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Hon Tony Zappia MP
Chair of the House Standing Committee on Climate Change, Energy, the Environment and Water
PO Box 6021
Canberra ACT 2600

10 March 2023

RE: Submission regarding the Inquiry into the 2009 and 2013 Amendments to the London Protocol (the "Submission")

Dear Chair of the House Standing Committee on Climate Change, Energy, Environment and Water,

My name is Daein Cha, Managing Director and Chief Executive Officer of deepC Store Pty Ltd ("**dCS**"). I am writing to you to make a Submission. For information about dCS, please see attached Appendix 1.

In response to your request for a Submission, please find below my contribution.

Submission Key Summary (see "Details regarding the Submission" section for more information)

1. **Regarding environmental benefits and impacts of exporting and importing carbon dioxide streams for the purpose of sub-seabed sequestration:**
   1) Carbon Capture Utilisation and Storage ("**CCUS**") is a key contributor and indispensable for Australia and the world to materially reduce emissions as per the interim 2030 and 2050 Paris Agreement targets.
   2) While noting the importance of pursuing technology and project development for Carbon Capture and Utilisation ("**CCU**"), the relatively limited market size for CCU applications (~5% of CCUS[1]) means that Carbon Capture and Storage ("**CCS**") should remain the primary focus of CCUS deployment.
   3) Australia has a large potential geological Carbon Dioxide ("**CO_2**") storage capacity (434 billion tonnes[2]), sufficient to potentially reduce ~870 years of Australia's emissions[3]. Noting the recognition by the Contracting Parties of the London Protocol that (1) CCS should not be considered as a substitute to other measures to reduce CO_2 emissions but considered as an important interim solution[4] and (2) not all countries have suitable sub-seabed geological

[1] IEA (2020) "CO_2 Capture and Utilisation" and IEA (2020) "Net Zero by 2050 A Roadmap for the Global Energy Sector" page 79. Available at https://www.iea.org/reports/co2-capture-and-utilisation and https://www.iea.org/reports/net-zero-by-2050.

[2] Carbon Storage Taskforce (2009) "National Carbon Mapping and Infrastructure Plan – Australia" pages 28 and 31. Available at https://www.parliament.wa.gov.au/parliament/commit.nsf/($lookupRelatedDocsByID)/518FAC2BBA6C246648257C29002DB8E6/$file/NCM_Full_Report.pdf

[3] Assuming Australia's current greenhouse gas emissions of 500 million per annum, as per Australian Government (2022) "Australia's Nationally Determined Contribution – Communication 2022" Page 7. Available at https://unfccc.int/sites/default/files/NDC/2022-06/Australias%20NDC%20June%202022%20Update%20%283%29.pdf

[4] Resolution LP.5(14) on The Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (Adopted on 11 October 2019) Page 2. Available at https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.5(14).pdf

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formations for the sequestration of CO_2 streams[5], Australia is favourably positioned to enable a series of domestic and transboundary CCS projects and offer significant contributions to the world for materially reducing CO_2 emissions. In that context, distance between geological CO_2 storage sites and emission sources remains a key challenge.

4) The technology maturity of CCS is high, with Research and Development ("**R&D**") activities for technologies related to large-scale liquefied CO_2 shipping and Floating Storage and Injection ("**FSI**") Hub facilities needed to address the key challenge of distance between geological CO_2 storage sites and emission sources, lower cost barriers, and fully unlock Australia's geological CO_2 storage potential. In this regard, dCS seeks the Australian Commonwealth Government's policy support including grant funding for such R&D activities.

5) While the geological CO_2 storage technology is mature for commercial deployment, the key to successful geological storage is to correctly select and appraise suitable geological storage sites. This will allow for the intended environmental benefits of material CO_2 emissions reduction to be delivered and also for the environmental impacts associated with building and operating a series of domestic and transboundary CCS projects to be prudently managed.

6) Australia has mature regulatory frameworks, that are compatible with the London Protocol, to manage the environmental impacts associated with building and operating a series of domestic and transboundary CCS projects while unlocking material environmental benefits from CO_2 emission reduction.

7) Based on the above dCS requests, by no later than 2025, for the Australian Commonwealth Government to not only (1) accept the 2009 Amendment to the London Protocol for supporting ratification, but to also (2) submit its declarations on the provisional application of the 2009 Amendment with the International Maritime Organisation ("**IMO**"), and (3) execute agreements or arrangements between prospective CO_2 exporting countries in the Asia Pacific region such as Japan, Korea and Singapore for enabling a series of transboundary CCS projects in Australia.

8) Other considerations regarding the 2009 Amendment to the London Protocol are as follows:

    (a) Need to develop a National Action List for the assessment of CO_2 streams for sequestration; and

    (b) Economic and social benefits that the development of each domestic and transboundary CCS project can offer for Australia.

2. Regarding the environmental benefits and impacts of marine geoengineering activity, such as ocean fertilisation, for scientific research:

dCS refrains from commenting in relation to this matter.

3. Regarding the international market for CO_2 stream:

[5] Resolution LP.5(14) on The Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (Adopted on 11 October 2019) Page 2. Available at https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.5(14).pdf

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The International Energy Agency ("**IEA**") highlights that globally, some 230 million tonnes of CO_2 are used every year by conventional users (e.g., fertiliser, oil and gas, food and beverage industries)[6]. This equates to less than 1% of total global CO_2 emissions from energy combustion and industrial processes (36.8 billion tonnes in 2022)[7].

While the international market for CO_2 streams for direct use by conventional users may grow, the international market for physical CO_2 streams for CCU will likely remain relatively small (~5% of CCUS[8]). Therefore, CCU can complement CCS, but is not an alternative to CCS.

4. **Regarding the interaction of the proposed amendments with greenhouse gas inventories and regulatory and reporting streams:**

   For transboundary CCS activities, Australia can manage the interaction of the proposed 2009 Amendment with its greenhouse gas inventories and regulatory and reporting streams by using its existing CCS policies and legal frameworks. dCS notes that Australia's National Inventory Reports 2020 (1) already includes information on fugitive emissions of greenhouse gases associated with CCS (CO_2 underground injection system for the Gorgon LNG project)[9], and (2) states that for the Gorgon and future commercial CCS projects, the (Australian) Commonwealth Government will source estimates of fugitive emissions of greenhouse gases from data collected under the National Greenhouse and Energy Reporting Scheme ("**NGER Scheme**")[10].

   For marine geoengineering activities, dCS refrains from commenting on this matter.

Details regarding the Submission

1. **Regarding environmental benefits and impacts of exporting and importing CO_2 streams for the purpose of sub-seabed sequestration:**

   1) **CCUS is a key contributor and indispensable for Australia and the world to materially reduce emissions as per the interim 2030 and 2050 Paris Agreement targets.**

      As recognised by leading international bodies and organisations such as the United Nation's Intergovernmental Panel on Climate Change and IEA, the commercial scale deployment of CCUS technologies needs to attain a global CO_2 reduction capacity of ~4 billion tonnes per annum by 2050 to achieve Paris Agreement targets[11]. This is in addition to all of the CO_2 reduction contributions that technologies such as hydrogen bioenergy other renewables electrification and other fuel shifts are expected to achieve as per the image below[12].

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[6] IEA (2019): "Putting CO_2 to Use – Creating Value from Emissions." Available at https://www.iea.org/reports/putting-co2-to-use

[7] IEA (2023): "CO2 Emissions in 2022" page 3. Available at https //iea.blob.core.windows.net/assets/3c8fa115-35c4-4474-b237-1b00424c8844/CO2Emissionsin2022.pdf

[8] IEA (2020) "CO_2 Capture and Utilisation" and IEA (2020) "Net Zero by 2050 A Roadmap for the Global Energy Sector" page 79. Available at https://www.iea.org/reports/co2-capture-and-utilisation and https://www.iea.org/reports/net-zero-by-2050.

[9] Commonwealth Government (2022), "Australia's Tracking and reporting greenhouse gas emissions" page xxiii of Volume 1. Available at: https://www.dcceew.gov.au/sites/default/files/documents/national-inventory-report-2020-volume-1.pdf

[10] Commonwealth Government (2022), "Australia's Tracking and reporting greenhouse gas emissions" page 166 of Volume 1. Available at: https://www.dcceew.gov.au/sites/default/files/documents/national-inventory-report-2020-volume-1.pdf#page=189&zoom=100,0,0

[11] IEA (2020): "CCUS in the transition to net-zero emissions." Available at: https://www.iea.org/reports/ccus-in-clean-energy-transitions/ccus-in-the-transition-to-net-zero-emissions

[12] Same as above.

