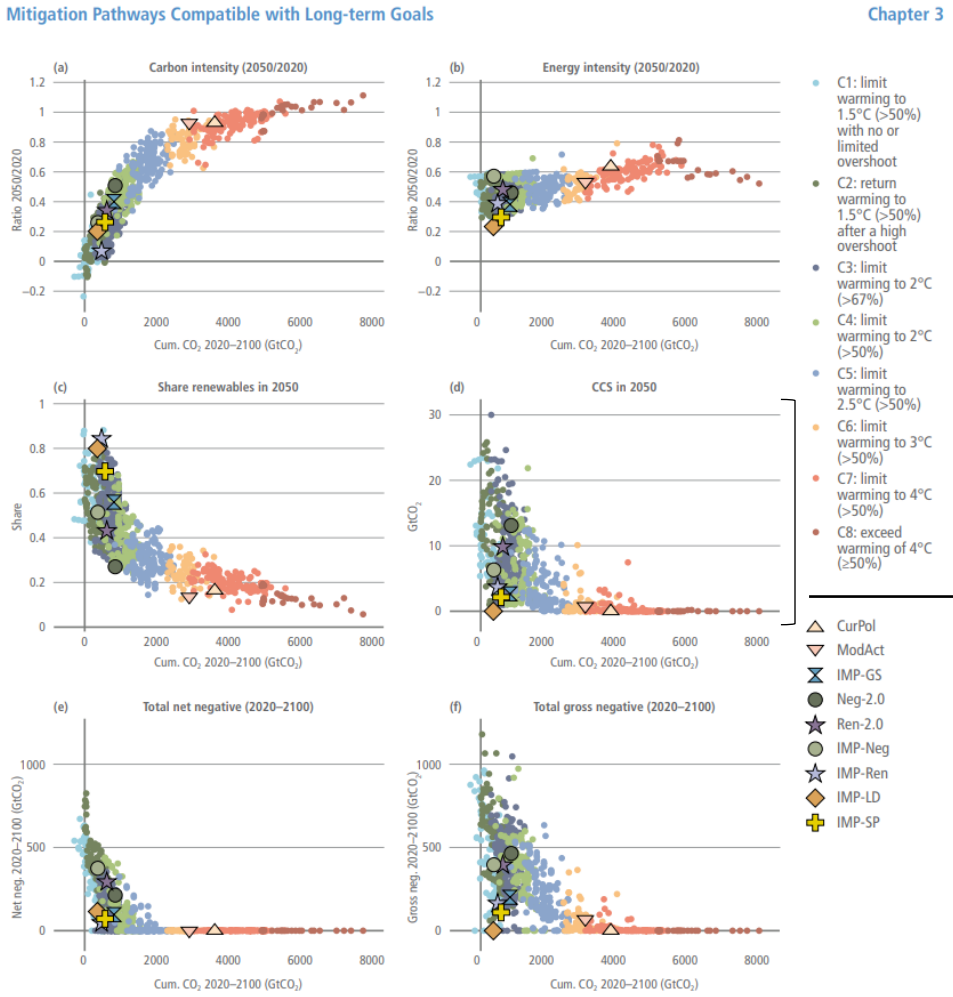
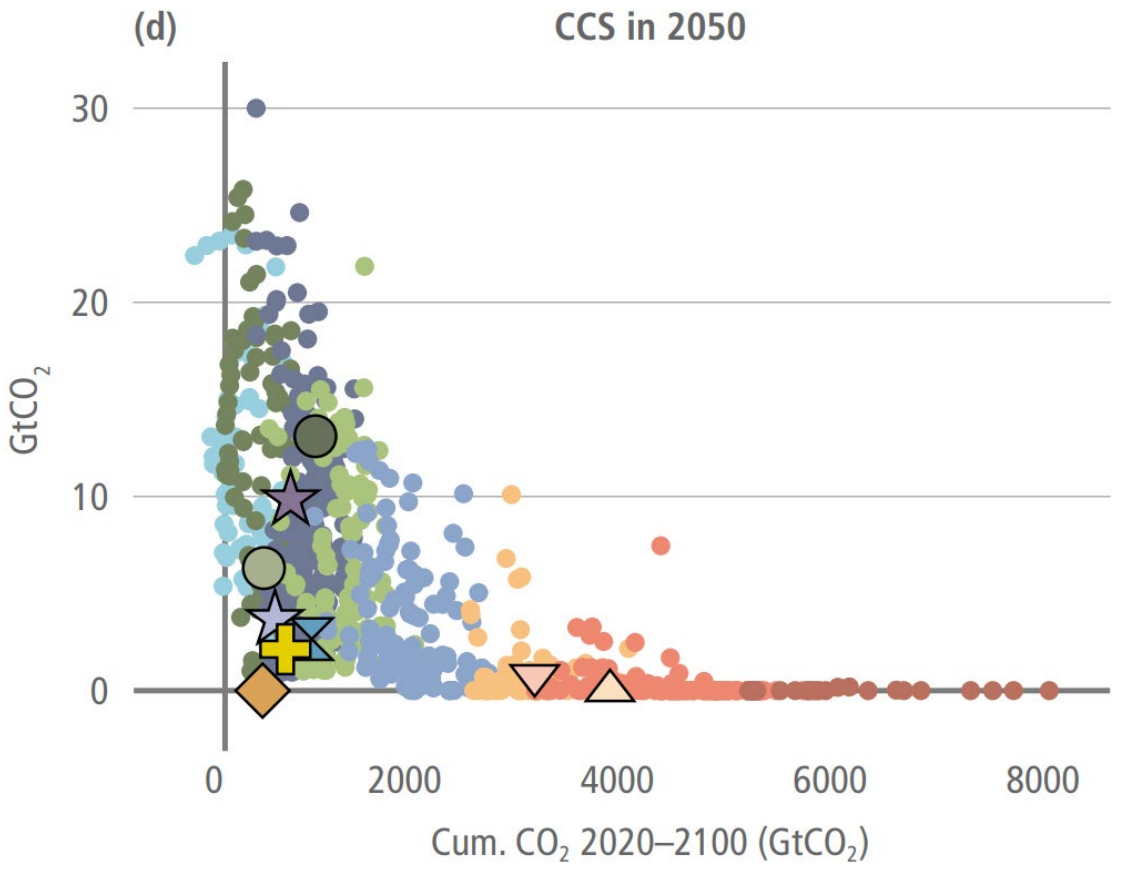


