Australian Government
Geoscience Australia

Submission to the Inquiry into the 2009 and 2013 amendments to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol)

Geoscience Australia

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Contents

Executive Summary

Geoscience Australia has considerable scientific and technical experience in relation to Carbon Capture (use) and Storage and will continue to have an important role in ensuring Australian Carbon Capture and Storage (CCS) projects and operators abide with the associated legislative, regulatory and operational requirements that give effect to the London Protocol.

Geoscience Australia's technical advice, geological expertise and offshore geological and marine studies will be required to provide Government, Australian offshore CCS proponents and regulators the evidence to support current and future decisions. Specifically, Geoscience Australia will inform and support:

- the Australian Government's future offshore Greenhouse Gas (GHG) Acreage Release areas;
- the exploration development and operations of offshore CCS facilities;
- development and implementation of current and future CCS policy and projects, including on matters such as transboundary movement of CO_2 and multi-agency input into Australia's contributions to the Meetings of the Scientific Groups to the London Convention and London Protocol;
- federal and state regulator(s) on operating and proposed CCS projects using our expertise in, for example, detection and mapping of micro and macro seismic events, Australia's earthquake hazard, and understanding the potential impacts of induced seismicity resulting from injection activities on faults in project areas;
- offshore CCS project proponents on geological matters to ensure the best outcome for the project;
- Australia's international science leadership by engaging with other nations who are or plan to pursue offshore CCS (such as Norway).

Geoscience Australia continues to provide technically sound precompetitive data, information and advice through new and updated geological studies, e.g. in areas such as offshore basin geology, including the impacts of CO_2 injection on faults, and understanding CO_2 and rock behaviour in the sub-surface. This will provide confidence in the successful and appropriate implementation and management of Australia's obligations under the London Protocol, including any future amendments.

Terms of Reference

This submission addresses the Terms of Reference (ToR) of the House of Representatives Standing Committee on Climate Change, Energy, Environment and Water inquiry into the 2009 and 2013 amendments to the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972* (London Protocol), regarding:

a. the environmental benefits and impacts of exporting and importing carbon dioxide streams for the purpose of sub-seabed sequestration,
b. the environmental benefits and impacts of marine geoengineering activity, such as ocean fertilisation, for scientific research,
c. the international market for carbon dioxide streams, and
d. the interaction of the proposed amendments with greenhouse gas inventories and regulatory and reporting streams.

Introduction

Geoscience Australia is Australia's national geoscience public sector organisation. Our mission is to be a trusted source of information on Australia's Earth science for government, industry and community decision-making. Our work covers the Australian landmass and marine jurisdiction, including external territories. Geoscience Australia delivers enduring data and advice that helps government, industry and the community to address challenges and enhance opportunities facing Australia now and into the future.

Geoscience Australia is the Australian Government's technical advisor on the Earth sciences of Australia and its marine jurisdiction and supports government policy development and implementation. We do this by delivering publicly available geoscience data and knowledge on Australia's energy and mineral resources and geological storage capacity, and foundational information on Australia's geography that are relevant to sub-seabed sequestration and marine geoengineering.

This submission outlines Geoscience Australia's capabilities in marine geoscience, geospatial information and geology that underpin our advice to government on matters relevant to the London Protocol.

Overview

Geoscience Australia is a national leader in applied marine geoscience and delivery of marine geospatial information that supports government priorities, especially the sustainable use and management of Australia's ocean area. We acquire, compile, analyse, integrate and interpret datasets that characterise seabed and sub-seabed environments across a range of scales (continental, regional, local). These data are used to produce accurate and detailed maps, which represent the seafloor shape and composition, habitats, and sub-seabed geological structure.