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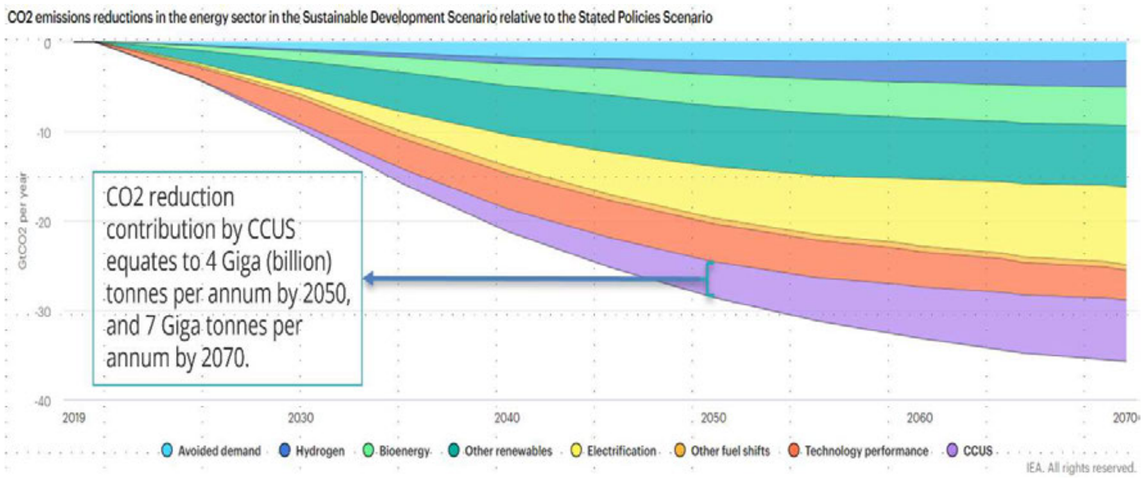

Figure 1: CO_2 Emission Reductions in the Energy Sector in the Sustainable Development Scenario[13]

2) **While noting the importance of pursuing technology and project development for CCU, the relatively limited market size for CCU applications (~5% of CCUS) mean that CCS should remain the primary focus of CCUS deployment.**

IEA highlights that, "globally, some 230 million tonnes of CO_2 are used every year. The largest consumer is the fertiliser industry, where 130 million tonnes CO_2 is used in urea manufacturing, followed by oil and gas, with a consumption of 70 to 80 million tonnes CO_2 for enhanced oil recovery. Other commercial applications include food and beverage production, metal fabrication, cooling, fire suppression and stimulating plant growth in greenhouses. Most commercial applications today involve direct use of CO_2."[14] To put into context, "global CO_2 emissions from energy combustion and industrial processes in 2022 was 36.8 billion tonnes[15]." Hence, the current international CO_2 market equates to less than 1% of total global CO_2 emissions from energy combustion and industrial processes.

IEA further highlights that:

(a) while some CO_2 utilisation could bring substantial climate benefits, the relatively limited market size for these applications means dedicated storage should remain the primary focus of CCUS deployment[16];

(b) In the Net Zero Scenario:

(1) over 95% of total CO_2 captured in 2030 is geologically stored and less than 5% is utilised[17]; and

[13] IEA (2020): "CCUS in the transition to net-zero emissions." Available at: https://www.iea.org/reports/ccus-in-clean-energy-transitions/ccus-in-the-transition-to-net-zero-emissions

[14] IEA (2019): "Putting CO_2 to Use – Creating Value from Emissions." Available at https://www.iea.org/reports/putting-co2-to-use

[15] IEA (2023): "CO_2 Emissions in 2022" page 3. Available at https://iea.blob.core.windows.net/assets/3c8fa115-35c4-4474-b237-1b00424c8844/CO2Emissionsin2022.pdf

[16] IEA (2020) "CO_2 Capture and Utilisation." Available at https://www.iea.org/reports/co2-capture-and-utilisation

[17] Same as above.

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(2) around 95% of total CO_2 captured in 2050 is geologically stored and 5% is utilised[18].

The limited CO_2 reduction contribution that is expected via CCU is also due to low emission and cost effective CCU applications still being in the early phases of development. The Commonwealth Scientific and Industrial Research Organisation ("**CSIRO**") highlights that[19]:

(c) different CCU applications will be developed over different time-horizons and have higher associated costs when compared to their current equivalent products and feedstocks;

(d) effective displacement will likely require renewable energy to power processes and large quantities of hydrogen as feedstock, while some will require substantial quantities of other inputs, such as mine tailings or minerals for carbonation; and

(e) In addition different CCU applications can lock in CO_2 for different time periods which impacts their carbon abatement and storage potential. "For example, some CCU applications can store CO_2 away for the long term, such as some high value polymers, or permanently in the case of most mineral carbonation applications. Products with shorter lifespans include fuels where the CO_2 contained within the product is released to the atmosphere when that product is used.[20]"

CSIRO further notes that[21]:

(f) creating the right incentives and minimising barriers to entry will be key for scale up, as almost all near term CCU applications will incur a green premium (i.e., the additional cost of choosing the low-carbon alternative). An exception is mineral carbonation which could be competitive in the near-term depending on the use case.

(g) The commercial potential of CCU applications will hinge on the speed at which green premiums can be reduced, and how incentives and policy and regulatory mechanisms can be used to bridge the remaining gap.

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[18] IEA (2020) "Net Zero by 2050 A Roadmap for the Global Energy Sector" page 79. Available at https://www.iea.org/reports/net-zero-by-2050

[19] CSIRO (2021): "CO_2 Utilisation Roadmap" page 4. Available at https://www.csiro.au/CO2utilisation

[20] CSIRO (2021): "CO_2 Utilisation Roadmap" page 19. Available at https://www.csiro.au/CO2utilisation

[21] CSIRO (2021): "CO_2 Utilisation Roadmap" page 10. Available at https://www.csiro.au/CO2utilisation

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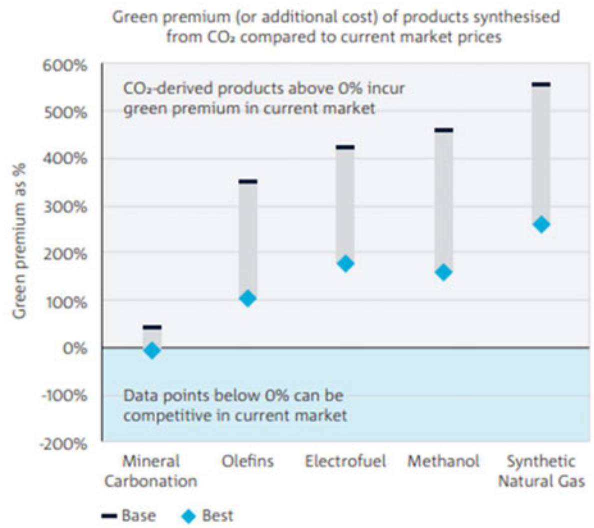

Figure 2: Additional cost of CCU products compared to current equivalent products[22]

While the international market for CO_2 streams for direct use by conventional users may grow, the international market for physical CO_2 streams for CCU will likely remain relatively small. Therefore, CCS should remain the primary focus of CCUS deployment for Australia and the world to materially reduce emissions as per the interim 2030 and 2050 Paris Agreement targets.

3) **Australia has a large potential geological CO_2 storage capacity (434 billion tonnes), sufficient to potentially reduce ~870 years of Australia's emissions. Noting the recognition by the Contracting Parties of the London Protocol that (1) CCS should not be considered as a substitute to other measures to reduce CO_2 emissions but considered as an important interim solution and (2) not all countries have suitable sub-seabed geological formations for the sequestration of CO_2 streams, Australia is favourably positioned to enable a series of domestic and transboundary CCS projects and offer significant contributions to the world for materially reducing CO_2 emissions. In that context, distance between geological CO_2 storage sites and emission sources remains a key challenge.**

Australia has a large potential geological CO_2 storage capacity of 434 billion tonnes[23]. Assuming Australia's current greenhouse gas emissions of 500 million per annum[24], CCS projects can potentially reduce ~870 years of Australia's emissions.

[22] CSIRO (2021): "CO_2 Utilisation Roadmap" page 10. Available at https://www.csiro.au/CO2utilisation
[23] Carbon Storage Taskforce (2009) "National Carbon Mapping and Infrastructure Plan – Australia" pages 28 and 31. Available at https://www.parliament.wa.gov.au/parliament/commit.nsf/($lookupRelatedDocsByID)/518FAC2BBA6C246648257C29002DB8E6/$file/NCM_Full_Report.pdf
[24] Australian Government (2022) "Australia's Nationally Determined Contribution – Communication 2022" Page 7. Available at https://unfccc.int/sites/default/files/NDC/2022-06/Australias%20NDC%20June%202022%20Update%20%283%29.pdf

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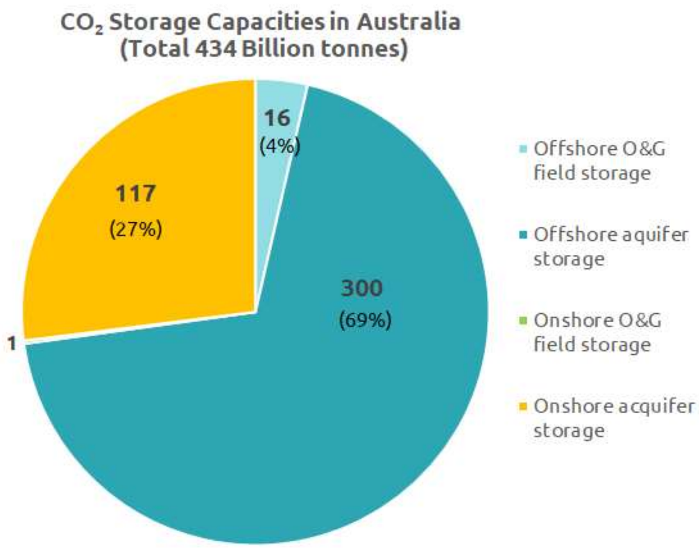


Figure 3: CO_2 Storage Capacities in Australia (O&G denotes oil and gas)[25]

Noting the recognition by the Contracting Parties of the London Protocol that

(a) CCS should not be considered as a substitute to other measures to reduce CO_2 emissions but considered as an important interim solution[26]; and

(b) not all countries have suitable sub-seabed geological formations for the sequestration of CO_2 streams[27]

Australia is favourably positioned to enable a series of domestic and transboundary CCS projects and offer significant contributions to the world for materially reducing CO_2 emissions by utilising its large potential geological CO_2 storage capacity.

