Background Information on Carbon Capture, Utilisation and Storage

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MINISTRY OF BUSINESS,
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HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
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Context

This document provides background information on carbon capture, utilisation and storage (**CCUS**). It has been published alongside a Consultation Document which outlines the Government's proposals for creating a regulatory regime for CCUS.

What is CCUS?

Capturing CO_2

CCUS involves the capture of CO_2 from large point sources, such as upstream natural gas extraction and production facilities, power generation or industrial facilities that use either fossil fuels or biomass. If captured CO_2 is not used on-site,[1] it is compressed and transported to be injected into deep geological formations (including depleted oil and gas reservoirs) for permanent storage. Some forms of CCUS also involve direct capture of CO_2 from the atmosphere.

In the case of CO_2 which is captured from extraction activities, capture technologies serve to *reduce* the amount of CO_2 that would otherwise be emitted into the atmopshere. In the case of direct air capture, these technologies *remove* existing atmospheric CO_2 that has already been emitted.

There are several technologies that can be used to capture CO2, with varying degrees of usage and technological maturity. The IEA gives a useful summary and description of these technologies.[2]

[1] CO2 can also be used in a range of applications, such as food production. This refers to *carbon capture and utilisation (CCU).*
[2] https://www.iea.org/reports/about-ccus

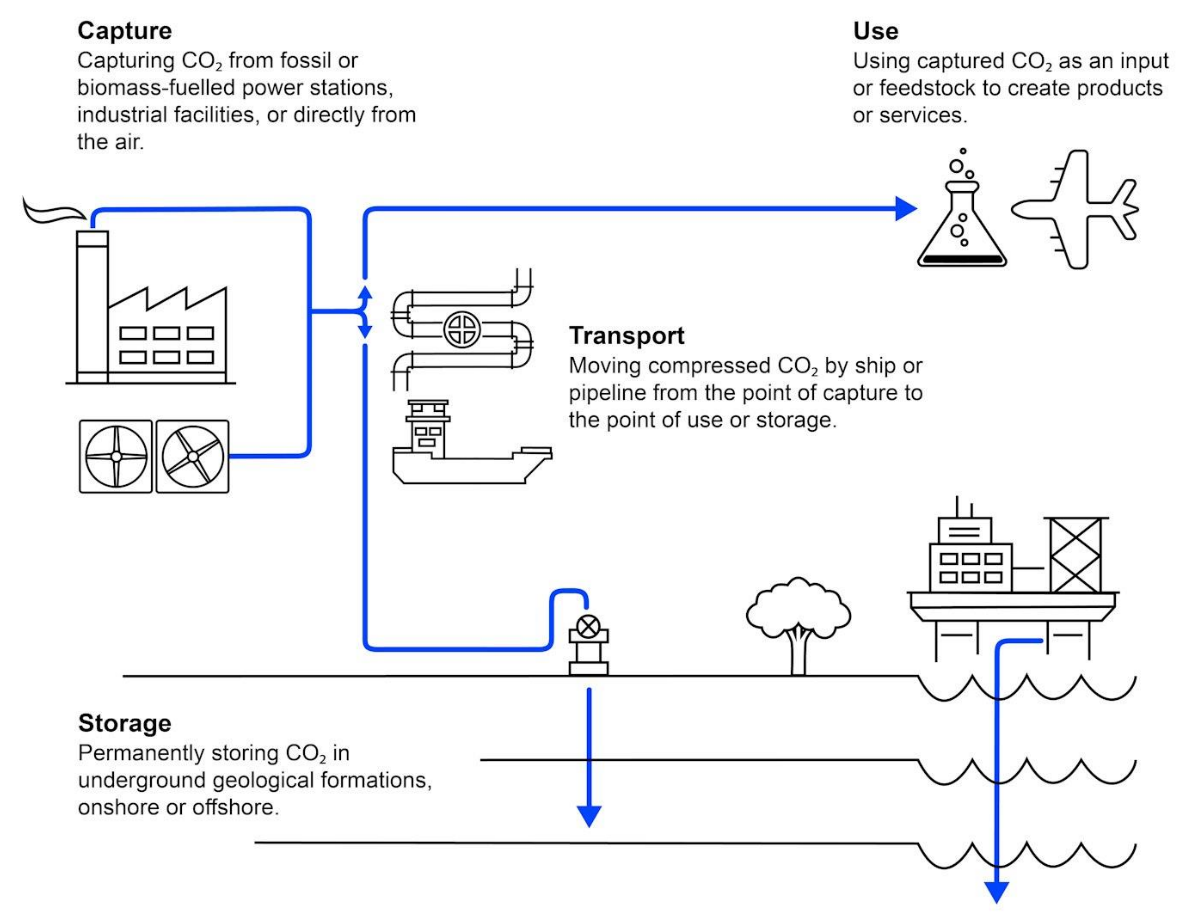

Figure 1 *an overview of CCUS*[3]