Geoscience Australia also plays a vital role in national coordination, bringing together the increasing volumes of marine geoscience data from multiple organisations into a single, national asset, and value-adding by interpreting the data and translating it into decision-ready products to benefit multiple users. These datasets and derived map products are delivered to end users through the Geoscience Australia portal.[1]

The marine geoscience information delivered by Geoscience Australia supports a range of applications, including:

- resource assessments of Australia's offshore energy geological potential, including petroleum (oil and gas), sites for geological carbon dioxide storage and offshore wind-power generation;
- scientific research to inform basin studies, biodiversity assessments, ocean and climate studies; and,
- environmental management of natural assets.

Geoscience Australia is also responsible for delivery of digital geospatial information depicting Australia's maritime boundaries and the extent of Commonwealth legislated zones, including for the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA), as well as improving access to information required for marine planning. This information is made publicly available through the Australian Marine Spatial Information System (AMSIS) online digital platform.[2]

Geoscience Australia has been researching Australia's Carbon Capture and Storage (CCS) potential for more than 20 years, providing geological and geospatial data and information both onshore and offshore, to assist governments with policy development and implementation, and industry investment. We provide technical advice to the Department of Industry, Science and Resources and the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on matters such as Greenhouse Gas Acreage Release areas, government carbon capture (use) and storage (CCS) initiatives, and CCS projects in Australia.

Geoscience Australia is undertaking work to improve our understanding of Australia's geological storage potential in strategic locations, considering geological, environmental and economic considerations to create the most cost-effective path to storage. This work supports planning and investment with respect to acreage release, projects, hubs, and potentially for storage of imported CO_2.

Under the Government's $225 million Exploring for the Future program,[3] Geoscience Australia is investigating Australia's onshore CO_2 storage potential. Through the Trusted Environmental and Geological Information program, which is being led by Geoscience Australia in collaboration with CSIRO, we are also examining the geological and environmental potential and impacts of CO_2 storage and broader resources developments in targeted basins.

[1] https://portal.ga.gov.au/

[2] https://amsis-geoscience-au.hub.arcgis.com/

[3] https://www.eftf.ga.gov.au/

Environmental benefits and impacts of exporting and importing carbon dioxide streams for the purpose of sub-seabed sequestration

Benefits and Impacts

The geological capture of carbon dioxide (CO_2) is a widely recognised strategy for helping to mitigate the potential impacts of global climate change, and for reducing acidification within the world's oceans (e.g. IPCC, 2007; The Royal Society, 2005). The potential environmental impacts of CO_2 capture and storage in geological basins are also acknowledged, as many countries assess and test the technology.

Carbon capture and storage (CCS) is a mature technology with commercial-scale projects operating around the globe, both onshore and offshore. CCS is regarded by many, including the International Energy Agency (IEA, 2020; 2021) and Intergovernmental Panel on Climate Change (IPCC, 2022), as an essential tool to meet emission targets and climate goals.

Even with full electrification, CCS will be required to abate emissions from industrial sectors that cannot be fully electrified (yet), for which there is, as yet, no alternative feedstock to natural gas or coal, or for those where CO_2 is a result of the manufacturing process (such as cement production). CCS is also required to produce blue hydrogen (clean hydrogen produced from fossil fuels with CO_2 capture and storage) and for removal of legacy CO_2 from the atmosphere through direct air capture and geological storage.

The 2009 Amendment to the London Protocol will allow transboundary movement of CO_2 for sub-seabed geological storage. The concept will be demonstrated by the world-first open-access Longship-Northern Lights project in the Norwegian North Sea. Operating under the Provisional Application to the 2009 Amendment, this project comprises a national hub that will store CO_2 imported from Norway and other European nations. Norway is a leader in CCS, having implemented the world's first commercial-scale offshore CO_2 storage project, Sleipner, in the North Sea in 1996. Much like Australia, Norway has low domestic CO_2 emissions (on a global scale) and considerable offshore geological storage resources that could be used for storage of CO_2 from geologically less well-endowed nations.[4, 5]

Storage of CO_2 in sub-seabed geological formations has been carried out internationally since the mid-1990s safely and without leakage (Alcalde et al., 2018). Industry is undertaking a considerable amount of work in these offshore regions to explore for suitable sites for CO_2 storage. Initially, these efforts largely aim to account for domestic emissions, however, future CO_2 storage hubs are being considered that could sequester both domestic and imported CO_2.