That said, dCS notes that:

(c) as shown in the Figure 3 above, 316 billion tonnes (73%) of the potential CO_2 storage capacity resides in offshore Australia[28]; and

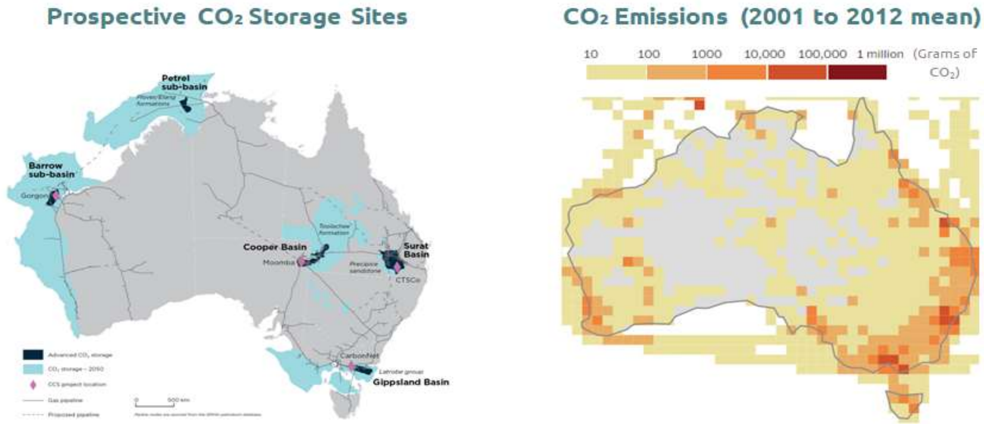
(d) as shown in the Figure 4 below, the prospective CO_2 storage sites are located hundreds of kilometres away from where Australia's CO_2 emission sources are located.

[25] Carbon Storage Taskforce (2009) "National Carbon Mapping and Infrastructure Plan – Australia" pages 28 and 31. Available at https://www.parliament.wa.gov.au/parliament/commit.nsf/($lookupRelatedDocsByID)/518FAC2BBA6C246648257C29002DB8E6/$file/NCM_Full_Report.pdf

[26] Resolution LP.5(14) on The Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (Adopted on 11 October 2019) Page 2. Available at https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.5(14).pdf

[27] Same as above.

[28] Carbon Storage Taskforce (2009) "National Carbon Mapping and Infrastructure Plan – Australia" pages 28 and 31. Available at https://www.parliament.wa.gov.au/parliament/commit.nsf/($lookupRelatedDocsByID)/518FAC2BBA6C246648257C29002DB8E6/$file/NCM_Full_Report.pdf



Source: Commonwealth of Australia (DISER) 2021

Source: The Washington Post 2015

Figure 4: Australia CO_2 Storage Sites versus CO_2 Emission Sources[29]

Since CCS projects considered to date in Australia use CO_2 pipeline transportation, this limits the number of CCS developments to those that have the emission sources and storage sites in proximity.

The key challenge for Australia to offer CCS to all of its industrial sectors as well as to other countries that do not have suitable sub-seabed geological formations within their jurisdictions is that the geological CO_2 storage sites and emission sources are not located in proximity.

4) **The technology maturity of CCS is high, with R&D activities for technologies related to large-scale liquefied CO_2 shipping and FSI Hub facilities needed to address the key challenge of distance between geological CO_2 storage sites and emission sources, lower cost barriers, and fully unlock Australia's geological CO_2 storage potential. In this regard, dCS seeks the Australian Commonwealth Government's policy support including grant funding for such R&D activities.**

Figure 5 shows the maturity of various technology elements of CCS in terms of Technology Readiness Level ("**TRL**") and Commercial Readiness Index ("**CRI**"), as evaluated by DNV GL[30] (DNV GL is an international accredited registrar and world's leading classification society[31]). The TRL is a measure used to rank different technologies according to their history of demonstration and qualification, while the CRI is a complement to TRL to assess commercial maturity.

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[29] Australian Commonwealth Government (2021) "Australia's Long Term Emissions Reduction Plan" and The Washington Post (2015) "Where Carbon Emissions Are Greatest." Available at https://unfccc.int/sites/default/files/resource/Australias_LTS_WEB.pdf and https://www.washingtonpost.com/graphics/national/carbon-emissions-2015/

[30] GASSNOVA (2020) "Developing Longship – Key Lessons Learned" page 44. Available at https://ccsnorway.com/app/uploads/sites/6/2020/11/Gassnova-Developing-Longship-FINAL.pdf

[31] More information on DNV GL available at https://www.dnv.com/about/index.html

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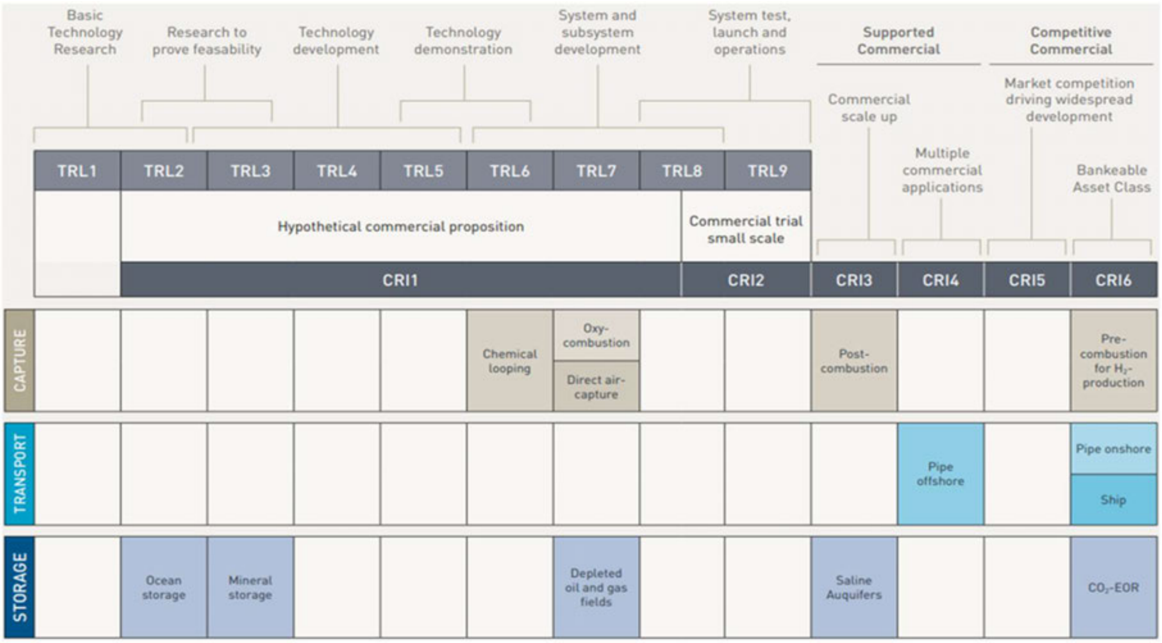

From "Potential for reduced costs for carbon capture, transport and storage value chains (CCS)", DNV GL, 2019. Report No.: 2019-1092, Rev. 2

Figure 5: Evaluation of the present state of technology maturity of CCS

As per the evaluation by DNV GL in Figure 5, dCS notes that:

(a) For capture technology:

The maturity of carbon capture technology is high, with that related to pre-combustion capture for hydrogen production rated as "CRI 6", and that related to post-combustion capture rated as "CRI 3." This is based on the wide use of such technologies by the oil and gas, Liquefied Natural Gas ("**LNG**") and coal industries since the "1930s for separating CO_2 from methane and for natural gas processing[32]."

With carbon capture technology increasingly being considered to decarbonize the power sector and other industries, new technologies are emerging reduce the cost of capture. Hence the maturity of carbon capture technologies varies depending on both the type of technology and the application. In that light, dCS welcomes the Australian Commonwealth Government's ongoing CCS policy support including the planned "Carbon Capture Technologies for Net Zero and Negative Emissions Program" to provide grant funding for R&D activities to lower cost barriers and enhance the technology readiness of CO_2 capture technology.