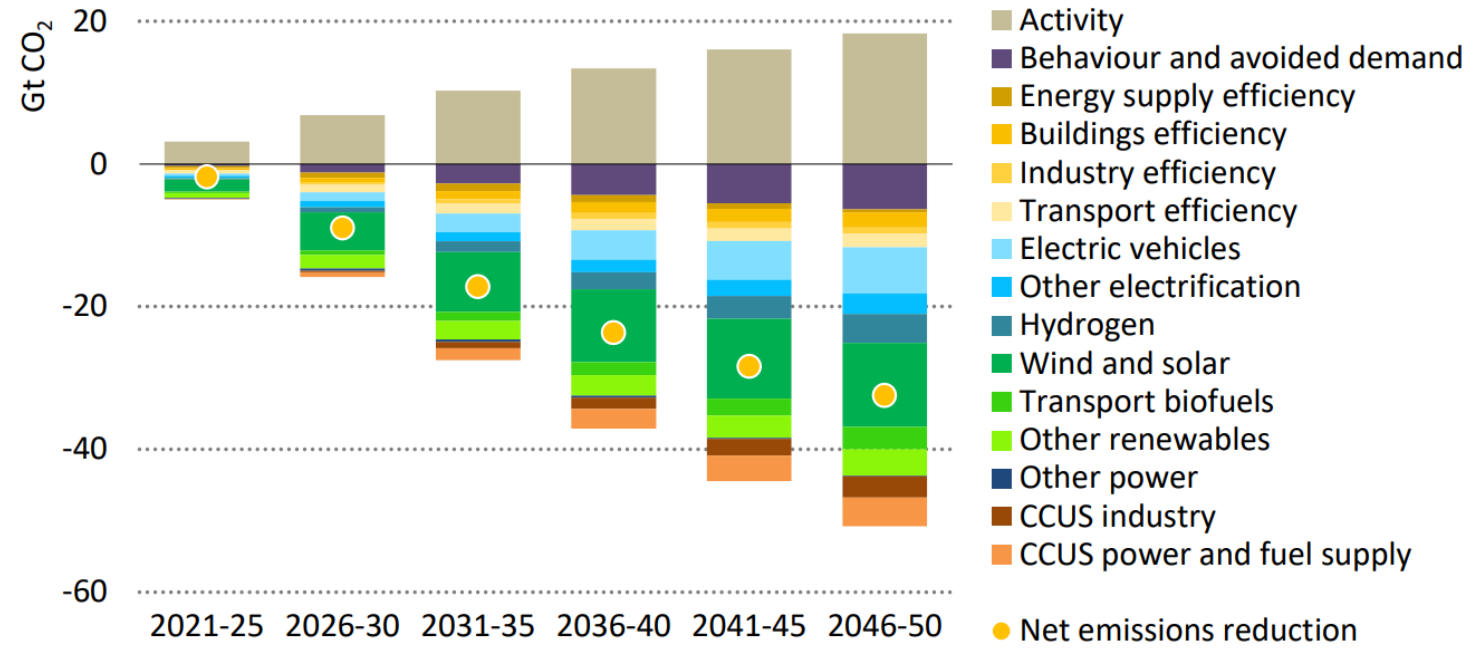
Figure 3.15 | Characteristics of scenarios as a function of the remaining carbon budget (mean decarbonisation rate is shown as the average reduction in the period 2010–2050 divided by 2010 emissions). The categories C1–C7 are explained in Table 3.1.