Globally, around 35 commercial Carbon Capture Use and Storage (CCUS) projects capture nearly 45 million tonnes (Mt) of CO_2 per year,[6] which is equivalent to growing 2 billion trees a year. Imperial College calculated that nearly 200 Mt CO_2 has been stored between 1996 and 2020 (Zhang et al., 2022). While this is significant, in the International Energy Agency's (IEA's) net zero scenario, more than 1.6 billion tonnes (Gt) of CO_2 needs to be stored each year by 2030 - equivalent to planting 80 billion trees each year (IEA, 2021; Climate Neutral Group, 2022).

Australia's annual greenhouse gas emissions to June 2022 were 486.9 Mt CO_2-e (DCCEEW, 2022). In comparison, Australia's geological storage potential is orders of magnitude larger, with a sub-commercial estimate of 20-30 Gt in the near to medium term and considerably more in undiscovered resources (Geoscience Australia; Oil and Gas Climate Initiative, 2022). Much of this storage resource is found in the sedimentary basins offshore Victoria (Gippsland Basin), Western Australia (Browse, Perth, Northern

[4] https://ccsnorway.com/the-project/

[5] https://norlights.com/about-the-longship-project/

[6] https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage

Carnarvon basins) and Northern Territory (Bonaparte Basin) (Figure 1). Onshore, the best storage potential is found in South Australia (Cooper Basin) and Queensland (Surat Basin).

A number of offshore CO_2 storage projects are proposed for Australia, including those exploring the newly awarded greenhouse gas (GHG) acreage areas offshore Western Australia and Northern Territory, as well as CarbonNet and SeaCCS in the Gippsland Basin, offshore Victoria. These projects are initially seeking to store related emissions (largely from natural gas processing), with some looking to take on third party CO_2 in the future, either domestic or imported. The Petrel Sub-basin is a particularly promising and strategic location for CO_2 storage hubs.