(b) For transport technology:

(1) Pipelines – This is the most common method of transporting very large quantities of CO_2. There are approximately 8,000 km of pipelines that can transport CO_2 today in

[32] Global CCS Institute (2021) "Technology Readiness and Costs of CCS" page 10. Available at https://www.globalccsinstitute.com/wp-content/uploads/2021/03/Technology-Readiness-and-Costs-for-CCS-2021-1.pdf

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North America[33]. Therefore, the technology readiness of pipelines is rated as "CRI 4" for offshore pipelines and "CRI 3" for onshore pipelines.

(2) Truck and rail (noting this is not mentioned in Figure 5 above) – This is possible for small quantities. Trucks are used at some project sites, moving the CO_2 from where it is captured to a nearby storage location[34]. Therefore, the technology readiness of truck and rail is rated as "CRI 3."

(3) Ship - CO_2 shipping is emerging as an essential transport option for CO_2, often when CO_2 emission sources and storage sites are too far apart for pipelines. Ship-based CO_2 transport relies on the refrigeration of CO_2 to liquefy it, making it denser and enabling ships to transport larger tonnages for a given volume. Shipment of CO_2 already takes place on a small scale in Europe, where ships transport food quality CO_2 (around 1,000 tonnes) from large point sources to coastal distribution terminals[35].

dCS notes that for ships that utilise a medium pressure and medium temperature regime which is the same as that used by the current fleet of CO_2 ships for the food and beverage industry in Europe the technology readiness is rated between "CRI 2 to 6" depending on the tank capacities per ship:

i. tank sizes that are less than 2,000m3 is "CRI 6" since these have been in operations for decades for the food and beverage industry.
ii. tank sizes that are between 2 000m3 and 7 500m3 is "CRI 4" noting that the Northern Lights CCS project in Norway being developed by Equinor is building two CO_2 ships with each having a tank size of 7,500m^3 and expecting delivery by mid-2024[36].
iii. tank sizes that are greater than 7 500m3 is "CRI 2" due to such sizes not being in existence to date but the tank sizes smaller than 7,500m3 already being commercially supported.

Furthermore, it is anticipated that larger scale shipment of CO_2, with capacities in the range of 10,000 to 40,000 cubic metres[37] (10,600 to 42,600 tonnes[38]), will likely be developed to facilitate longer open water shipping routes for the CCS industry using clean sheet designs. dCS together with its industry partner Mitsui O.S.K. Lines is pursuing the development of such large-scale liquefied shipping via its offshore CCS

33 Global CCS Institute (2021) "Global Status of CCS 2021" page 12. Available at https://www.globalccsinstitute.com/wp-content/uploads/2021/10/2021-Global-Status-of-CCS-Report_Global_CCS_Institute.pdf
34 Global CCS Institute (2015) "Transporting CO_2." Available at https://www.globalccsinstitute.com/archive/hub/publications/191083/fact-sheet-transporting-co2.pdf
35 Global CCS Institute (2015) "Transporting CO_2." Available at https://www.globalccsinstitute.com/archive/hub/publications/191083/fact-sheet-transporting-co2.pdf
36 Northern Lights JV (2021), "Northern Lights awarding ship building contracts." Available at https://norlights.com/news/northern-lights-awarding-ship-building-contracts/
37 Global CCS Institute (2015) "Transporting CO_2." Available at https://www.globalccsinstitute.com/archive/hub/publications/191083/fact-sheet-transporting-co2.pdf
38 Utilises a conversion factor (density ratio) of 1.065 tonnes per cubic meter of liquefied CO_2.

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project ("**CStore1**") development in Australia[39]. (For more information on CStore1, see Appendix 1 of this Submission.)

Regarding the maturity of technology related to large-scale liquefied CO_2 shipping, Equinor, who is the operator of the Northern Lights project highlights that[40]:

iv. Low pressure (and low temperature) ship studies could be key to reduce logistic costs, as larger ships could offer economies of scale.
v. Multiple studies have concluded that operating close to the triple point is acceptable although no actual de-risking of the operational challenges has been performed.
vi. The maturity level TRL 4 will not be available to be used for Northern Lights initial infrastructure but may be implemented in future extension.

Based on the above, dCS supports Equinor's view of the maturity of the technology for large-scale liquefied CO_2 shipping that utilise low pressure and low temperature regime to be TRL 3. For more information, see Appendix 2 of this Submission.

Regarding cost comparison among different modes of transportation (while noting that such comparison is subject to various factors such as volume, distance, site-specific conditions), Japan's Ministry of Economy Trade & Industry (METI) highlight (as per Figure 6) that[41]**:**

vii. Large volume CO_2 transportation enables cost reduction for both pipeline transportation and ship transportation; and

viii. Pipeline is advantage for short-distance CO_2 transport. Upon exceeding 200km of CO_2 transportation distance, shipping is lower cost. It is noted that the technical capability to manage "low temperature and low pressure" conditions for large volume transportation via CO_2 ships is essential.

[39] dCS (2022) "deepC Store signs LOI with Mitsui O.S.K. Lines and Technip Energies for Floating CCS Hub Development." Available at https://www.deepcstore.com/news/deepc-store-signs-loi-with-mol-and-ten-floating-ccs-hub-development
[40] Equinor (2020) "Northern Lights FEED Report," page 113. Available at https://norlights.com/wp-content/uploads/2021/03/Northern-Lights-FEED-report-public-version.pdf
[41] Japan's Ministry of Economy, Trade & Industry (METI) (2022), "CCS Long-term CCS Roadmap Investigative Commission Interim Summary" report (page 17). Available (in Japanese) at https://www.meti.go.jp/shingikai/energy_environment/ccs_choki_roadmap/20220527_report.html

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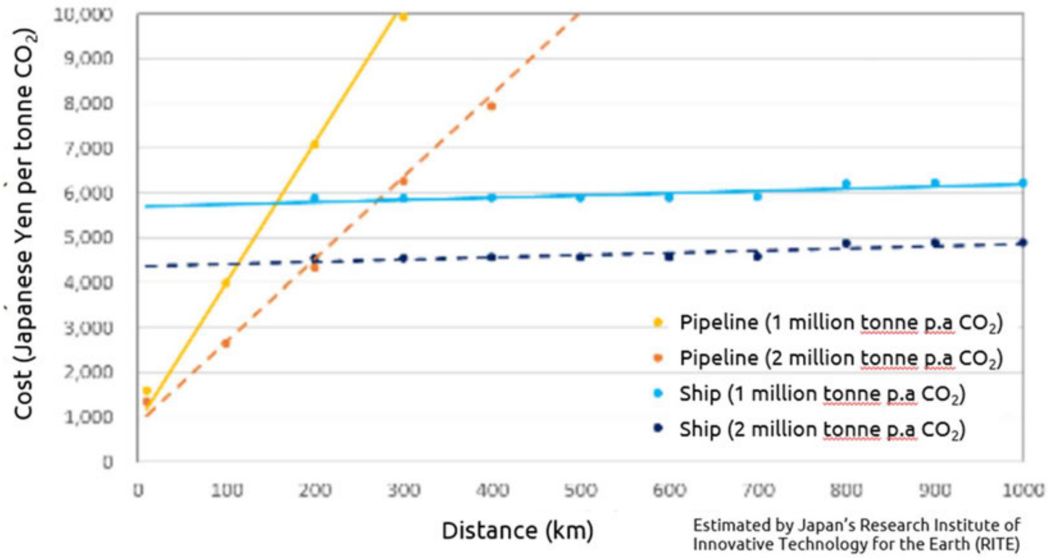

Figure 6: Comparison of pipeline and ship transport cost (in Japanese yen per tonne CO_2) as function of volume and distance[42]

Based on the above, dCS highlights that R&D activities are needed for the technology related to large-scale liquefied CO_2 shipping to address the key challenge of distance between geological CO_2 storage sites and emission sources lower cost barriers and fully unlock Australia's geological CO_2 storage potential.

(c) For Floating Injection and Storage ("**FSI**") Hub facility (noting this is not mentioned in Figure 5 above)

dCS together with its industry partners Technip Energies and Mitsui O.S.K. Lines are pursuing the development of the FSI Hub facility technology via its offshore CCS project development (CStore1) in Australia[43]. (For more information on CStore1, see Appendix 1 of this Submission.)

As shown in Figure 7, the FSI Hub facility is a multi-user hub infrastructure for receiving and storing CO_2 from multiple emission sources and industries.