There are several technologies that can be used to capture CO_2, with varying degrees of usage and technological maturity. An IEA summary and description of these technologies is available online.[4]

Transporting CO_2

The two main options for the large-scale transport of CO_2 are via pipeline and ship, although for short distances and small volumes CO_2 can also be transported by truck or rail, albeit at higher cost per tonne of CO_2.

Pipelines are the cheapest way of transporting CO_2 in large quantities onshore and, depending on the distance and volumes, offshore. Transport by pipeline has been practised for many years and is already deployed at large scale. For example, there is an extensive onshore CO_2 pipeline network in North America, with a combined length of more than 8 000 km.

[3] IEA (2020) Special Report on Carbon Capture Utilisation and Storage
[4] https://www.iea.org/reports/about-ccus

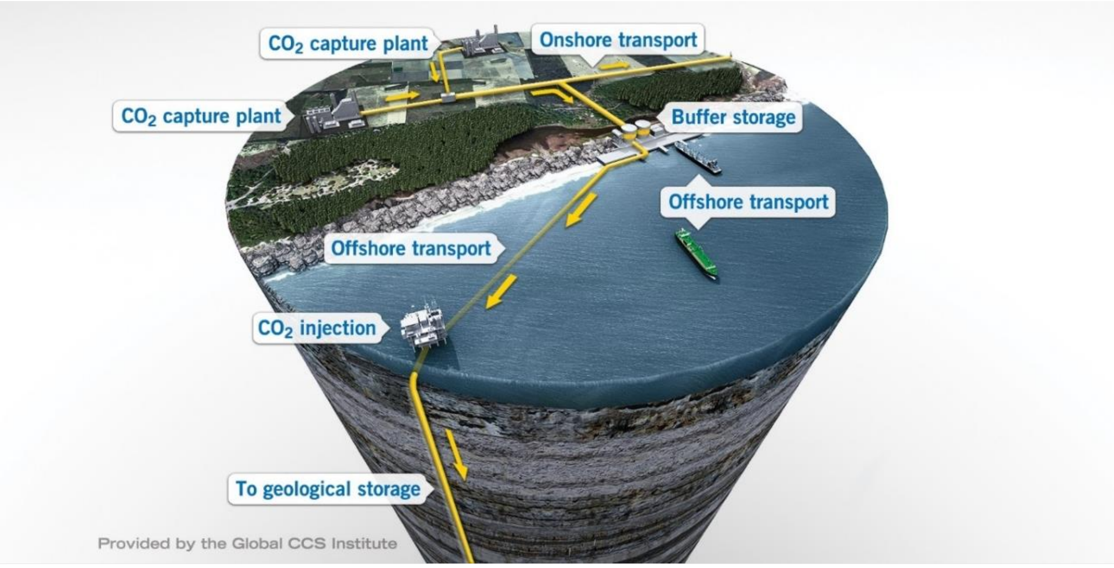

Figure 2. *CCUS Capture, Transport and Storage. Provided by the Global CCUS Institute.*

While CO_2 is currently shipped in small quantities for use in the food and beverage industry, large-scale transportation of CO_2 by ship has not yet been demonstrated but would have similarities to the shipping of liquefied petroleum gas and liquefied natural gas. Norway's Longship CCS project will be the first to transport large quantities of CO_2 to an offshore CO_2 storage site.

Storing CO_2

Storing CO_2 involves the injection of captured CO_2 into a deep underground geological reservoir of porous rock overlaid by an impermeable layer of rocks, which seals the reservoir and prevents the upward migration or "leakage" of CO_2 into the atmosphere. Depleted oil and gas reservoirs are porous rock formations that have trapped crude oil or gas for millions of years before being extracted and which can similarly trap injected CO_2.

The IEA estimates that global CO_2 storage resources will be well in excess of likely future requirements.[5]

Is captured carbon stored permanently?