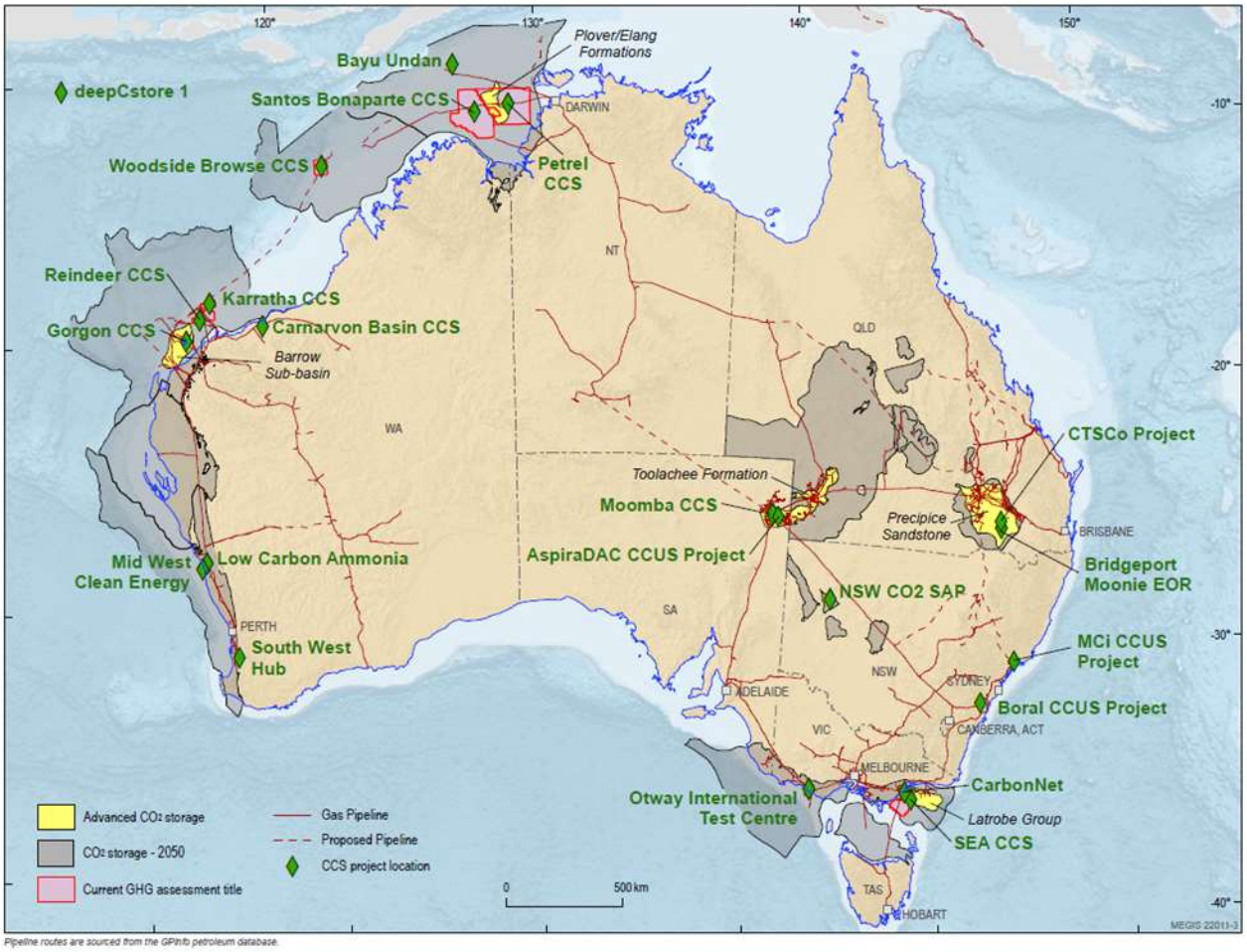

Figure 1: Carbon capture, utilisation and storage projects (proposed, feasibility, under construction, operating) across Australia as of December 2022. Also shown are advanced storage sites (yellow) and regions with mid-term storage potential (grey) (updated from Geoscience Australia, 2022).

CO_2 Leakage

In the marine environment, sub-seabed sequestration of CO_2 as an option has been under consideration for over two decades, including within Australia, with the Sleipner CCS Project in the North Sea operating since 1996 From the impact perspective, of primary concern is the potential impact of CO_2 leakage into ocean waters, either during the transport and injection process, or following sequestration into a geological formation (sedimentary rock) (Carroll et al., 2014).

It is important to note that to date, no leakage has been detected from any CO2 storage project, including those located offshore. The risk is extremely low and can be mitigated, noting that the security of geological storage increases with time, as CO2 becomes trapped in the subsurface through several mechanisms.

Although highly unlikely, potential leakage points are always considered as part of any development. For example, CO_2 leakage could occur:

- through an injection well, which can be shut off and remediated;
- through legacy wells that intersect the storage formation, although these are not likely not be included or approved in a declared storage site;
- a geological fault, although these are typically screened out during site assessment; and
- infrastructure such as pipelines or shipping incidents, which would require remediation of the infrastructure.

Monitoring technologies allow for detailed tracking of CO_2 once injected as well as detecting potential leakage points. Modelling has shown that, even in the event of a catastrophic leakage event from the subsurface, the released CO_2 would dissolve into the water and disperse within 50 m of the seafloor (Oldenburg and Pan, 2020). Dissolution into the surrounding seawater is observed in natural CO_2 leakage scenarios such as sub-sea volcanic vents.

Other potential risks and impacts, excluding CO_2 leakage or release, include CO_2 purity and induced seismicity as detailed below.