[42] Japan's Ministry of Economy, Trade & Industry (METI) (2022), "CCS Long-term CCS Roadmap Investigative Commission Interim Summary" report (page 17). Available (in Japanese) at https://www.meti.go.jp/shingikai/energy_environment/ccs_choki_roadmap/20220527_report.html

[43] dCS (2022) "deepC Store signs LOI with Mitsui O.S.K. Lines and Technip Energies for Floating CCS Hub Development." Available at https://www.deepcstore.com/news/deepc-store-signs-loi-with-mol-and-ten-floating-ccs-hub-development

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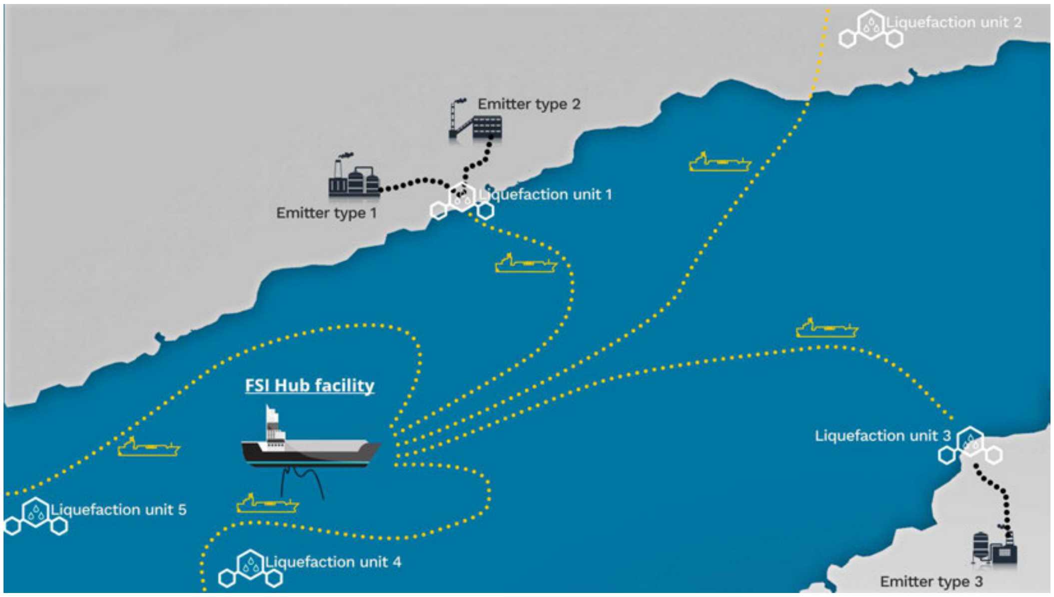

Figure 7: Image of FSI Hub facility (courtesy to Technip Energies for the image)

There is a range of key benefits associated FSI Hub facilities (noting that these benefits also apply for the utilisation of CO_2 ships), including:

(1) Multi-user: Compared to CCS projects that can be accessed by only one or very few designated CO_2 emitters due to limitations such as CO_2 pipeline distances and land use, the FSI Hub facility can offer CCS to any CO_2 emission source located along the coasts of Australia and overseas.

(2) Minimal pipeline distance with reduced environmental impacts: The FSI Hub facilities can be located in proximity to offshore CO_2 storage sites, minimising transport pipeline requirement. Together with the use of CO_2 ships, the FSI Hub facilities significantly reduce its onshore and offshore environmental impacts including land clearing and disturbance that result from pipeline, storage, and injection infrastructure installation.

(3) Reduced residual value risk: The FSI Hub facilities are relocatable, reducing the exposure to residual value risks such as those related to the CO_2 storage site performance.

(4) Replicable and scalable: Use of FSI Hub facilities minimises development constraints related to transport pipeline distances and land use. This enables replicability and scalability to fully unlock the Australian offshore potential CO_2 storage capacity and offer CCCS to wide range of CO_2 emission sources within and overseas.

Regarding the technical maturity of FSI Hub facilities, dCS rates this as "TRL 4" since much of the technology required to build and operate the FSI Hub is demonstrated by the offshore oil and gas, LNG, and maritime industries. For more information, see Appendix 2 of this Submission.

dCS therefore highlights that R&D activities are needed for the technology related to FSI Hub facilities to address the key challenge of distance between geological CO_2 storage sites

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and emission sources lower cost barriers and fully unlock Australia's geological CO_2 storage potential.

(d) For geological storage technologies:

(1) CO_2 Enhanced Oil Recovery ("**CO_2-EOR**"): CO_2-EOR has been practiced for many decades as a means to enhance the recovery of oil from depleted reservoirs, especially onshore. 14 operating commercial-scale CCUS projects already use CO_2-EOR and there is a significant amount of existing experience and knowledge, which has enabled CO_2-EOR to reach the highest level of technology maturity and operates commercially with bankable assets[44]. Based on this the maturity of CO_2-EOR technology is rated "CRI 6."

(2) Saline Aquifers: Saline formations have been used for CO_2 storage at commercial scale projects, including Sleipner CO_2 Storage (offshore), Snøhvit CO_2 Storage (onshore capture, offshore storage) and Quest (onshore)[45]. The injection and storage of around 1 Mtpa CO_2 at individual sites is technically viable, demonstrated by five currently operating industrial scale projects injecting into saline aquifer systems[46]. Based on this the maturity of technology for using saline aquifers as geological storage is rated "CRI 3."

(3) Depleted oil and gas fields: Geological storage in depleted oil and gas fields is technically mature (i.e. substantively no different to storage in saline aquifers) but has a lower TRL of 7 as it has only been applied in demonstration projects[47]. Twelve pilot or demonstration projects have utilised depleted oil and gas fields[48]. Commercial maturity is imminent with at least eight projects in the CCS pipeline actively pursuing storage in depleted oil and gas fields especially in the North Sea[49]. Based on this the maturity of technology for using depleted oil and gas fields as geological storage is rated "TRL 7."

dCS highlights that the geological storage technologies are sufficiently mature for commercial deployment.

Based on the content above dCS concludes that the technology maturity of CCS is high with R&D activities for technologies related to large-scale liquefied CO2 shipping and FSI Hub facilities needed to address the key challenge of distance between geological CO2 storage sites and emission sources lower cost barriers and fully unlock Australia's geological CO2 storage potential. In this regard dCS seeks the Australian Commonwealth Government's policy support including grant funding for such R&D activities.

5) While the geological storage technology is mature for commercial deployment, the key to successful geological storage is to correctly select and appraise suitable geological storage sites. This will allow for the intended environmental benefits of material CO_2 emissions

[44] DNVGL (2019) "Potential for reduced costs for carbon capture, transport and storage value chains (CCS)" page 11. Available at https://ccsnorway.com/app/uploads/sites/6/2020/07/Report-Cost-reduction-curves-for-CCS-Gassnova-version-2b-1.pdf
[45] Same as above.
[46] Same as above.
[47] Global CCS Institute (2021) "Technology Readiness and Costs of CCS" page 23. Available at https://www.globalccsinstitute.com/wp-content/uploads/2021/03/Technology-Readiness-and-Costs-for-CCS-2021-1.pdf
[48] Same as above.
[49] Same as above.

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reduction to be delivered and also for the environmental impacts associated with building and operating a series of domestic and transboundary CCS projects to be prudently managed.

As mentioned above, dCS shares the industry view that the geological storage technology is mature for commercial deployment. That said, dCS cannot overemphasize that the key to successful geological storage is to correctly select and appraise suitable geological storage sites.

CSIRO highlights that[50]:

(a) the selection of a suitable site is the first step and the most critical part of any project development. For example, proximity to groundwater or other hydrocarbon resources may eliminate a prospective site. Faults are of particular importance as they can act either as barriers to constrain the size of the container, hence limiting the capacity, a conduit to another reservoir, or have no impact at all. Wells (injection, monitoring and legacy) are a recognised risk of vertical migration of small volumes of CO_2.

(b) The highest risk associated with CCS is the economic risk that once investment occurs the storage container is either too small or the injectivity is insufficient to justify the capital investment.

dCS further notes that:

(c) while excellent foundation work funded by the Australian Commonwealth Government has been conducted in the past for enhancing the regional understanding of geological storage prospectivity of CO_2 in Australia, the site-specific work needed to select and appraise suitable geological storage site has not yet been undertaken. dCS additionally notes that the outputs and supporting details of the said work conducted in the past, while being funded by the Australian Commonwealth Government, are not all publicly accessible; and

(l) lessons learned such as those from the 2008 ZeroGen project in Queensland[51] and the Gorgon CCS project in Western Australia[52] show that sufficient site-specific geological work is crucial to avoid project cancellations and suboptimal project performance.

6) Australia has mature regulatory frameworks, that are compatible with the London Protocol, to manage the environmental impacts associated with building and operating a series of domestic and transboundary CCS projects while unlocking material environmental benefits from CO_2 emission reduction.

Commercial scale CCS projects (with CCS capacity of 1+ million tonnes per annum per project) are in essence large-scale infrastructure projects. Each of these will require major up-front capital expenditure (between hundreds of millions to multi billion Australian Dollars per project)

[50] CSIRO (2022) "Australia's sequestration potential" page 134. Available at https://www.csiro.au/en/research/environmental-impacts/emissions/carbon-sequestration-potential

[51] A J Garnett, C R Greig, M Oettinger (University of Queensland) (2014) "ZeroGen, IGCC with CCS, A Case History" Page xxiii. Available at https://energy.uq.edu.au/files/1084/ZeroGen.pdf

[52] Chevron Australia (2019) "Gorgon Gas Development and Jansz Feed Gas Pipeline Environmental Performance Report 2021" page 44. Available at https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-gas-development-and-jansz-feed-gas-pipeline-environmental-performance-report-2021.pdf

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to build and involve a long period of operations and maintenance (25+ years per project) to offer its intended environmental benefits of material CO_2 emissions reduction.