According to the IEA, the nature and the type of the trapping mechanisms for reliable and effective CO_2 storage, are well-understood internationally, thanks to decades of experience in injecting CO_2 for enhanced oil recovery (**EOR**) and dedicated storage.[6] The IPCC has reported that the fraction of CO_2 retained in appropriately selected and managed reservoirs is "very likely to exceed 99% over 100 years, and is likely to exceed 99% over 1000 years."[7] Similar percentages retained are likely for even longer periods of time, as the risk of leakage is expected to decrease over time as other mechanisms provide additional trapping.

[5] https://www.iea.org/commentaries/the-world-has-vast-capacity-to-store-co2-net-zero-means-we-ll-need-it
[6] https://www.iea.org/reports/about-ccus
[7] https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport.pdf

A variety of monitoring technologies have been successfully deployed at storage sites around the world. Monitoring a CO_2 storage site occurs over its entire lifecycle from pre-injection to operation to post-injection. Operational and research experience over several decades demonstrates that injected CO_2 can be monitored to confirm its containment. According to the Global CCUS Institute, should a leak occur there are decades of experience to detect and then remediate a CO_2 leak.

Utilisation of CO2

Carbon capture and utilisation (**CCU**) refers to a range of applications through which CO2 is captured and used either directly (i.e. not chemically altered) or indirectly (i.e. transformed) into various products. According to the IEA, around 230 Mt of CO2 are currently used each year, mainly in direct use pathways in the fertiliser industry for urea manufacturing (~130 Mt) and for enhanced oil recovery (EOR) (~80 Mt). This may be compared to the total global operational CO_2 capture capacity in 2023/24 of around ~45Mt.[8]

New utilisation pathways in the production of CO2-based synthetic fuels, chemicals and building aggregates are gaining momentum. The IEA estimates that just under 15 Mt of CO2 per year could be captured globally for these new uses by 2030, including around 8 Mt CO2 in synthetic fuel production.

If all announced CCU projects are commissioned, the IEA estimates that they could reach around two-thirds of the level of CO2 utilisation needed for synthetic fuel production by 2030, as envisaged in the IEA's 'Net Zero Emissions by 2050' (NZE) Scenario[9]. However, for these fuels to be compatible with the NZE Scenario, all of the captured CO2 would need to come from air or biogenic sources. This is currently only the case for just over 4 Mt CO_2 per year of planned CCU to fuels capacity for 2030.

In New Zealand, CO_2 is currently used to:

a) Produce dry ice including for primary sector exports of meat and seafood (around 7% of seafood and 2% of meat exports) – this accounts for around 20 per cent of CO_2 use.

b) Produce beer – this accounts for around 15 per cent of our CO_2 use.

c) Serve beverages – around 11,000 hospitality venues rely on CO_2.

d) Package dairy exports such as milk powder – around $450m per annum of exports.

e) Improve the growth of greenhouse crops – such as tomatoes and capsicum.

f) Help weld heavy steel construction – such as bridges – as part of the welding gas mix.

g) Increase the shelf life of packaged products – especially meat, which reduces waste.

h) Help treat our drinking water to make it safe.

i) Supply the active gas for fire suppression systems.

[8] https://www.globalccsinstitute.com/wp-content/uploads/2024/01/Global-Status-of-CCS-Report-1.pdf
[9] https://iea.blob.core.windows.net/assets/ff3a195d-762d-4284-8bb5-bd062d260cc5/GlobalEnergyandClimateModelDocumentation2023.pdf

It has been estimated that just over half of the domestic CO_2 supply comes from production at Kapuni. The majority of the remainder is imported by BOC and Air Liquide with a much smaller amount being imported by Coregas. A few large businesses such as Coca Cola directly import CO_2.

International Perspectives on CCUS

There is growing international momentum for CCUS. Both the IPCC and the IEA consider that CCUS could play an important role in reducing global emissions.[10]

The IPCC acknowledges that CCUS is a major option for aligning future CO_2 emissions (from sources such as power generation and natural gas production) with emissions in their assessed least-cost global model pathways.[11] In 2023, the decision text of the COP28 global stocktake also highlighted the importance of accelerating removal technologies, such as CCUS.[12]

Some countries have played a leading role in supporting and enabling CCUS

CCUS uptake and planned deployment has recently increased in countries with clear enabling regulation, and strong policy support. Four useful case studies are Australia, the EU, Norway and Canada. The Australian Government has provided significant funding for CCUS development, and has implemented a dedicated regulatory framework, with some differences between states. The European Union is taking a mixed approach, with some funding for CCUS projects but also a focus on enabling regulation. Canada is focusing on developing regulatory and permitting frameworks. Further information on international regulatory regimes for CCUS is included in the Regulatory Impact Statement, published alongside this document.