CO_2 purity

The purity of CO_2 is a risk factor, particularly when it is imported from countries with potentially different requirements to Australia and could in turn, if not managed appropriately, adversely affect the efficiency of transport and storage of CO_2. For example, depending on composition, impurities in the CO_2 stream could affect transport infrastructure (pipelines, ships) by corroding the materials, and possibly pose a safety or environmental hazard. Impurities could also affect the behaviour of CO_2, for example, the conditions at which it becomes supercritical (very dense) for storage.

This is a low risk as the London Protocol requires the injection stream to be “overwhelmingly carbon dioxide”, providing a consistent definition for countries under the Protocol to abide by. Geoscience Australia’s technical expertise would assist the government to ensure that this requirement is being met by Australian CCS operators.

Induced seismicity

Injection of substances such as CO_2 or water into the subsurface could induce some seismic activity, and possibly reactivation of faults at some distance from the injection site (this does not, however, mean that CO_2 would be released). This can be initially managed through continuous monitoring of seismic activity and faults in the region of the injection, and through production of water or brine from the storage formation with the intention of making more space for injected CO_2 and reducing the risk of seismic activity. Further research is required; Geoscience Australia demonstrates leadership in this research. For example, Geoscience Australia is conducting a fault-injection experiment with CO2CRC and geomechanical research to understand the behaviour of CO_2 and faults in the sub-surface.

Relevant activities

Seabed and sub-seabed information is a key requirement for understanding the potential impacts of CO_2 leakage from geological storage. The information provided by seabed mapping allows for a detailed understanding of the physical characteristics of the seabed, its connection to deeper geological structures, and of the biological communities (habitats) that may be impacted by CO_2 seepage in the unlikely event that CO_2 migrates out of the storage formation. It is essential that this information is collected at local scales, specific to the location of CO_2 storage. It is also important that these studies are placed in a regional context, particularly with regard to ‘downstream’ effects.

Geoscience Australia has demonstrated experience in applied research to better understand the risks of CO_2 leakage from geological storage through an integrated program of seabed studies. For example, as part of the National Low Emission Coal Initiative (NLECI) and National CO_2 Infrastructure Plan ((NCIP) (2012-2015),

Geoscience Australia provided assessments of seabed features and associated biota in areas identified as potentially suitable for sub-seabed CO_2 sequestration (Heap et al., 2014; Carroll et al., 2014). Prospective sites offshore northern, southwest and southeast Australia were considered, with mapping that targeted seabed features diagnostic of CO_2 seepage from the sub-seabed (or other fluids) (see Carroll et al., 2012; Nicholas et al., 2013, 2014; Picard et al. 2018).

International best practice for monitoring of geological CO_2 storage involves marine environmental characterisation to understand natural baselines and an adaptive monitoring approach (Dean et al. 2020; Blackford et al. 2021).

Geoscience Australia contributes its marine geoscience capabilities to national initiatives to advance our understanding of the marine environment and the risks associated with sub-seabed CO_2 storage. Key activities include the development of national guidelines for data acquisition to ensure common standards are used when monitoring (Przeslawksi and Foster, 2020); use of new technologies (e.g. Autonomous Underwater Vehicles and Remote Underwater Vehicles) to enable more precise observations of the seabed; and production of regional seabed maps depicting the shape and composition of seabed features.

Opportunities

An understanding of the environmental benefits and impacts (risks) associated with sub-seabed sequestration of CO_2 is critical to supporting Australia's commitments toward reduced carbon emissions and maintaining healthy ecosystems, onshore and offshore Australia. To that end, the application of a scientifically rigorous approach to assessing Australia's geological storage potential, identifying suitable sites and understanding potential impacts is essential. Moreover, the use of new technologies and standards to collect the information needed will ensure Australia is at the forefront internationally in this emerging field.

Australia has an opportunity to continue to promote 'best practices' with regard to setting and adopting standards for environmental information that is used to understand the benefits and impacts of activities in the marine area. A key mechanism for achieving uptake of such standards across the marine sector is through collaborative programs. Government can continue to play a role in resourcing and supporting collaboration across sectors, as it is already doing (e.g. National Environmental Science Program). Geoscience Australia is well placed to participate in such collaborative programs and to bring a unique capability in marine geoscience to address the challenge of understanding the opportunities and impacts of sub-seabed sequestration of CO_2.