Due to this very nature each commercial scale CCS project will likely require full environmental and safety case approvals. In addition, dCS expects that a significant number of government approvals from a range of different Australian Commonwealth and State or Territory Government Agencies will be required to enable each CCS project. dCS also notes that the context, planning framework and requirements for Australian Commonwealth and State or Territory Government approvals are dependent on:

(a) CO_2 emitter site location(s),

(b) the CO_2 storage site location,

(c) Other site-specific factors, for example the ability to use existing infrastructure at the emitter site location(s)

Above said and within the context of fulfilling the intent of the London Protocol, dCS expects that the following approvals would be required for developing, operating and maintaining commercial scale CCS projects that utilise geological storage site located within the jurisdiction of the Australian Commonwealth Government.

(d) Referral under the Environment Protection and Biodiversity Conservation Act 1999 ("**EPBC Act**")

(e) Offshore Project Proposal

(f) Sea Dumping Permit

(g) National Greenhouse and Energy Reporting Act 2007 ("**NGERS**") Reporting

(h) Section 22 Application and Project Plan required under the Carbon Credits (Carbon Farming Initiative—Carbon Capture and Storage) Methodology Determination 2021 (dCS notes that the applicability of this is subject to the outcome of the Safeguard Mechanism reform)

(i) Approved Ship Security Plan (if CO_2 ships are to be used for CO_2 transport)

(j) Domestic Commercial Vessel Certificate of Survey and Certificate of Operation (if CO_2 ships are to be used for CO_2 transport)

(k) Safety Cases

(l) Well Operations Management Plan

(m) Environment Plan

These approvals will be sought in accordance with laws that dCS deems to be compatible with the London Protocol and that have been heavily utilised by the oil & gas and LNG industries for developing major capital projects including the EPBC Act and the Offshore Petroleum and Greenhouse Gas Storage Act 2006 ("**OPGGS Act**").

For CCS projects that utilise geological storage site located within the jurisdiction of the Australian State or Territory Government Approvals dCS notes that some Australian State and Territory jurisdictions are yet to establish their relevant CCS legislation. dCS expects that (and plans to participate in the stakeholder consultation processes to confirm that) the future establishment of the said CCS legislations will take into account the regulatory frameworks and other

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requirements set by the Australian Commonwealth Government and the London Protocol. That said and assuming for illustration purposes that a commercial scale CCS projects is to be developed operated and maintained by utilising a geological storage site located within the jurisdiction of Western Australia ("**WA**"), dCS expects that the following government approvals would be required (in addition to those that may be required under the CCS legislation that is undergoing the process of establishment in WA):

(n) Referral under the Environmental Protection Act 1986 (WA)

(o) Major Hazard Facility (MHF) Safety Case

(p) Dangerous Goods Storage Licence

(q) Development Application

(r) Building Licences

These approvals will be sought in accordance with laws that dCS deems to be compatible with the London Protocol and that have been heavily utilised by the oil & gas and LNG industries for developing major capital projects.

Based on the above dCS highlights that Australia has mature regulatory frameworks that are compatible with the London Protocol to manage the environmental impacts associated with building and operating a series of domestic and transboundary CCS projects while unlocking material environmental benefits from CO_2 emission reduction.

7) **dCS requests, by no later than 2025, for the Australian Commonwealth Government to not only (1) accept the 2009 Amendment to the London Protocol for supporting ratification, but to also (2) submit its declarations on the provisional application of the 2009 Amendment to Article 6 with the IMO, and (3) execute agreements or arrangements between prospective CO_2 exporting countries in the Asia Pacific region such as Japan, Korea and Singapore for enabling a series of transboundary CCS projects in Australia.**

While the 2009 Amendment effectively allows CO_2 streams to be exported for CCS purposes (provided, that the protection standards of all other requirements have been met) between cooperating countries, the 2009 Amendment is not yet in force as it needs to be ratified by being formally accepted by two-thirds of the Contracting Parties to the London Protocol[53].

Noting that:

(a) subsequent to the adoption (but not ratification) of the 2009 Amendment, the following key guidelines have been adopted by the Contracting Parties of the London Protocol to address the responsibilities of the Parties engaging in transboundary CCS activities (i.e. permitting characterization of the chemical and physical properties of the CO_2 Stream, disposal site selection and characterization, assessment of potential exposures and effects, verification the compliance, monitoring and risk management arrangements, mitigation or remediation planning).

[53] London Protocol (1996), Article 21. Available at https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/PROTOCOLAmended2006.pdf

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(1) 2012 Specific Guidelines for the Assessment of CO_2 for Disposal into Sub-seabed Geological Formations (Adopted November 2012)[54]

(2) Guidance on the Implementation of Article 6.2 on the Export of CO_2 Streams for Disposal in Subseabed Geological Formations for the Purpose of Sequestration (Adopted October 2013)[55]

(b) subsequent to the adoption (but not ratification) of the 2009 Amendment, "a number of CCS projects around the North Sea basin that planned to receive CO_2 from other sources (including from other countries, for geological storage in sub-seabed formations) were moving forward, with the lack of acceptances of the 2009 Amendment to the London Protocol identified as a legal and regulatory barrier to these projects[56]." This has subsequently led to the development, discussion and adoption by the Contracting Parties of the London Protocol of the provisional application of the 2009 Amendment to the London Protocol. Based on similar needs identified by other jurisdictions, 7 countries (Belgium, Denmark, Netherlands, Norway, Republic of Korea, Sweden, and United Kingdom) have deposited declarations on the provisional application of the 2009 Amendment with the IMO to date[57].

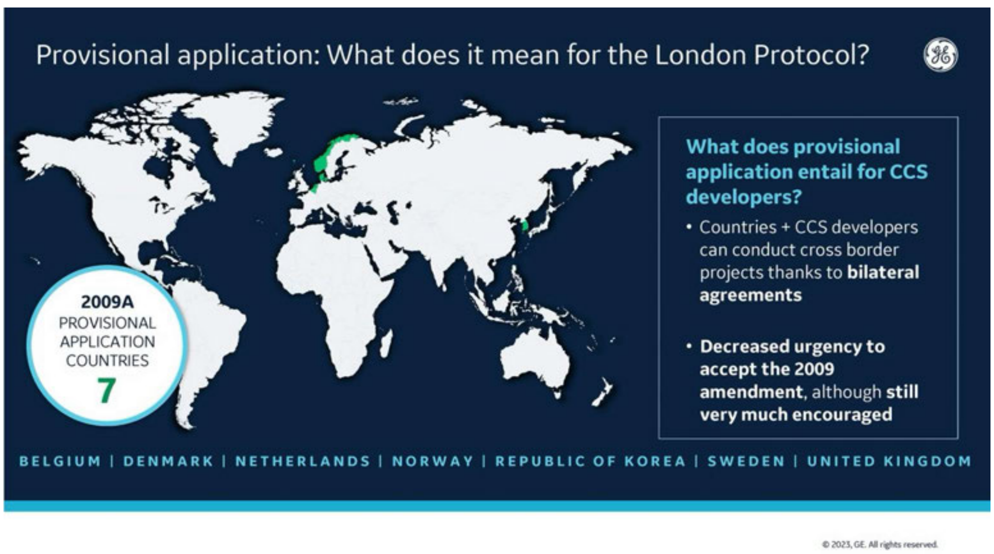

Figure 8: Status of deposited declarations on the provisional application of the 2009 Amendment (courtesy to GE Gas Power and Global CCS Institute for the image)

54 2012 Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-seabed Geological Formations.LP.7. LC 34/15, Annex 8. 2012. Available at https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/2012%20SPECIFIC%20GUIDELINES%20FOR%20THE%20ASSESSMENT%20OF%20CARBON%20DIOXIDE.pdf

55 Guidance on the Implementation of Article 6.2 on the Export of CO_2 Streams for Disposal in Subseabed Geological Formations for the Purpose of Sequestration. LC 35/15 Annex 6. 2013. Available at https://www.umweltbundesamt.de/sites/default/files/medien/381/dokumente/london_protocol_-_lc_35-15_-_report_of_the_thirty-fifth_consultative_meeting_and_the_eight_meeting_of_the_contracting_parties.pdf

56 IEAGHG (2021), "Exporting CO_2 for Offshore Storage -The London Protocol's Export Amendment and Associated Guidelines and Guidance," page 6. Available at: https://www.club-co2.fr/files/2021/04/IEAGHG-2021-TR02-Exporting-CO2-for-Offshore-Storage-The-London-Protocol-s-Export-Amendment-and-Associated-Guidelines-and-Guidance.pdf

57 GE Gas Power and Global CCS Institute (2023), "The London Protocol: Is it the answer to carbon capture? webinar, hosted by GE Gas Power" presentation (as per figure 8, with courtesy to GE Gas Power and Global CCS Institute for the image).

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(c) the national acceptance processes of the 2009 Amendment have shown to be time consuming and the lack of acceptances of the 2009 Amendment is a legal and regulatory barrier to develop transboundary CCS projects in Australia.

(d) Contracting Parties of the London Protocol including Australia recognises (from the conclusion of Contracting Parties in 2008 (document LP 30/16) that the London Protocol should not constitute a barrier to the transboundary movement of CO_2 streams to other States for disposal as a measure to mitigate climate change and ocean acidification[58].