Australia

Australia's Carbon Credit Unit Scheme

Australia's Carbon Credit Unit Scheme lets companies earn Australian carbon credit units (**ACCUs**) for each tonne of carbon stored or avoided. The units may then be sold to the federal government, or on the market to provide revenue. Private buyers purchase ACCUs to voluntarily offset their emissions or meet compliance requirements.

As part of the scheme, carbon capture and storage projects are included, and can be awarded ACCUs if project activities capture and inject CO_2 for permanent underground storage.[13]

Australia's CCUS monitoring regime

To participate in the ACCU, CCUS project proponents must develop and implement a CCUS project plan. This plan must outline how the project will be undertaken, including characteristics and operation of the storage site, and monitoring, verification and reporting activities.

If all injection activities have ceased, the licence holder for a storage operation must apply for a site closing certificate. If this application is accepted by the responsible minister, a pre-site closing

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[10] IEA (2020) Special Report on Carbon Capture Utilisation and Storage & IPCC (2022) Mitigation of Climate Change, Summary for Policy Makers.

[11] https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_HeadlineStatements.pdf

[12] COP28 global stocktake, decision text: https://unfccc.int/documents/637072

[13] https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/accu-scheme-methods/carbon-capture-and-storage-method

certificate may be issued setting out a monitoring and verification program, as well as a required level of security to cover the costs of that program.

Australia's National Greenhouse and Energy Reporting Scheme[14] provides the framework for counting emissions. The framework requires industry to share information about captured emissions, emissions stored underground, leaked emissions, and emissions sent to, or imported from, another country.

Long term liability for stored carbon in Australia – Indemnification after 15-years

If a CCUS facility is decommissioned, liability for CO_2 leakage may still exist. The liability for CCUS projects is typically specified in regulatory approvals granted by relevant Australian authorities. The project operators may be required to provide financial assurance or secure funds to cover post-closure activities, including long-term liability management.

If all injection activities have ceased the licence holder must apply to the responsible minister for a site closing certificate, who must decide on the application within 5 years of the application date.

The Australian state takes on liability for potential future damages resulting from CCUS activities if the responsible minister declares a closure assurance period. The minister can only declare a closure assurance period if 15 years has passed after a site closing certificate has been issued and the minister is satisfied that there are no significant risks of leakage. After the closure assurance period is declared, the government must indemnify the site operator against liability if the storage formation was specified under the GHG licence, and a site closing certificate is in force.

The European Union

The European Union's CCS directive, emissions trading scheme (EU ETS) and GHG quota system

The EU's Directive 2009/31/EC on the geological storage of CO_2 (CCS Directive) establishes the overall legal framework for the environmentally safe geological storage of CO_2.[15]

Since the 2015 amendment to the Emissions Trading Directive, capture, transport and storage installations are explicitly included in the EU ETS. CO_2 that is captured and safely stored is considered "not emitted". Currently, the ETS does not reward carbon capture and *utilisation* due to lack of evidence and methodologies.

The EU quota system establishes a maximum level of total emissions. This ceiling is reduced on an annual basis to ensure that contributions are made toward the system's set emission target when the relevant quota period expires. Quotas are either auctioned or allocated free. In recent years, the CO_2 price in the EU quota system has been increasing.

Norway's carbon tax, and connection to the EU ETS and quota system

Norway was one of the first countries in the world to introduce a carbon tax in 1991. The tax is levied on all combustion of gas, oil and diesel in petroleum operations on the continental shelf and on releases of CO_2 and natural gas, in accordance with the CO_2 Tax Act on Petroleum Activities. The 2005 Climate Quota Act connects Norway to the EU's quota system for greenhouse gas emissions,

14 https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme

[15] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF

and the country joined the European Emission Trading System in 2008. Norwegian companies are subject to the same quota obligations as those in the EU.