Environmental benefits and impacts of marine geoengineering activity, such as ocean fertilisation, for scientific research

Benefits and impacts

Geoengineering refers to deliberate large-scale intervention in the Earth's natural systems to counteract climate change. It includes a range of technologies with the potential to make a significant contribution to climate change mitigation and maintenance of healthy marine and coastal ecosystems through 'nature-based' solutions. In addition to ocean fertilisation, coastal carbon sequestration provides an alternate geoengineering technique with significant environmental benefits. Coastal carbon sequestration refers to the enhancement of 'blue carbon' stocks in coastal and marine ecosystems, notably by cultivation of macroalgae in nearshore waters and restoration of coastal mangrove and saltmarsh areas. The environmental benefits of restoring marine and coastal ecosystems derive from enhancing the contribution to processing (filtering) of nutrients (including pollutants) and sediments received from land, and in removing carbon dioxide from the atmosphere.

Potential impacts of coastal carbon sequestration, particularly through introduction of cultivated species, include facilitation of disease, alteration of population genetics and unintended alterations to the local physical and/or chemical environment. These impacts are likely to be low risk for current small-scale cultivation projects, but warrant greater consideration for any future large-scale cultivation activities.

Relevant activities

Geoscience Australia delivers data and information products that can support the design and implementation of geoengineering activities. These products include:

- Seabed maps published through AusSeabed[7] depicting the depth, shape and composition of nearshore areas to identify sites suitable for cultivation of macroalgae. These maps show the locations of stable (rock) reefs that are required for the re-establishment of species such as giant kelp (as is currently being trialled along the east coast of Tasmania by the University of Tasmania).[8]
- National maps showing the distribution of mangrove canopy cover published on the DEA Portal[9] DEA mangrove cover product provides valuable information about the extent and density of mangroves from 1987 to 2022 for the entire Australian coastline. These maps are currently used to underpin research on the potential for mangrove carbon sequestration by the University of Wollongong[10] (with support from Geoscience Australia), and contribute to National Ocean Account Estimates through the DCCEEW and the Australian Bureau of Statistics (ABS) (with support from Geoscience Australia), and contribute to National Ocean Account Estimates through the DCCEEW and the Australian Bureau of Statistics.
- AMSIS[11] provides digital access to official information on maritime boundaries, geographic extents of Commonwealth regulation, use of the marine environment and relevant scientific information (e.g. seabed maps). This information is pertinent to the planning of proposed geoengineering activities, particularly regarding existing infrastructure, marine protected areas, fisheries and shipping activities.

[7] https://portal.ga.gov.au/persona/marine
[8] https://www.imas.utas.edu.au/news/news-items/restoring-tasmanias-giant-kelp-forests-the-focus-of-new-research-project
[9] https://www.dea.ga.gov.au/products/dea-mangrove
[10] https://www.uow.edu.au/global-challenges/sustaining-coastal-and-marine-zones/blue-carbon
[11] https://amsis-geoscience-au.hub.arcgis.com/

Geoscience Australia marine and coastal data and information supports the development of emerging technologies such as coastal carbon sequestration by reducing uncertainty with regard to the potential for success of such projects.

Opportunities

As with the sub-seabed sequestration of CO_2, the suitability of geoengineering and nature-based solutions requires a scientifically rigorous approach to better understand the biophysical factors at play. Such research is currently being undertaken at the local scale by universities and science agencies (e.g. CSIRO), including through projects funded by the National Environmental Science Program Marine and Coastal Hub.[12] There is therefore an opportunity for these efforts to be better co-ordinated nationally (Saunders et al., 2022). This extends to development of nationally consistent spatial datasets that map and classify coastal and marine ecosystems. Geoscience Australia can play a role in this regard and is working closely with DCCEEW to establish this capability utilising satellite data in the coastal zone for ecosystems such as saltmarsh and mangroves.