(e) dCS and other Australian CCS project proponents have confirmed sufficient interest from CO_2 emitters in Japan and other countries in the Asia Pacific region for transboundary CCS project development that will be operational ready by 2030 to meet their interim net-zero targets, including;

1) Agreement executed with Nippon Steel Corporation (Japan's largest steel producer) to provide up to 5 million tonnes of CO_2 per annum to dCS's offshore CCS project (CStore1) in Australia[59];
2) Agreement executed with Kansai Electric Power (Japan's 2nd largest power utility) to consider developing a supply chain for capturing and transporting up to 10 MTPA of CO_2 from KEPCO's power station to dCS's offshore CCS project (CStore1) in Australia [60];

dCS highlights that the legal and regulatory barrier to develop transboundary CCS projects in Australia need to be addressed by no later than 2025 for such projects to be operational ready by 2030.

Based on the above, dCS requests by no later than 2025 for the Australian Commonwealth Government to (1) not only accept the 2009 Amendment to the London Protocol for supporting ratification, but to also (2) submit its declarations on the provisional application of the 2009 Amendment with the IMO and (3) execute agreements or arrangements between prospective CO_2 exporting countries in the Asia Pacific region such as Japan Korea and Singapore for enabling a series of transboundary CCS projects in Australia.

Upon consideration by the Australian Commonwealth Government to address dCS's request mentioned above dCS highlights that:

[58] Resolution LP.5(14) on The Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (Adopted on 11 October 2019) Page 2. Available at https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.5(14).pdf

[59] More information on dCS's agreement with Nippon Steel available at: https://www.nipponsteel.com/en/news/20220214_100.html

[60] More information on dCS's agreement with Kansai Electric Power available in Japanese at https://www.kepco.co.jp/corporate/notice/notice_pdf/20221130_2.pdf and in English at https://www.deepcstore.com/news/co2offtake-kepco-deepcstore

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(f) (as mentioned above) 7 countries (Belgium, Denmark, Netherlands, Norway, Republic of Korea, Sweden, and United Kingdom) have deposited declarations on the provisional application of the 2009 Amendment with the IMO to date[61];

(g) Contracting Parties of the London Protocol recognize that those who utilise the provisional application of the 2009 Amendment to the London Protocol for enabling transboundary CCS projects are "urged (via the adoption by the Contracting Parties of the provisional application of the 2009 Amendment to the London Protocol) to share the information on the provisional application of the 2009 Amendment, including agreements or arrangements entered into between exporting and receiving States and experience with the application of the 2012 Specific Guidelines for the assessment of CO_2 for disposal into subseabed geological formations[62]."

dCS trusts that Australia will be in a position to meet dCS's request by (1) seeking open sharing of information and experience from other Contracting Parties of the London Protocol who have set precedence for enabling transboundary CCS projects and (2) leveraging the precedence set to cater to the needs for enabling a series of transboundary CCS projects in Australia.

8) Other considerations regarding the 2009 Amendment to the London Protocol are as follows:

(a) Need to develop a National Action List for the assessment of CO_2 streams for sequestration

Noting the following matters as stated in the London Protocol[63], dCS highlights the need to develop a National Action List for the assessment of CO_2 streams for sequestration.

1) CO_2 streams from CO_2 capture processes for sequestration may only be considered for dumping, if:
   i. disposal is into a sub-seabed geological formation; and
   ii. they consist overwhelmingly of CO_2. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and
   iii. no wastes or other matter are added for the purpose of disposing of those wastes or other matter.
2) Each Contracting Party shall develop a national Action List to provide a mechanism for screening candidate wastes and their constituents on the basis of their potential effects on human health and the marine environment.

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[61] GE Gas Power and Global CCS Institute (2023), "The London Protocol: Is it the answer to carbon capture? webinar, hosted by GE Gas Power" presentation (as per Figure 8 in this Submission, , with courtesy to GE Gas Power and Global CCS Institute for the image).

[62] Resolution LP.5(14) on The Provisional Application of the 2009 Amendment to Article 6 of the London Protocol (Adopted on 11 October 2019) Page 3. Available at https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.5(14).pdf

[63] 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (as amended in 2006)," page 17 – 18, and 20. Available at https://www.epa.gov/sites/default/files/2015-10/documents/lpamended2006.pdf

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dCS understands that the Sea Dumping Section of the Department of Climate Change, Energy, the Environment and Water ("**DCCEEW**") is addressing this matter, and has provided the following information to relevant members of the Sea Dumping Section of DCCEEW**:**

3) CO_2 supply specification for dCS's offshore CCS hub project; and
4) CO_2 supply sources for dCS's offshore CCS hub project.

dCS is happy to further engage, upon request, with relevant members of DCCEEW to complete the development of the National Action List for the assessment of CO_2 streams for sequestration.

(b) Economic and social benefits that the development of each domestic and transboundary CCS project can offer for Australia

In addition to the CO_2 emission reduction volumes, dCS (and other CCS project proponents) expects to deliver the following benefits via its CCS project development.

1) generation of direct economic benefits for progressing the R&D activities and other development activities to build, operate and maintain CCS projects;
2) generation of direct and indirect Australian jobs for progressing the R&D activities and other development activities to build, operate and maintain CCS projects; and
3) generation of corporate tax during the period of operating and maintaining CCS projects.

While the quantification of these benefits is work-in-progress, dCS highlights again that commercial scale CCS projects (with CCS capacity of 1+ million tonnes per annum per project) are in essence large-scale infrastructure projects. Each of these will require major up-front capital expenditure (between hundreds of millions to multi billion Australian Dollars per project) to build and involve a long period of operations and maintenance (25+ years per project) to offer its intended environmental benefits of material CO_2 emissions reduction.

dCS therefore highlights the significant economic and social benefits that the development of each domestic and transboundary CCS project can offer for Australia.

In the context dCS is happy to further engage upon request with relevant members of DCCEEW to share information on the quantification of these benefits.

2. Regarding the environmental benefits and impacts of marine geoengineering activity, such as ocean fertilisation, for scientific research:

dCS refrains from commenting in relation to this matter.

3. Regarding the international market for CO_2 streams

As mentioned above in section 1.2 of this Submission:

1) IEA highlights that globally, some 230 million tonnes of CO_2 are used every year by conventional users (e.g. fertiliser, oil and gas, food and beverage industries)[64]. This equates to less than 1%

[64] IEA (2019): "Putting CO_2 to Use – Creating Value from Emissions." Available at https://www.iea.org/reports/putting-co2-to-use

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of total global CO_2 emissions from energy combustion and industrial processes (36.8 billion tonnes in 2022)[65].

2) While the international market for CO_2 streams for direct use by conventional users may grow the international market for physical CO_2 streams for CCU will likely remain relatively small (~5% of CCUS[66]).

Therefore, CCU can complement CCS, but is not an alternative to CCS.

4. Regarding the interaction of the proposed amendments with greenhouse gas inventories and regulatory and reporting streams.

1) For transboundary CCS activities Australia can manage the interaction of the proposed 2009 Amendment with its greenhouse gas inventories and regulatory and reporting streams by using its existing CCS policies and legal frameworks. In that context, dCS notes that Australia's National Inventory Reports 2020 (submitted in May 2022)

   (a) already includes information on "fugitive emissions of greenhouse gases associated with the capture, transport, injection and long-term geological storage of greenhouse gases, with the Gorgon LNG project (the first of its kind in Australia) commencing trials of the CO_2 underground injection system at the Gorgon natural gas facility in August 2019[67]; and

   (b) states that for the Gorgon and future commercial CCS projects, the Department of Industry, Science, Energy and Resources sources estimates of fugitive emissions of greenhouse gases associated with the capture, transport, injection and long term geological storage of greenhouse gases from data collected under the NGER Scheme[68].

2) For marine geoengineering activities, dCS refrains from commenting on this matter.

I thank you very much for the opportunity to make a Submission. For any questions or comments on this matter, please contact Daein Cha.

Kind regards,

[redacted]

Daein Cha
Managing Director and Chief Executive Officer
DEEPC STORE PTY LTD

[65] IEA (2023): "CO_2 Emissions in 2022" page 3. Available at https://iea.blob.core.windows.net/assets/3c8fa115-35c4-4474-b237-1b00424c8844/CO2Emissionsin2022.pdf

[66] IEA (2020) "CO_2 Capture and Utilisation" and IEA (2020) "Net Zero by 2050 A Roadmap for the Global Energy Sector" page 79. Available at https://www.iea.org/reports/co2-capture-and-utilisation and https://www.iea.org/reports/net-zero-by-2050.