The combination of the CO_2 tax and a quota obligation (under the EU ETS) means that companies operating on the Norwegian continental shelf face an extremely high price per tonne for CO_2 they emit. Emissions pricing measures in Norway have incentivised two world leading CCS projects (Sleipner in 1996, and Snøhvit in 2008). Both facilities separate CO_2 from their respective produced gas, then compress, pipe and reinject it underground. More recently, the Norwegian government is supporting the Longship CCUS project, which is the first industrial CCUS chain in construction under the current European legal framework. This includes:

- a CO_2 capture project at the Heidelberg Materials cement factory in Brevik
- a CO_2 capture project at the Hafslund Celsios' Waste to Energy facility in Oslo
- the 'Northern Lights' transport and storage infrastructure (the final part of the Longship CCUS chain). CO_2 captured from across Europe can be transported and stored at the Northern Lights offshore storage facility in the North Sea.

The EU's monitoring regime for CCS

The EU has extensive requirements for selecting storage sites for CO_2.[16] A site can only be selected if prior analysis shows that, under the proposed conditions of use, there is no significant risk of leakage or damage to human health or the environment. If leakage does occur, operators must surrender emission allowances for any resulting emissions under the EU ETS. The monitoring regime in the EU includes:

- Monitoring and reporting CO_2 emissions
- Tracking capture efficiency
- Monitoring to ensure safe and efficient transport of CO_2
- Continuous monitoring of CO_2 storage sites to verify integrity
- Utilisation monitoring systems.

Long term liability for stored carbon in the EU – Indemnification after 20-years, and industry payment for 30-years of monitoring

Directive 2009/31/EC[17] of the EU establishes that long-term liability for CCS activities is eventually transferred to Member States. The EU framework functions similarly to Australia's, in that it provides for a minimum 20-year closure assurance-like period.

Several conditions must be met prior to transfer of liability, including that 'the CO_2 will be completely and permanently contained'. A report must be published by the operator before liability can be transferred, demonstrating that the storage site is evolving towards a situation of long-term stability.

[16] Directive - 2009/31 - EN - EUR-Lex (europa.eu)
[17] Directive 2009/31/EC of the European Parliament and of the Council [2009] OJ L 140/114. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF

A security must be paid by the operator to cover at least the cost of monitoring and post-transfer obligations of a Member State for a period of 30 years.

Canada

Canada's price on pollution, and CCUS investment tax credit

Canada has a Federal Carbon Pricing System, which is set out under the Canadian Greenhouse Gas Pollution Pricing Act.[18] The system includes a 'fuel charge', a regulatory charge on fossil fuels like petrol and natural gas. A separate performance-based regulatory emissions trading system is also designed to ensure that there is a price incentive for industrial emitters to reduce GHG emissions.

Projects that enable permanent CO_2 storage are also eligible for a refundable CCUS investment tax credit[19]. The credit is valued at $3.1 billion over the first 5 years, and around $7.6 billion up to 2030.

Canada's monitoring regime for CCUS activities

Canadian provinces hold much of the responsibility for regulating requirements for measurement, monitoring, verification and oversight of geological storage. However, there are federal responsibilities for certain aspects. As of 2017, all facilities engaged in CCUS activities are required to report to the Government of Canada the amounts of CO_2 captured, transported, injected (or used for enhanced oil recovery), and geologically stored. Facilities must also report CO_2 emissions (leakages) from equipment or infrastructure used in CCUS activities and from geological storage sites.

Long term liability for stored carbon in Alberta, Canada – Government can assume liability, with costs offset by an industry-financed Post-Closure Stewardship Fund

In Alberta Canada, the Mines and Minerals Act[20] (as amended by the Carbon Capture and Storage Statutes Amendment Act 2010) allows the Government to assume long-term liability for storage sites. The Act makes it mandatory for carbon capture and storage operators to contribute to the Post-Closure Stewardship Fund.

The Post-Closure Stewardship Fund is administered by the Department of Energy and financed by carbon-capture and storage operators in Alberta. CCUS operators that obtain a carbon sequestration lease are required to contribute to the fund. The amount paid into the fund is based on a project-specific rate per tonne of CO_2 injected into the sequestration lease each year.

The fund helps to finance long-term maintenance of storage sites after operations cease, and helps to offset the cost of the government's obligations, particularly in the post-closure period. The provincial government will use this fund for ongoing monitoring and any required maintenance and remediation.

[18] https://laws-lois.justice.gc.ca/PDF/G-11.55.pdf
[19] Refundable CCUS Investment Tax Credit (ITC)
[20] Mines and Minerals Act