[12] https://www.nespmarinecoastal.edu.au/project-1-6/

International markets for carbon dioxide streams

There is no established international trade of CO_2 for the purpose of geological storage. However, there is significant interest in Australia's geological storage potential from nations in the Asia-Pacific region, including Singapore, Korea, and Japan. Like Australia, they are committed to rapidly decarbonising their economies to net zero by 2050 but have little or no domestic geological storage.

With its large storage potential, Australia is therefore an attractive proposition. The majority of Australia's geological potential lies in the hydrocarbon-producing basins offshore Western Australia, Northern Territory, and Victoria. Recently, the Japanese company Inpex, for example, has secured Greenhouse Gas acreage in the Petrel Sub-basin and has committed to an extensive exploration work program.

Australia has several competitive advantages in the Asia-Pacific region with respect to CO_2 storage which includes:

- experience in commercial scale CCS (e.g. Gorgon CCS Project) with several other commercial CCS projects in various stages of development (Figure 1);
- an established legislative and regulatory environment with expertise in CCS regulation and monitoring; and
- relatively low domestic GHG emissions but enormous potential for geological storage of CO_2, both onshore and offshore.

Government-funded precompetitive data and information provided by Geoscience Australia has had a significant impact on generating interest and investment in the establishment of CCS projects both onshore and offshore. This includes studies that led to the award of five offshore areas, as part of the Government's 2021 Greenhouse Gas Acreage Release, for CO_2 storage exploration programs that have a minimum exploration value of A$271m for the primary term of the permit, up to a potential maximum of A$400m[13]. The work programs in these blocks include drilling new offshore appraisal wells and 3D seismic data acquisition.

Currently, the London Protocol, under the Provisional Application of the 2009 Amendment (2019), allows for arrangements for cross-jurisdictional movement of CO_2 for storage to be made. The Norwegian Government is using the Provisional Application to develop the world-first, cross-border, open access, full-scale CCS project, Longship-Northern Lights. Under this project, CO_2 will be imported from Norwegian and European emission sources such as a cement plant (Norcem), waste-to-energy facility (Hafslund Oslo Celsio), and fertiliser manufacturer Yara in the Netherlands, and temporarily stored onshore in Norway before being transferred by pipeline to an offshore storage site in the North Sea (Figure 2).

Geoscience Australia is engaging with the Norwegian Government as part of the newly established bilateral relationship on CCUS. The Department of Climate Change, Energy, the Environment and Water is leading this engagement with potential collaboration on regional monitoring and management considerations for large CCS projects. The establishment of the Northern lights project will see both Australia and Norway hosting the world's largest CO_2 injection projects.