[67] Australian Commonwealth Government (2022), "Australia's Tracking and reporting greenhouse gas emissions" page xxiii of Volume 1. Available at: https //www.dcceew.gov.au/sites/default/files/documents/national-inventory-report-2020-volume-1.pdf

[68] Australian Commonwealth Government (2022), "Australia's Tracking and reporting greenhouse gas emissions" page 166 of Volume 1. Available at: https //www.dcceew.gov.au/sites/default/files/documents/national-inventory-report-2020-volume-1.pdf#page=189&zoom=100 0 0

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Appendix 1 – Overview of deepC Store Limited ("dCS")

dCS is an Australian company headquartered in Perth and a CCS project developer and operator. Our flagship project "**CStore1**" has a first mover position in the Asia Pacific region as an offshore floating CCS hub (image below). CStore1 covers all of the value chain of CCS, that is, liquefaction of CO_2 onshore, transport by ships to the hub, and injection from the floater.

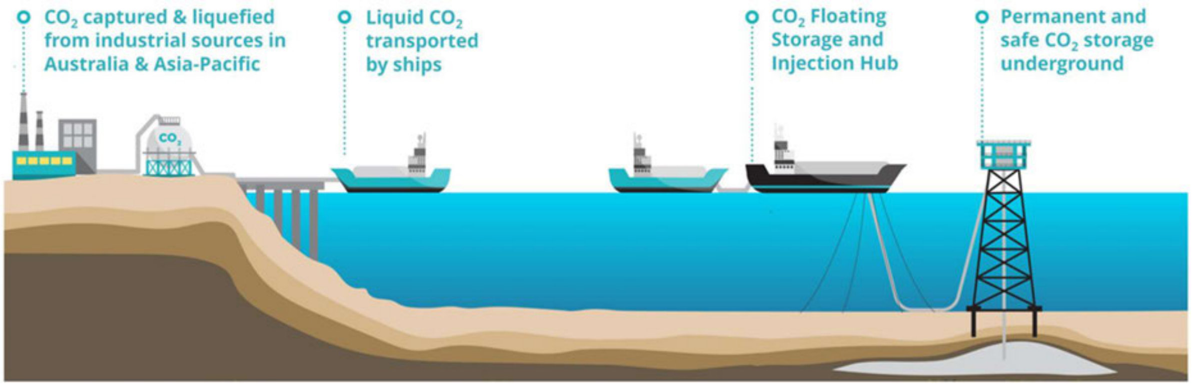

Image of CStore1

dCS partners with Commonwealth Scientific and Industrial Research Organisation (CSIRO) and world class energy companies Add Energy Group, JX Nippon Oil and Gas Exploration Corporation ("**JX NOEX**"), Kyushu Electric Power, Mitsui O.S.K. Lines, Osaka Gas and Osaka Gas Australia, Technip Energies and Toho Gas to deliver CStore1[69]. Our partners bring significant experience and expertise to develop our CStore1, including those as technical experts, operators of large-scale industrial facilities and ships, potential CO_2 suppliers and prospective investors in CStore1. Key development milestones include:

1. Agreement executed with Nippon Steel Corporation (Japan's largest steel producer) to provide up to 5 million tonnes of CO_2 per annum to CStore1[70];
2. Agreement executed with Kansai Electric Power (Japan's 2nd largest power utility) to consider developing a supply chain for capturing and transporting up to 10 MTPA of CO_2 from KEPCO's power station to CStore1[71];
3. Joint bid submitted with JX NOEX for GHG acreage offshore Australia[72];
4. Shares subscription agreement executed with PGS[73]; and
5. Letter of Intent executed with Mitsui O.S.K. Lines and Technip Energies in relation to the Pre-FEED, FEED, EPCI and O&M services for the FSI Hub facility for CStore1[74].

CStore1 is currently in pre-FEED phase, with operations aimed to start by 2030.

End

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[69] More information on dCS's CStore1 Partners available at: https://www.deepcstore.com/cstore1-partners
[70] More information on dCS's agreement with Nippon Steel available at: https://www.nipponsteel.com/en/news/20220214_100.html
[71] More information on dCS's agreement with Kansai Electric Power available in Japanese at https://www.kepco.co.jp/corporate/notice/notice_pdf/20221130_2.pdf and in English at https://www.deepcstore.com/news/co2offtake-kepco-deepcstore
[72] More information on dCS's joint bid with JX NOEX available at: https://www.nex.jx-group.co.jp/english/newsrelease/2022/joint_bid_for_a_greenhouse_gas_assessment_permit_for_a_greenhouse_gas_storage_acreage_release_area_i.html
[73] More information on dCS's shares subscription agreement with PGS available at: https://www.pgs.com/media-and-events/news/pgs-and-deepc-store-sign-share-subscription-agreement/
[74] More information on dCS's letter of intent available at: https://www.technipenergies.com/en/media/news/technip-energies-deepc-store-and-mitsui-osk-lines-join-forces-floating-carbon-capture-storage-hub

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Appendix 2 – Technology Maturity for Large-Scale Liquefied CO_2 Shipping and FSI Hub Facilities

1. Large-scale liquefied CO_2 shipping

Regarding the maturity of technology related to large-scale liquefied CO_2 shipping, Equinor, who is the operator of the Northern Lights project highlights that[75]:

1) Low pressure (and low temperature) ship studies could be key to reduce logistic costs, as larger ships could offer economies of scale.
2) Multiple studies have concluded that operating close to the triple point is acceptable although no actual de-risking of the operational challenges has been performed.
3) The maturity level TRL 4 will not be available to be used for Northern Lights initial infrastructure but may be implemented in future extension.

<u>Based on the above, dCS supports Equinor's view of the maturity of the technology for large-scale liquefied CO_2 shipping being TRL 3.</u>

To also provide context regarding the point raised by Equinor on "operating close to the triple point," this refers to the risks and challenges associated with operating the CCS project close to the triple point (approx. 5.2 bara, -56.6 °C). DNV GL highlights that[76]:

4) At the triple point, the CO_2 can be present in solid, liquid and gas phases. This has potential implications on the transportation chain. A reduced margin to the triple point leads to an increased risk of dry ice formation, which may threaten the reliability of cargo handling operations.
5) Another challenge with a low-pressure solution is the low temperature. Identifying suitable materials for the entire value chain – such as cargo piping, storage tanks and a liquefication plant – is therefore vital to operationalizing a low-pressure value chain. For the containment system, extra-high-tensile steel is anticipated to be a possible solution for increasing the tank size while limiting the cost. However, the performance at a low temperature needs to be proven.

2. FSI Hub facilities

Regarding the FSI Hub facility, dCS notes that:

1) much of the technology required to build and operate the FSI Hub is demonstrated by the offshore oil and gas, Liquefied Natural Gas ("**LNG**"), and maritime industries; and
2) a facility that is technically comparable to the FSI Hub is the Floating Storage and Regasification Unit ("**FSRU**"). FSRU is an LNG storage ship that has an onboard regassification plant capable of conditioning LNG into a gaseous state and supplying it directly into the gas network. Having

[75] Equinor (2020) "Northern Lights FEED Report," page 113. Available at https://norlights.com/wp-content/uploads/2021/03/Northern-Lights-FEED-report-public-version.pdf
[76] DNV GL (2021) "CO_2 Efficient Transport via Ocean – CETO." Available at https://www.dnv.com/maritime/jip/ceto/background.html

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a technical maturity of CRI 6, there are 45 active FSRUs in the world as of 2022[77] (image of an FSRU below).

Figure 9: Image of Mitsui O.S.K. Lines ("MOL") FSRU "Challenger"

FSRUs are comparable to FSI Hub facilities because the FSRU:

3) receives and stores cryogenic gas (LNG with high quality specification) at an offshore location; and

4) conditions the LNG (regasification) and supplies it from an offshore location, directly into the gas network.

Similarly, the FSI Hub facilities:

5) receive and store cryogenic gas (liquefied CO_2 with high quality specification) at an offshore location; and

6) condition the liquefied CO_2 and supplies it from at an offshore location, directly into the CO_2 storage site.

More specifically regarding each of the key technical functionality of the FSI Hub as demonstrated in the context of CO_2, dCS highlights that:

7) Offshore offloading of CO_2 has not occurred to date. However, technologies and products have been developed and are used for the offshore transfer of LNG that provides for more extreme conditions (hoses rated to 20 bara and -196°C) than is required for liquid CO_2 transfer[78].

8) Offshore injection of CO_2 (comingled with natural gas) from a floating vessel has been conducted by the Tupi Project offshore Brazil since 2013. Gas reinjection has also been used globally for at least 50 years, with CO_2 injection using the same proven technology.

[77] International Gas Union (2022) "World LNG Report 2022" (page 61). Available at https://www.igu.org/resources/world-lng-report-2022/

[78] Peter Brownsort, 2015 "Offshore offloading of CO_2 - Review of single point mooring types and suitability," pages 8 and 14. Available at https://www.pure.ed.ac.uk/ws/portalfiles/portal/57628535/SCCS_CO2_EOR_JIP_Offshore_offloading.pdf

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9) Other contemporary CCS projects are planned based on the use an FSI Hub facilities, including the Stella Maris Project in the North Sea planning to use an FSI Hub facility to inject up to 10 MTPA of CO_2[79].

Based on all of the subsystems being used in established industries dCS evaluates that the FSI Hub facility has a technical maturity of "TRL 4."

End

[79] Altera Infra, 2023 "One step closer to realising Stella Maris CCS." Available at https //alterainfra.com/articles/one-step-closer-to-realising-stella-maris-ccs