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

Global Emissions Reductions

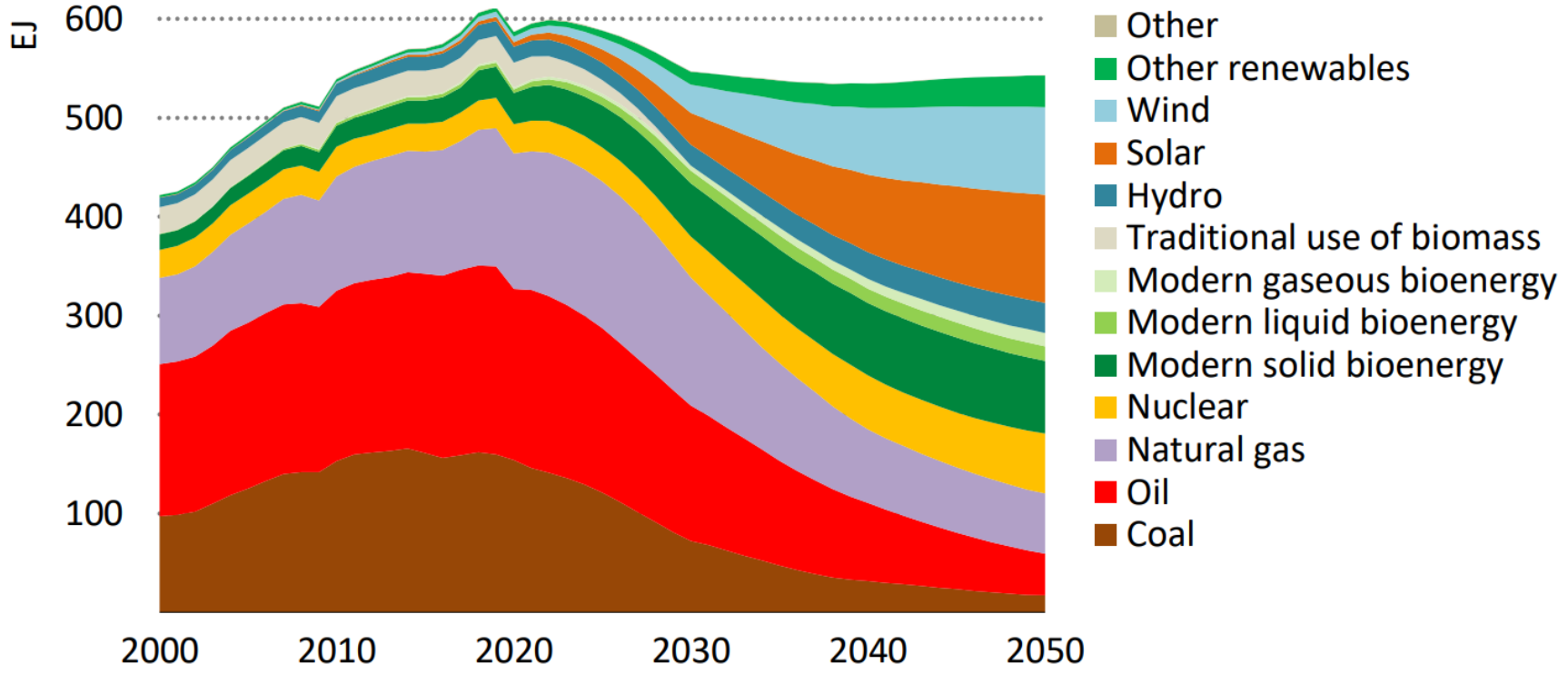
Figure 2.4 ▷ Average annual CO_2 reductions from 2020 in the NZE