[13] National Offshore Petroleum Title Authority

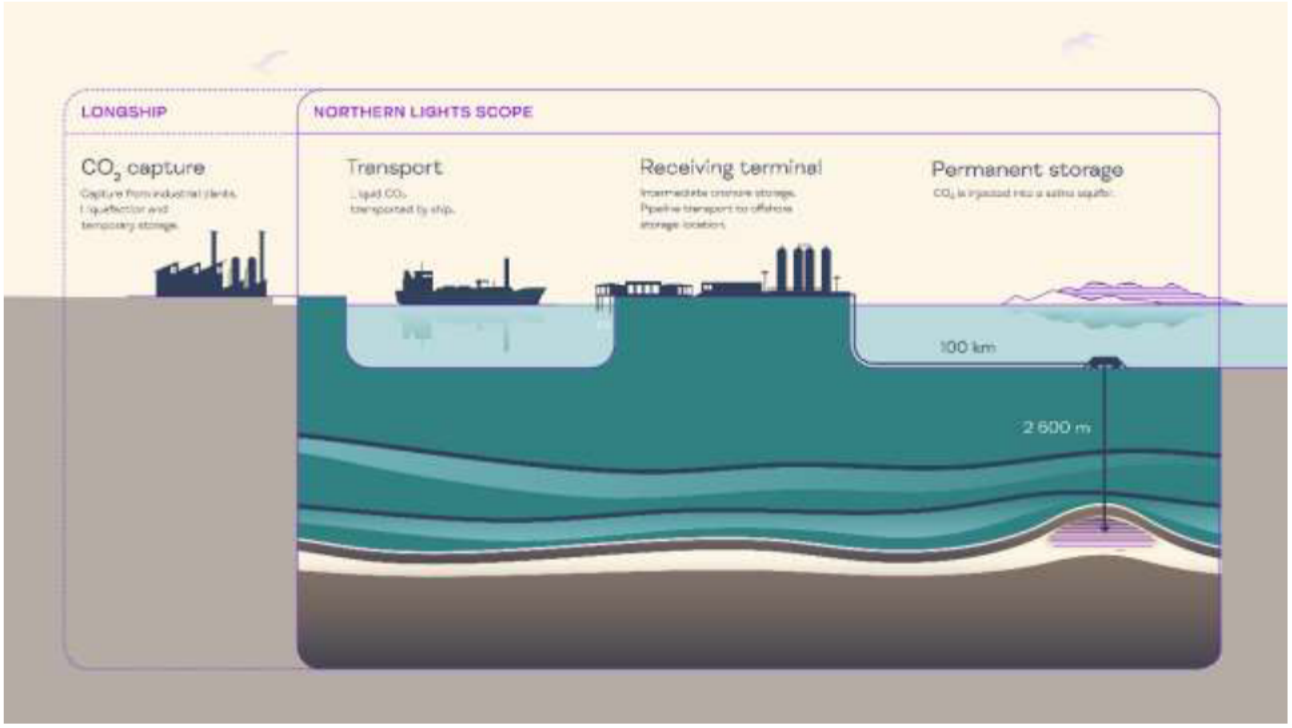

Figure 2: Pictorial representation of the Longship - Northern Lights operation[14]

[14] https://norlights.com/about-the-longship-project/

Interaction of the proposed amendments with greenhouse gas inventories and regulatory and reporting streams

Australia gives effect to the London Protocol through the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) and the OPGGSA, which provides the legislative framework for GHG storage in Commonwealth waters.

Under the OPGGSA, approvals are required for GHG activities including exploration for CO_2 storage sites through the Greenhouse Gas Acreage Release program, declaration of storage formation, injection and storage licences, and the operation, monitoring and closure of projects offshore. Project proponents are required to meet stringent technical and environmental conditions and the source of the greenhouse gas must be identified.

Australia's commonwealth offshore regulatory regime requires approvals at all stages of CO_2 offshore sequestration operation, exploration, development, operational and closure/decommissioning. These are issued by the National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) Australia's independent offshore energy regulator established under the OPGGSA. NOPSEMA is also authorised to regulate protected matters under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Finally, a permit is required under the Sea Dumping Act for the injection of CO_2 into sub-seabed formations from an offshore platform or facility. The process and issuance of approvals is led by DCCEEW.

Operation in waters within state and territory limits is a matter for the jurisdiction.

Conclusion

Geoscience Australia's technical advice, our offshore geological and marine expertise and data acquisition programs and continued engagement domestically and internationally in respect to offshore carbon sequestration will remain a critical component of ensuring the continued and appropriate implementation of the London Protocol. It will be required to provide Government, Australian offshore CCS proponents and regulators, the evidence to support current and future decisions. It will also be required in delivering new offshore marine and geological data and information in areas such as offshore basin geology, the impacts of CO_2 injection on faults, and understanding CO_2 and rock behaviour in the sub-surface will be needed.

The technical information and evidence delivered by Geoscience Australia's science programs will demonstrate and uphold 'best practice' in regard to setting and adopting standards for environmental data information across a range of marine activities. It will also provide a science framework for ensuring Australia's obligations under the London Protocol, including any future amendments, continues to be met.

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