IEA (2021), Net Zero by 2050, IEA, Paris

Global Energy Supply

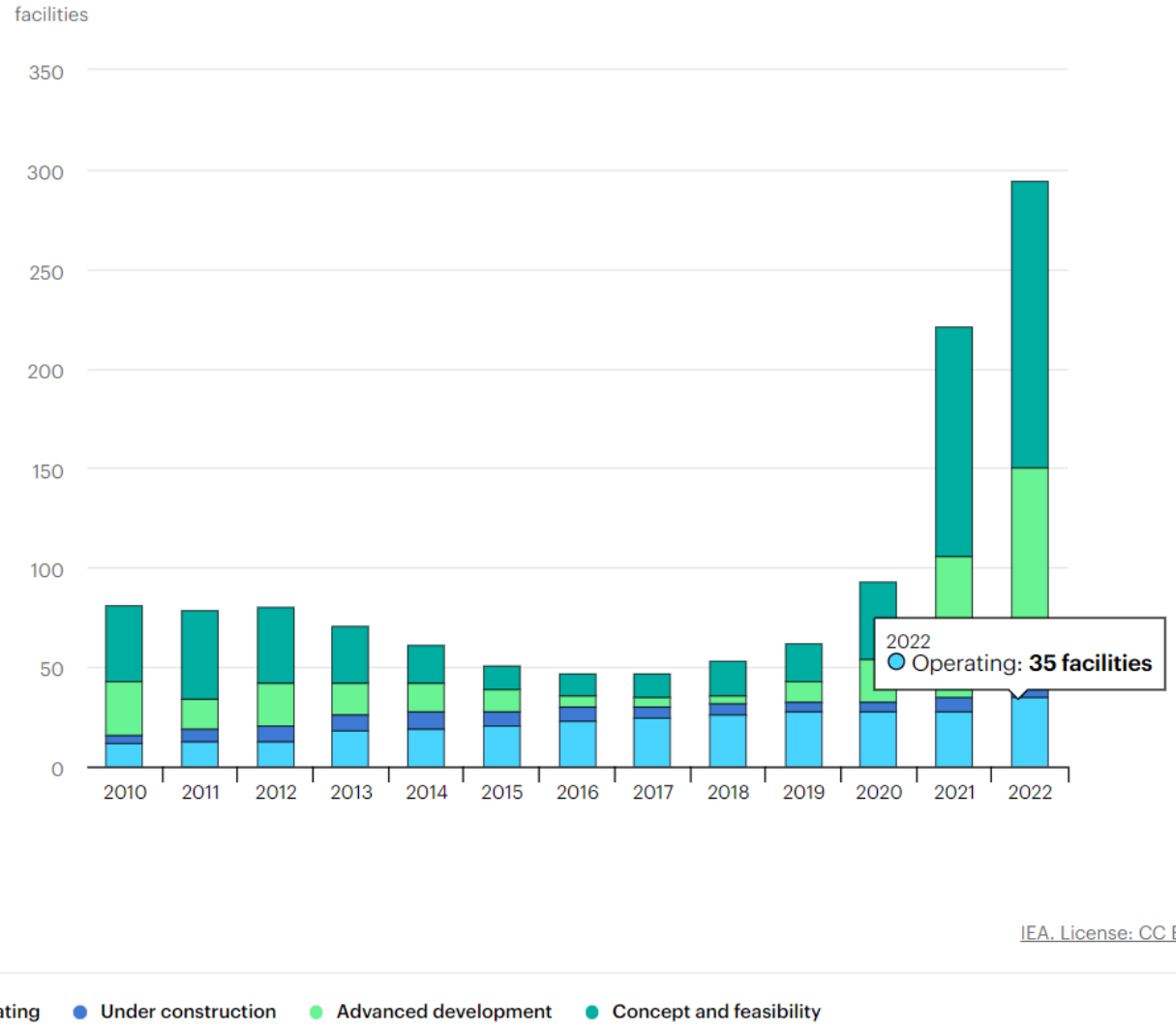
Figure 2.5 ▷ Total energy supply in the NZE



IEA (2021), Net Zero by 2050, IEA, Paris

CCUS facilities worldwide

- Approximately 6x increase of proposed, under construction and operating CCUS facilities since 2017.



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